Crop dynamics in the Neolithic period in the NW Mediterranean area and the Swiss Plateau

The role of opium poppy (*P. somniferum/setigerum*)

Inauguraldissertation
zur Erlangung der Würde eines Doktors der Philosophie
vorgelegt der
Philosophisch-Naturwissenschaftlichen Fakultät
der Universität Basel

von

Ana Cláudia Sousa Jesus
aus Porto, Portugal

Basel, 2022

Genehmigt von der Philosophisch-Naturwissenschaftlichen Fakultät

auf Antrag von

Dr. Ferran Antolín, Dr. Laurent Bouby, Prof. Dr. Sabine Deschler-Erb und Prof. Dr. Natàlia Alonso Martínez

Basel, 14. Dezember 2021

Prof. Dr. Marcel Mayor

Dekan

Publications associated with this research

Paper 1

Jesus, A., Prats, G., Follmann, F., Jacomet, S., & Antolín, F. (2021). Middle Neolithic farming of open-air sites in SE France: new insights from archaeobotanical investigations of three wells found at Les Bagnoles (L'Isle-sur-la-Sorgue, Dépt. Vaucluse, France). *Vegetation History and Archaeobotany, 30*(4), 445–461. https://doi.org/10.1007/s00334-020-00793-z

Paper 2

Jesus, A., Bonhomme, V., Evin, A., Ivorra, S., Soteras, R., Salavert, A., Antolín, F., & Bouby, L. (2021). A morphometric approach to track opium poppy domestication. *Scientific Reports, 11*(1), 9778. https://doi.org/10.1038/s41598-021-88964-4

Paper 3

Jesus, A., Bonhomme, V., Evin, A., Soteras, R., Jacomet, S., Bouby, L. & Antolín, F., First spread, then domestication? Morphometrics of archaeological seeds suggest the pathway of domestication of *Papaver somniferum* in the Western Mediterranean. To be submitted in PLOS ONE

<u>Other papers within the project:</u>

Antolín, F., Bouby, L., Martin, L., Rottoli, M., **Jesus, A.** (accepted, to be published in 2021): Archaeobotanical evidence of plant food consumption among early farmers (5700-4500 BC) in the Western Mediterranean region. Food & History.

de Vareilles, A., Bouby, L., **Jesus, A.**, Martin, L., Rottoli, M., Vander Linden, M., & Antolín, F. (2020). One sea but many routes to Sail. The early maritime dispersal of Neolithic crops from the Aegean to the western Mediterranean. *Journal of Archaeological Science: Reports, 29*(April 2019), 102140. https://doi.org/10.1016/j.jasrep.2019.102140

van Willigen, S., André, G., Antolín, F., Bader, M., Follmann, F., Jacomet, S., **Jesus, A.**, Quesnel, Y., & Denaire. (2020). Déroulement des opérations et moyens mis en œuvre. In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 87–100). Presses Universitaires de Provence.

van Willigen, S., Antolín, F., Brochier, J., D'Anna, A., Follmann, F., Jacomet, S., **Jesus, A.**, Reggio, A., Schäfer, M., Schibler, J., & Schmitt, A. (2020). Les apports du site pour la connaissance du Néolithique moyen. In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 281–352). Presses Universitaires de Provence.

Antolín, F., Delefosse, C., Errera, M., Follmann, F., Jacomet, S., **Jesus, A**., Kühn, M., Pétrequin, P., Schäfer, M., Schibler, J., Reggio, A., & van Willigen, S. (2020). Les structures attribuables au Néolithique moyen de type La Roberte (fin du Ve millénaire-début de l'Ive millénaire avant notre ère). In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt

(Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 229–280). Presses Universitaires de Provence.

Antolín, F., Schimitt, A., Bader, M., D'Anna, A., Delefosse, C., Errera, M., Follmann, F., Jacomet, S., **Jesus, A**., Kühn, M., Pétrequin, P., Reggio, A., Röder B., Schäfer, M., Schibler, J., Schoch WH, Viel, L., & van Willigen, S. (2020). Les structures attribuables au Néolithique moyen de type Chassey (dernier tiers du Ve millénaire avant notre ère). In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 117–228). Presses Universitaires de Provence.

Antolín, F., **Jesus, A.**, Francis, F., & Jacomet, S. (2020). Économie et alimentation. In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 316–329). Presses Universitaires de Provence.

Antolín, F., Häberle, S., **Jesus, A**., Martínez-Grau, H., Prats, G., Schäfer, M., & Steiner, B. (2018). The AgriChange project: an integrated on-site approach to agricultural and land-use change during the Neolithic in Western Europe. *Past Global Change Magazine*, *26*(1), 26–27. https://doi.org/10.22498/pages.26.1.26

Acknowledgements

First and foremost, I would like to thank my three Ph.D. supervisors. To Prof. Ferran Antolín, who has mentored me on my academic development, pushing me to publish and present papers, encouraged me to tutor other students and be part of interdisciplinary collaborations with more experienced researchers. I am deeply grateful to my second first supervisor, Dr Laurent Bouby, whose expertise was invaluable in formulating the research questions and methodology. His insightful feedback and patience in reading and correcting my texts pushed me to do better and allowed my research to reach a higher level. I also want to extend my sincere thanks to my second supervisor, Dr Sabine Deschler-Erb, who supported me with a positive attitude and encouragement.

I would like to acknowledge my colleagues from office 303 at Integrative Prähistorische und Naturwissenschaftliche Archäologie (IPNA) for their support and friendship. Dr Bigna Steiner was always available to help me with anything related to IPNA, work and life in Basel. Dr Örni Akeret always made me laugh with his comments, music and German words. Dr Patricia Vandorpe, my desk mate who was always supportive and caring. Marlu Kühn made sure I was up-to-date with the news and shared German culture and recipes. I would like to offer my special thanks to Dr Georgina Prats and Dr Lizzie Wright for their friendship. They were always available to discuss work, academia, and life over a cup of coffee or after-work drinks, even during the pandemic. Both helped me to keep sane during tough times. Thanks also to Dr Lizzie Wright for checking my English. To Francis Follman, my fellow vegan friend, for her support and friendship, all the late dinners and snacks in the office and sharing of vegan food.

I would like to extend my sincere thanks to the Montpellier team, Dr Allowen Evin and Sarah Ivory, who helped me with my geometric morphometric analysis, answering my emails and reading my drafts. I am deeply grateful to Vincent Bonhomme for his assistance dealing with the R code and quickly answering my emails, as well as reading and commenting on drafts and presentations.

Many thanks to everyone working at IPNA for making me feel welcome. To Dr Dorota Wojtczak for her empathy and words of encouragement. To Raül Soterras, besides working side by side on the Agrichange project, he took the time to show me around Basel, always sharing and inviting me to go to events. To Sarah Lo Russo for the friendship and support during my thesis. Many thanks to all the collaborators of the project (such as Stefanie Jacomet, Aurélie Salavert, and Lucie Martin) who helped me by sharing seeds and papers but also commented on the presentations and papers. Special thanks to Brigitte Heiz Wyss and Viviane Kotler, who helped me uncountable times with bureaucratic matters and their care for my well-being.

I would like to extend my sincere thanks to Dr Joao Tereso for his unwavering support and belief in me. His enthusiasm and passion for the work encouraged me to keep going. Also, for keeping the weekly journal club via Zoom during the pandemic.

My gratitude extends to Marianne Petrucci-Bavaud and Sonja Zürcher who always helped me with my academic and financial situation. This work was supported by the Swiss National Science Foundation (SNSF). My gratitude extends to the Freiwillige Akademische Gesellschaft (FAG) and Philosophisch-Naturwissenschaftliche Fakultät for funding my last few months and allowing me to finish my studies at the Departement Umweltwissenschaften (DUW) at the University of Basel. Without these three grants, this thesis would not have been completed.

I would like to thank my family for supporting me throughout the years, my parents Rosária and Paulo, my sister Sofia, my grand-aunt Gusta and my deceased grandparents Rosa and Jerónimo.

Other special thanks to my group of friends, Catarina Castro, for always helping me with my problems, including my mental health, and for reviewing my drafts and words of encouragement. To Ana Catarina Basilico for the daily talks and for being such an outstanding, hardworking person who inspires me. She shares her academic endeavours and gives me much support in times of need. To Lisa Güllüce, for keeping me sane in my work-life balance and reminding me to do some exercise even when I do not want to. I would also like to thank Ines Oliveira, Joana Leite, Margarida Leite, Dr Inés Lopez-Doriga, Dr Éva Halbrucker and Filipe Correia for their support and kind words during every stage of my PhD.

Finally, I would like to thank my husband, Mehdi Ramezani, for his companionship, support, and patience, as well as his stubbornness in making me disconnect from the work and go on adventures with him even when I did not want to, but I needed it. Without his tremendous understanding and encouragement during the past year, it would have been impossible to complete my PhD.

Abbreviations

NW Mediterranean	North Western Mediterranean
cf.	c*onfer* (compare) This abbreviation is used when there is an uncertain identification. Can be used before a family name or genus name (e.g. cf. *Papaver)* or before species (*Papaver* cf. *somniferum*)
cal.	Calibrated
BC	Before Christ
sp.	Species. It is used when the taxon is not identified beyond the genus level.
subsp.	Subspecies can also be used spp.
var.	Variety
VBQ	Square Mouthed Vases culture (Italian: Cultura dei vasi a bocca quadrata) is a culture of the Middle Neolithic period
EN	Early Neolithic period
MN	Middle Neolithic period
LN	Late Neolithic period
NE Iberia	North-eastern Iberia
SE France	South-eastern France
m a.s.l.	metres above sea level
IPNA	Integrative Prähistorische und Naturwissenschaftliche Archäologie
LBK	*Linearbandkeramik*

Table of contents

List of figures

List of tables

Chapter 1 Introduction

1.1 The framework of the project

This PhD was done as part of the Agrichange project (Antolín, Häberle, et al., 2018), which focuses on the north-west Mediterranean and its connections with the areas north of the Alps (North-eastern Iberia, South-eastern France, Northern Italy and Switzerland) during the Neolithic period (5700-2300 cal. BC). This project is funded by the Swiss National Science Foundation (SNF Professorship project AgriChange nr. PP00P1_170515) under project leader Dr Ferran Antolín.

Three tasks were assigned to this PhD project, which were meant to provide the core archaeobotanical dataset to build a complex narrative, along with other proxies such as stable isotope analysis, small animals, insect remains and storage capacity analysis, on agricultural decision-making processes during the Neolithic in the study area. The first task was to collect archaeobotanical data from different sites in the study area for the Neolithic period; the second task was to analyse archaeobotanical samples of some of the project's case studies. Only one site was included in this manuscript, Les Bagnoles dating from 4250 to 3700 cal. BC, in Vaucluse, France (van Willigen et al., 2020). The third and last task was to use morphometric analyses on *Papaver somniferum* (opium poppy) seeds. The geometric morphometric approach is chosen to investigate its potential to discriminate modern seeds of *P. setigerum* and *P. somniferum* and then apply it to archaeological seeds. Combining these three tasks will allow us to identify spatial patterns of the different crop dynamics in the study area through the Neolithic period (5700-2300 cal. BC). Additionally, this study focuses on the history of the opium poppy and its role in the Neolithic communities.

The opium poppy has several important uses for human societies, e.g. seeds for food and oil; and capsules for their psychoactive properties. Nevertheless, it is still unclear how this plant was used by prehistoric communities and the characteristics of the wild plant used during prehistory. Nonetheless, large quantities of seeds are found during the Neolithic period at wetland sites such La Marmotta (Italy), La Draga (Spain) and several sites in Switzerland, especially at sites dating 3500/3400-2850 cal. BC and associated with the Horgen culture (Antolín, 2016; Jacomet, 2006b, 2013, 2014; Rottoli, 1993; Rottoli & Castiglioni, 2009). Large concentrations are also found in few dryland sites, e.g. Sion-La Gillière 2 (Martin, 2015), suggesting the cultivation of a wild species of the opium poppy.

1.2 State of research

Diverse crops are noticed throughout the Neolithic period (5700-2300 cal. BC). These crop dynamics or changes are attributed to a multitude of factors. These can be environmental, extreme wet or dry conditions that can influence crop choice, location and size of the fields, and social-cultural factors.

Social mechanisms of crop exchange are essential in order to understand how crops circulated in Prehistory. However, most researchers focus on the timing of crop dispersal, such as poppy (Salavert, 2010; Salavert et al., 2018, 2020); barley (G. Jones et al., 2012; H. Jones et al., 2016; Lister et al., 2018); einkorn (Brandolini et al., 2016; Brandolini & Heun, 2019) and emmer (Oliveira et al., 2011, 2020). These works lay the foundation for concrete evidence of domesticated species' evolutionary history by combining genetics and well-dated sites to pinpoint the beginnings and routes of the various crops' domestication, introduction and diffusions.

Unlike the cereals domesticated in SW Asia, the opium poppy (*Papaver somniferum* L. subsp. *setigerum*/*somniferum*) is thought to be domesticated in Europe (Antolín, 2016; Bakels, 1982; Kreuz, 2012; Merlin, 1984; Salavert et al., 2018, 2020; Zohary et al., 2012). The seeds of opium poppy (*P. setigerum/somniferum*) are found in large quantities in the Neolithic Swiss sites (Jacomet, 2006b, 2007, 2008, 2009; Jacomet et al., 1989; Jesus & Antolín, 2021; Karg & Märkle, 2002); however, it is unknown if these seeds are of the wild or domestic type as there are no criteria to distinguish them (Fritsch, 1979; Merlin, 1984). The possible progenitor of opium poppy is a Mediterranean species (Bojnanský & Fargašová, 2007; KewScience, 2017b; Zohary et al., 2012) which suggests that the Neolithic alpine poppies were spread from the Mediterranean area in a wild or domestic form to the North of the Alps, probably during the Neolithic period. Therefore, this species is the perfect case study since the project focus on the crop dynamics in the NW Mediterranean area and the Swiss Plateau. The following section summarises the state of research for the three main topics of this PhD.

1.2.1 Systematic assessment of archaeobotanical data for the study of Neolithic agriculture in the NW Mediterranean and North Alps

Archaeobotanical syntheses for the Neolithic period have been recently published for North-eastern Iberia (Antolín, 2016; Antolín et al., 2015). In the case of Southern France, syntheses for each period have been published for the Early Neolithic (Bouby, Marinval, Durand, et al., 2020), the Middle Neolithic (Martin et al., 2016) and the Late Neolithic (Bouby, Marinval, & Rovira, 2020). Less systematic archaeobotanical syntheses have been done in northern Italy (Mottes et al., 2009; Rottoli & Castiglioni, 2009; Tecchiati et al., 2013). There is no single recently updated study that summarises the archaeobotanical data for the Neolithic period in Switzerland. Archaeobotanical research is presented based on the type of site: lakeshore sites (Jacomet et al., 1989, 1991; Jacomet, 2006b, 2007, 2008, 2014; Jacomet & Brombacher, 2005) or dry sites (Akeret & Geith-Chauvière, 2011; Martin, 2010, 2015). There are published regional syntheses for the study area that show the potential of studying these regions as a whole (Antolín et al., 2015; de Vareilles et al., 2020; Martin, 2010). These several compilations of carpological studies focus on crops and agricultural changes, although no systematic assessment of the data quality (sensu Livarda & Kotzamani, 2013; van der Veen et al., 2007, 2013) has been made. Can the data collected be used to infer information on food, agriculture and the environment? This PhD aims to fill this gap in the research by assessing the data collected and providing a high quality archaeobotanical data. Building a detailed synthesis should be done in conjunction with interdisciplinary approaches to archaeological sites, with archaeozoology, traceology, storage analysis, pottery analysis, organic residue analysis, and other disciplines to understand past realities better, but this is unfortunately out of the scope of this work.

1.2.2 The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal. BC)

Archaeobotanical syntheses highlighted a change in crop assemblage after 4000 BC with a reduction of naked wheat and an increase of glume wheat in France (Martin et al., 2016). In this panorama, one dry site – Les Bagnoles, 4250-3700 cal. BC (van Willigen, Bailly, et al., 2020), Vaucluse (France) – with waterlogged preservation (due to three wells) might give extra insight into the data that previous dry sites with charred material could not do. While for North-eastern Spain, the archaeobotanical data suggests that naked barley and wheat are the predominant cereal, so there is no shift in the assemblage during the Middle Neolithic, ca. 4400-3500 cal. BC (Antolín, 2016; Antolín et al., 2015). The data does not suggest this change for Italy; nevertheless, the carpological data is still chronologically poorly understood (Rottoli & Castiglioni, 2009). In Switzerland, emmer starts to be more important from around ca. 3400 cal. BC emerged from the influence of eastern communities (Jacomet, 2004).

1.2.3 Status of *Papaver somniferum* in the Neolithic period and its transfer from the Mediterranean to the Alpine area

The *Papaver somniferum*/*setigerum* seeds appear in large quantities in the Swiss pile dwellings; however, the wild progenitor of opium poppy is not native to these areas. *P. setigerum* is a possible wild progenitor of *P. somniferum* subsp. *somniferum* is native to the western Mediterranean region. Therefore, these findings raise the question of when this species was introduced and was it a domesticated or cultivated form. The distinction of the seeds of *P. setigerum* from *P. somniferum* is thought to be impossible using size only (Fritsch, 1979). Therefore, a new approach is needed. The application of geometric morphometric methods with other descriptors previously used, such as width/length (Bosi et al., 2006; Fritsch, 1979; Hammer & Fritsch, 1977; Merlin, 1984; Villaret-von Rochow, 1967) and the number of cells (Fritsch, 1979; Villaret-von Rochow, 1971) will be investigated. First, it was applied to modern sets of seeds of different *Papaver* species and then to archaeological seeds of the study area.

1.3 Research objectives

This thesis focuses on the crop dynamics between the north-west Mediterranean (North-eastern Iberia, South-eastern France, Northern Italy) and its connections with the areas north of the Alps (Switzerland) in the Neolithic period (5700-2300 cal. BC). Identification of carpological remains in archaeological sites from this region started hand in hand with archaeological excavations (Courtin & Erroux, 1974; Jacomet, 2004). Although not with the modern sampling, processing or recording methods, those early studies were unique. Examples of exceptional finds are the complete capsules of opium poppy in Murciélagos cave in Spain (Merlin, 1984) and woodwork at La Marmota site in Italy, recently re-analysed by Caruso Fermé (2021), or even the pots full of grains, in Trou Arnauld site, in France (Marinval, 1988b, p. 100) described but never photographed in situ or recently studied. As a result, there is a considerable amount of valuable data that we cannot fully exploit.

Seeds and fruits preserved by carbonisation present in archaeological sites are dependent on the usage of these species by past human communities (Tereso, 2012; van der Veen, 2007). These seeds preserved by carbonisation primarily due to accidents (van der Veen et al., 2007) are our study material; for that reason, interpretations should be done in that light and not directly extrapolated for past reconstructions.

In wetland sites, the unique preservation of the material (Menotti, 2004, 2015; Menotti & O'Sullivan, 2013) cannot only be attributed to food-related accidents of plant use but can also be environmental depositions (plants growing naturally there, water dispersion) and human activities. Early on, researchers (Birks, 2002; Cappers, 1993; Jacomet, 2013; Steiner, 2018; Steiner et al., 2018) understood that waterlogged deposits are a combination of food remains from local vegetation and deposits of seeds by water dispersion. Usually, wild species are used for environmental reconstructions as those are prompter to be classified as being transported by water from elsewhere (Cappers, 1993). For those reasons, carpological studies should be done at the contextual level, which in the cases of waterlogged sites, the contextual data is often not available.

1.4 Research questions, aims and objectives

The state of the art and the associated research problematics have been introduced in the previous sections of this chapter, agreeing with the three tasks designed for the Agrichange project. In this section, there is an outline of the questions to be addressed in the subsequent chapters:

1) Systematic assessment of archaeobotanical data for the study of Neolithic agriculture in the NW Mediterranean and North Alps

Archaeobotanical data will be used to address the question regarding the regional and chronological changes in crop dynamics over time. The following research questions will be addressed using the database to reassess North-eastern Spain, South-eastern France, Northern Italy and Switzerland botanical records on a chronological-regional level. Concerning the data collected, the following questions will be addressed:

a) How good is the data collected, and can it be used to infer information on food and agricultural practices?
b) Are there regional and chronological patterns evident in the archaeobotanical assemblages?

2) The contribution of waterlogged deposits to the study of crop change: Middle Neolithic agricultural practice (4400-3500 cal. BC)

This research includes some of the archaeobotanical results of the Middle Neolithic site Les Bagnoles. The following questions will be addressed:

a) Does the waterlogged and charred material show different patterns according to its context type?
b) What crops are present on this site, and how different is it from the other Middle Neolithic sites in the region to see any crop change between MN1 and MN2.

The overview of the results will be compared with other open-air sites in the region. (The results are published in **<u>Paper 1</u>**)

3) Status of *Papaver somniferum* in the Neolithic period and its transfer from the Mediterranean to the Alpine area

The application of seed morphology and the implementation of geometric morphometrics to distinguish *Papaver setigerum/somniferum* seeds has never been done before. This approach will be performed on modern seeds first and later on uncharred *Papaver somniferum*/*setigerum* seeds from archaeological sites.

a) Can we distinguish between modern seeds of the wild (*Papaver setigerum*), domestic (*P. somniferum)* and other *Papaver* species?
b) Can we further identify *Papaver* species in archaeological assemblages previously identified as *P. setigerum/somniferum*?

(The results will be published in **Paper 2**)

c) Can we identify domestic *Papaver somniferum* seeds in the Neolithic archaeological assemblages and in which proportion?
d) Is there any relation between the seeds' changes in size and shape and their chronology? Can we detect diachronic size and shape changes?
e) Can we establish connections between archaeological seeds found in sites in the Mediterranean area and those found in the Alpine area? Furthermore, what does this tell us about the process of domestication and diffusion of opium poppy outside of the Mediterranean area?
(The results will be published in **Paper 3**)

4) Organization of the manuscript

The primary aim is to combine all results and understand the state of the archaeobotanical analysis in the four regions of the project. Along with the crops, the poppy was introduced in Switzerland during the Early Neolithic. In this thesis, the findings of *P. setigerum/somniferum* seeds are the perfect case study to investigate its introduction in areas north of the Alps and pinpoint the evolution of this species. The aim is not to focus on regional neolithization but to give an overview of the dataset by highlighting the dataset's main patterns and assessing the data collected to provide a more usable dataset for future analyses.

This thesis is divided into eight chapters. **Chapter 2** provides the research parameters, with the study area outline and the chronological, archaeological and botanical criteria. **Chapter 3** summarises and critically assesses the archaeobotanical record gathered from the study area. **Chapter 4** searches for spatial-chronological patterns in the archaeobotanical data. **Chapter 5** introduces the data analysed from Les Bagnoles, including Paper 1. **Chapter 6** describes the importance of modern opium poppy and other *Papaver* species and a new methodology to distinguish modern *Papaver* seeds. Paper 2, found at the end of the chapter, shows the results of this new methodology. **Chapter 7** focuses on the archaeological finds of *Papaver* species and their role during the Neolithic period, along with Paper 3, which applies the methodology presented in the previous chapter on archaeological poppy seeds to differentiate the wild from the domestic seeds. **Chapter 8** presents the main results of the thesis and suggestions for future research.

Chapter 2 Research parameters

2.1 Study area

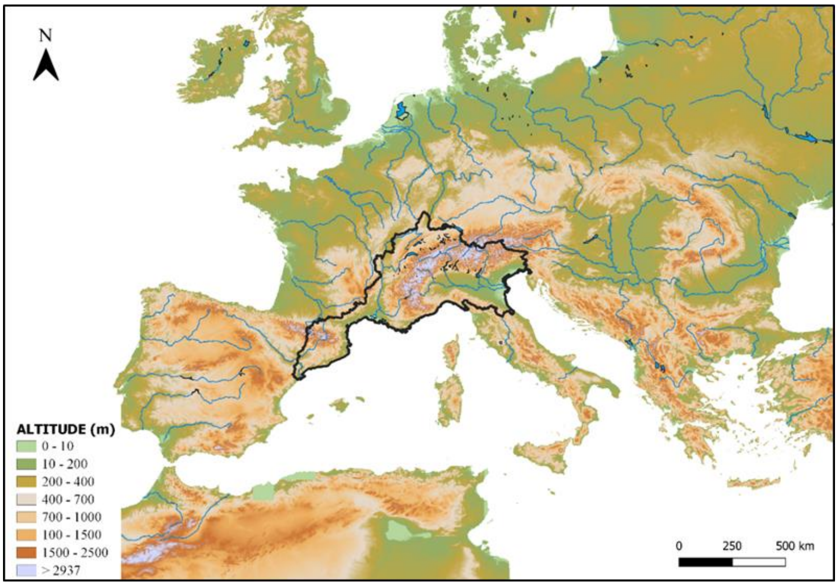

Figure 2.1 Study area: north-western of the Mediterranean and the North of the Alps

This thesis will focus on the north-western part of the Mediterranean and the Northern part of the Alps, an area broadly defined as North-eastern Iberia (from now on NE Iberia), South-eastern France (SE France), Northern Italy, and all of Switzerland (Figure 2.1). The organization of this thesis will follow this order consistently from west to east. Therefore, a geographic organization is intended and not a chronological one. See Figure 2.2 and Table 2.1 with the Spanish, French and Italian provinces for more details. In terms of the regions in SE France, Alsace, Franche-Comté, Rhône-Alpes, Midi-Pyrénées, Languedoc Roussillon and Provence Alpes Côte d' Azur were included, even though they are no longer administratively valid, the reason being they are smaller and more convenient to analyse than the current ones (Table 2.1). This work comprises several thematic approaches described in Chapter 1; therefore, some area and period variations will be in agreement with each study/chapter.

The synthesis focuses on the Neolithic period. For each site, the regional chronology was considered and it was then added to a broader phase, as can be seen in Table 2.2, following the chronology within the Agrichange project (Antolín, Häberle, et al., 2018; Martínez-Grau et al., 2021). The Early Neolithic corresponds to 5700-4500 cal. BC, Middle Neolithic between 4500 and 3300 cal. BC and the Late Neolithic spans from 3300 to 2300 cal. BC. Another term used was *Neolithic,* when there is no radiocarbon date or precise chronology.

In Chapter 5 and Paper 1, the area analysed is located only in SE France. This work combines archaeobotanical analysis of Les Bagnoles, Vaucluse, region Provence Alpes Côte d' Azur and its integration with other open-air dry sites during the regional chronology of Middle Neolithic 1 and Middle Neolithic 2 periods.

Chapter 6 (Paper 2) and 7 (Paper 3) focus on studying modern and archaeological poppy seeds from the Neolithic period. In order to clearly visualize change in morphology and size aspects, one site from the Late Bonze Age ca. 1050-800 BC was added (Chapter 7).

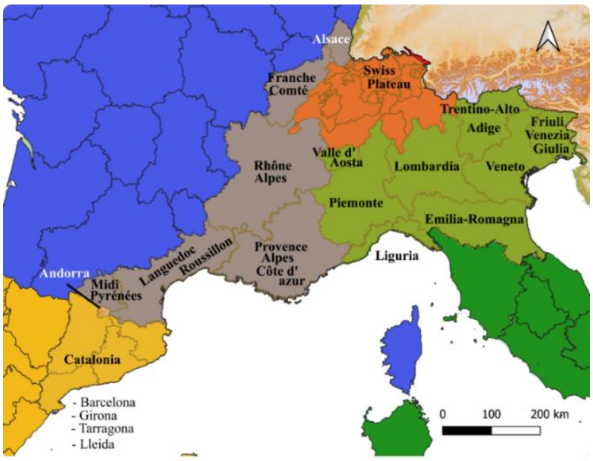

Figure 2.2 Study-area with the name of the regions in NE Iberia (yellow colour with Andorra and Catalonia), SE France (blue colour), Northern Italy (green colour) and Switzerland (red colour).

Table 2.1 Regions of South-eastern France with the French administrative regions (name and number of the Departments) included in this study.

	French former administrative regions					
	Alsace	**Franche-Comté**	**Rhône-Alpes**	**Midi-Pyrénées**	**Languedoc Roussillon**	**Alpes Côte d'azur**
French departments	Bas-Rhin (67)	Doubs (25)	Ain (01)	Ariège (09)	Aude (11)	Vaucluse (84)
	Haut-Rhin (68)	Jura (39)	Ardèche (07)		Gard (30)	Hautes-Alpes (05)
		Territoire de Belfort (90)	Drôme (26)		Hérault (34)	Alpes de Haute Provence (04)
			Haute-Savoie (74)		Pyrénées-Orientales (66)	Var (83)
			Isère (38)			Bouches du Rhone (13)
			Rhône (69)			Alpes-Maritimes (06)
			Savoie (73)			

The Alps are the highest and most extensive mountain range in Europe, covering the north of Italy, the southeast of France, Monaco, Switzerland, Liechtenstein, Austria, southern Germany and Slovenia. This massif extends over a length of 1000 km, from the lower Rhône valley to almost Vienna, and over a width of between 200 and 500 km, between the Swiss and Bavarian plateau to the north and the plains of the Po and Veneto to the south (Martin, 2010, p. 19). The other mountain range of the study area is the Pyrenees, which extends for about 491 km from its union with the Cantabrian Mountains to the Mediterranean Sea (Cap de Creus), connecting the borders of Spain, France and Andorra. The Apennines are a mountain range consisting of parallel smaller chains extending c. 1,200 km along the length of peninsular Italy. The study area entails the northwest Apennine joining with the Ligurian Alps.

Figure 2.3 Main rivers in the study area. Colour code: Blue = France; Green = Italy; Yellow = North-eastern Spain and Red = Switzerland.

The main rivers in the study area are Rhine and Rhône, which connects France and Switzerland. However, other rivers are equally large and important, such as Po, Adige and Ticino. In France, Rhône river tributes to Durance and Saone. Saone then tributes to Doubs, which goes along the border of France and Switzerland territories (Figure 2.3), in the Neuchatel and Jura cantons. In NE Spain, the large river Ebro tributes to Segre. Other larger rivers are near the study area, such as the Drava and Inn tributaries of the Danube, connecting the study area with central and south-eastern Europe. Rhône river flows from Swiss territory to the Mediterranean Sea, while the Rhine river goes from Switzerland to the north, passing Liechtenstein, Austria, Germany, France and Netherlands. Drava river flows eastwards through Italy, Austria, Slovenia, Croatia and Hungary, whereas the Inn river runs north-eastwards from Switzerland, Austria and Germany.

Understanding the study area's main geographic characteristics is important as, in most cases, it influences and constrains human occupation. These can be temporary dwellings close to rivers for water resources. It can be settlements hidden and protected in high-altitude places. In the early stages of the Neolithic period, most sites found in the study area were close to the Mediterranean Sea. They slowly started to appear inland near rivers, but sites in high altitudes were also chosen. For example, evidence of such occupations is available in the Pyrenees before and during the Neolithic period in these mountain ranges (Antolín, Navarrete, et al., 2018; Gassiot Ballbè et al., 2017; Oms et al., 2016).

The main concentration of settlements will be near rivers and lakes due to the easy access to water for drinking and preparing food as well as for other activities such as farming, cleaning, and making pottery. Rivers were the quickest "road" for products to be exchanged. An explicit route known is along the River Rhone connecting the Swiss plateau with the Mediterranean region, where shells were exchanged since the Mesolithic period (Nielsen, 1997). Provenience studies aim to locate potential places of origin by characterizing the composition of the artefacts. This method has been done mainly with lithics (Affolter et al., 2022; Kolb, 2014; Perrin, 2016).An example is the circulation of the large polished axe heads and rings made of Alpine jades that are originated from the Italian Alps but present all over Europe (Pétrequin et al., 2019).

The circulation of people and objects can be done by water, via rivers and seas, and on land, using mountain passages. Evidence of human passages through the Alps (Della Casa, 2007) has been found in this region since the Middle Neolithic, 4800 to 4300 BC (Hafner, 2012). The best example of using the passage of the *Tissenjoch* around 3230 BC is Ötzi (frozen mummy). This man was found near this passage, preserved in the ice (Oeggl et al., 2007).

2.2 Chronological parameters

The archaeobotanical database depends on the correct chronological interpretation; this can be by 14C radiocarbon dating, dendrochronology and, in most cases, by relative chronology (pottery, lithic or other types of typologies). As the study area is a broad space, the Neolithic period is attributed to different "realities" in the different regions, even within the same country and the same period. This multitude of periodizations was maintained; however, in this thesis, the objective is first to outline the dataset and then assess its quality. We used a broader periodization such as Early, Middle and Late Neolithic, as shown in Table 2.2.

Table 2.2 List of local periods with pottery types identified in the four regions. These local designations, sometimes in the original language, correspond to the sites with archaeobotanical remains found on regional syntheses (Antolín, 2016; Bouby, Marinval, & Rovira, 2020; Bouby, Marinval, Durand, et al., 2020; Jacomet, 2006b, 2007, 2008, 2014; Martin, 2010; Martin et al., 2016; Rottoli & Castiglioni, 2009) and from site publications see Appendix A: List of all sites with archaeobotanical data.

	Early Neolithic	**Middle Neolithic**	**Late Neolithic**
	5700-4500 cal. BC	4500-3300 cal. BC	3300-2300 cal. BC
	Archaeological groups/periods		
SE France	Cardial ancien/moyen/final; Epicardial I & II; Impressa; Rubane; Perícardial; Hinkelstein/Grossgartach; Neolithique ancien Rhodane;	Pre-chassen; Chasséen ancien; Chassen classique /chassien recent; Néolithique moyen bourguignon; Chassen; Saint-Uze; type Mourre de la Barque; Chassen languedocien; Roberte; Pfyn Cortaillod; Montbolo-chasséen; Chasséen méridional; Lagozza; VBQ	Vérazien; Campaniforme = Bell Beaker; Ferrières (LN1); Fontbouisse (LN2) ; Auvernier Cordé helvétique; Horgen; Néolithique final languedocien; Néolithique final méridional; Saint-pono-vérazien; Mourre du Tendre; type Cavalade; Chalcolithique
Northern Italy	Cardial; Post Cardial; Impressa; Gaban; Danilo; Friulani; Fiorano; Vhó; Diana; Vasi di bocca quadrata I (VBQ I)	VBQ II; III; Proto Lagozza-Chassey; Chassey-Lagozza; Lagozza	Chalcolithic; Bell Beaker; Remedello; White ware phase
NE Iberian Peninsula	Cardial; Epicardial; Postcardial; Epicardial I; Neolitique antic postcardial; Neolithic antic evolucionat; Late EN	Mittelneolithikum; Early Middle Neolithic 1; Early Middle Neolithic 2; Neolítico Medio Inicial;	Vérazien; Neolític final
Switzerland	Rössen; Hinkelstein; Isolino;	Pfyn;Cortaillod;Egolzwil;Cortaillod tardif; Fruheszentral Cortaillod; Jungneolithikum; zentralschweizerisches Cortaillod;Cortaillod, type Petit-Chasseur;Cortaillod	Spätneolithikum; Schnurkeramik = Corded ware Horgen;Lüscherz; Glockenbecher = Bell Beaker Endneolithikum; Cortaillod Tardif; Auvernier cordé; Lüscherz recent; Late Pfyn.

Here we present the chronological boundaries for sorting the carpological data (Table 2.2). In order to compare contemporaneous sites, the chronological division combines regional chronology and its broad phases following the chronology within the Agrichange project

(Antolín, Häberle, et al., 2018). The project chronology divides the Neolithic period as Early Neolithic from 5700 to 4500 cal. BC, Middle Neolithic from 4500 to 3300 cal. BC, and Late Neolithic from 3300 to 2300 cal. BC (Table 2.2). The regional chronology derives from already published carpological syntheses done in the different regions (Antolín, 2016; Bouby, Marinval, & Rovira, 2020; Bouby, Marinval, Durand, et al., 2020; Jacomet, 2006b, 2007, 2008, 2014; Martin, 2010; Martin et al., 2016; Rottoli & Castiglioni, 2009 for more references see Appendix A).

2.3 Botanical criteria

This thesis will follow the botanic nomenclature of Info flora (2019) and Flora Gallica (Tison & Foucault, 2014). Traditional classification will be used for common names for the cultivated plants, but with some modifications from other archaeobotanical and genetics studies (Salamini et al., 2002; Zohary et al., 2012). Table 2.3 and Table 2.4 show the biological species name, common name, original identification and English designation of the main species mentioned in the text. To simplify, we adopted a more straightforward method of grouping a common name to homogenise nomenclature when gathering published data and help make comparisons between sites by different investigators. The morphological types only establish a similarity between the archaeobotanical remains and the actual fruits and seeds. Therefore, the morphological type can have different species (e.g. *Triticum aestivum*/*turgidum*/*durum*).

The most common edible or used plants were selected from the extensive list of taxa present in the database. They include the domestic crops and the most frequently gathered nuts, fruits, and other possible seeds important by their oil and fibre (Table 2.3 and Table 2.4). Weeds and wild species are essential for studying palaeoenvironment, and farming strategy/processing or seasonality. Not all wild species were considered relevant to the research questions, except in the study case of Les Bagnoles, where more detailed analysis was done (Chapter 5).

The new DNA analysis on the "new glume wheat" classified it within the group of *T. timopheevii* (Czajkowska et al., 2020), therefore denominated here as such. In order to not create a bias (due to different degrees of identification precision among different specialists) in the dataset, the differentiation between *T. aestivum* and *durum* and *Hordeum vulgare* and *H. vulgare nudum* were not taken into account for the analysis. However, when counting the number of taxa, the original identification according to the different authors was used for evaluating the maximum number of taxa found at the site. This number might be biased as different archaeobotanists count taxa differently; therefore, it was not used in the end for any analyses, but it is recorded in Table 1 in Appendix B.

When compiling the macroremains found in the study area, some species were present in the database. However, they might be intrusions from early periods or not dated. For this matter, a quick overview of the species that appear but were not counted and their explanations. The domestication story of spelt wheat (*Triticum spelta*) is still not clearly understood. Early finds of this wheat around 6050-4650 cal. BC from South Caucasus and in Eastern European, in countries such as Georgia, Moldavia, Slovakia, Poland, Rumania and Hungary (Zohary et al., 2012, p. 50). The presence of Neolithic spelt is questioned based on grain morphology and not on the glumes; therefore invalid or assumed to be a common weed (*Aegilops cylindrica*) (Nesbitt, 2001; Zohary et al., 2012, p. 50). Molecular evidence suggested that spelt was not brought from southwest Asia to Europe, but new domestication occurred perhaps in Europe (Akeret, 2005; Zohary et al., 2012, p. 50).

Table 2.3 Designations of the main species identified in the archaeobotanical studies

Taxa /Group (common name)	Original Identification	Common name
Grains		
Hordeum vulgare	*Hordeum* sp., *Hordeum vulgare* var *vulgare*, *Hordeum vulgare* var *nudum*	hulled and naked barley
Triticum monococcum	*Triticum monococcum*	einkorn
Triticum dicoccum	*Triticum dicoccum*	emmer
Triticum aestivum/durum/turgidum	*Triticum aestivum*; *Triticum aestivum compactum, Triticum durum;*	bread and durum wheat
Triticum timopheevii group	"new glume wheat"; *Triticum timopheevii*	zanduri wheat Timopheevii wheat
Triticum spelta		spelt
Secale cereale		rye
Panicum miliaceum		broomcorn millet
Setaria italica		foxtail millet
Triticum sp.	when there is no wheat identified at the species level	
Cerealia	when there are no other cereals, *Hordeum/Triticum*	
Leguminosae		
Cicer arietinum	*Cicer* sp.	chickpea
Lathyrus cicera/sativus	*Lathyrus cicera*; *Lathyrus sativus*;	grass pea
Lens culinaris	*Lens* sp., *Lens culinaris*	lentil
Pisum sativum	*Pisum* sp., *Pisum sativum*	field pea
Vicia ervilia	*Vicia ervilia*	bitter vetch
Vicia faba	*Vicia faba minor*	broad bean
Vicia sativa		common vetch
Oil and Fibre plants		
Linum usitatissimum	*Linum usitatissimum*	flax
Papaver somniferum	*Papaver setigerum/somniferum*	opium poppy

Early evidence of rye (*Secale cereal*) suggested that it evolved as a weed and was later picked as a crop. Even though there is no clear evidence of when it was domesticated and brought to Europe, rye appears in early sites during the Neolithic period in Italy and Slovakia, suggesting an Aegean Basin and the south Balkan as a possible route (Zohary et al., 2012, pp. 65–66).

Foxtail millet (*Setaria italica*) and Broomcorn millet (*Panicum miliaceum*) were the most important crops from the dry-land agriculture in the north of China in the Neolithic period around 6000 cal. BC (Kirleis et al., 2022; Liu et al., 2012; Motuzaitė Matuzevičiūtė & Liu, 2021; Zhao, 2011). Early finds of foxtail millet appear in Europe at Bronze age sites (1850-800 cal. BC, such as in Switzerland (Brombacher, 2005; Brombacher & Jacomet, 1997; Favre, 2002). In comparison, Broomcorn millet (*Panicum miliaceum*) appears more frequent but as single seeds in several samples in the dataset. Recent investigation on this crop argues that its presence in Europe did not happen before c. 1600 cal. BC (Filipović et al., 2020). There are broomcorn millet seeds identified from the *Vasi di Bocca Quadrata* (VBQ) communities (Middle and Late Neolithic period) in Italy (Mottes et al., 2009). However, these early seeds were not directly dated. In a later period, there is a possible isotopic signal of millet consumption in the Bronze age. Stable carbon and nitrogen isotopes in bone collagen done on individuals and animals (Tafuri et al., 2018) from the Terramare communities in the Po valley indicate the consumption of C4 plants. C4 plant signals are regarded as an indication of millet consumption. Nevertheless, other wild C4 plants would have been available, although there is no clear indication that these would be eaten in the necessary amounts to generate a marker similar to the millet (Pyankov et al., 2010). The state of research in Italy suggests that the broomcorn millet exchange route might have come along the Adige river and not from the Friuli area (Tafuri et al., 2018, p. 140) and the Carpathian Basin through lowland Austria and Slovenia (Filipović et al., 2020). The presence of millet on Corded ware Neolithic sites in Switzerland (e.g. site of Basel-Landschaft-Binningen) was recently dated and given a later date (Final Bronze Age) and was an intrusion (Filipović et al., 2020).

Regarding pulses, lentil seeds and pea are usually found together with wheat and barley in European Neolithic sites in Greece, Bulgaria, and Macedonia, but also in Italy, Germany and Switzerland (Zohary et al., 2012). Chickpea and fava bean (*Vicia faba*) are as well as lentil and pea accompanying cereals in the Fertile Crescent (Zohary et al., 2012, p. 89). However, chickpea rarely appears in the European Neolithic except in rare cases in Greece, Bulgaria and NE Spain (Antolín & Schäfer, 2020; de Vareilles et al., 2020; Ivanova et al., 2018; Marinova & Valamoti, 2014). At the same time, the fava bean does not appear in Greek sites (de Vareilles et al., 2020) but appeared during the Neolithic period in Italy, France and Spain, as will be discussed in Chapter 4. Bitter vetch (*Vicia ervilia*) and common vetch (*Vicia sativa*) are commonly found in the Fertile Crescent and Europe during the Neolithic and Bronze Ages, appearing especially in Greece and Bulgaria but also in Italy (Zohary et al., 2012, pp. 93–94). The grass pea (*Lathyrus cicera/sativus)* appears in south-western Asian, Aegean and west Mediterranean Neolithic sites (Kislev, 1989; Zohary et al., 2012, p. 96).

In terms of oil plants, flax accompanies pulses and cereals while they spread from the Fertile Crescent into Europe in the early Neolithic (Zohary et al., 2012). Early sites with flax seeds in Europe are in Greece and Crete, dating from 6000-5600 BC, and in central Europe, 5400-4900 BC (Harris, 2014; Zohary et al., 2012, p. 31). Opium poppy (*Papaver somniferum*) has not been found in the Fertile Crescent (except for two sites), suggesting that its domestication was elsewhere for more details, check Chapters 6 and 7. The domestication centre of origin of *P. somniferum* has been assumed to be in the Western Mediterranean area and from there it was spread together with other crops (Bakels, 1982; De Candolle, 1884; Kreuz, 2012; Zohary et al., 2012).Besides domestic plants, wild edible plants were also analysed; these included wild species of trees, vines, and shrubs (e.g. *Olea* sp., *Vitis* sp., *Pistacia* spp., *Ficus*). The selection of these plants was inspired by the paper of Ivanova et al. (2018) and adapted to our dataset. The possible uses and products were defined for each species; see Table 2.4. Most of the common edible plants analysed are native to Europe or, more specifically, from the Mediterranean, such as wild olive, wild grape and figs. These early finds from the Neolithic are likely wild fruits, including figs (Zohary et al., 2012, p. 129).

2.4 Quantification and standardisation

The seed counts were taken from the original publications. The taxa comprise eighteen domestic crops (including *P. setigerum/somniferum* seeds, Table 2.3) and twenty-five of the most frequent gathered nuts and fruits (Table 2.4). The analysis explores similarities/differences in taxonomic composition and not on individual plant parts (e.g., grains, chaff, and others).

Chaff remains were eventually not integrated in the general synthesis of chapter 4 because grains were more commonly identified and they provide the general trends. Chaff remains are small and fragile, the chance of being found in the archaeobotanical assemblage is related to the type of sampling, mesh size and processing. This information was gathered for a large number of sites presented here. However, not all sites had enough information. Therefore, assessing the quality of each site was needed and excluding the sites that did not apply the adequate methods. All specimens identified as 2-row, 6-row, or indeterminate barley were pooled to represent one category: *H. vulgare*. This classification was done because of the identification problems associated with barley; specifically, there have been differences and inconsistencies in identifying the 2-row and 6-row varieties and naked and hulled types. Not all authors had such detailed identification. All free-threshing wheat or naked wheat was grouped in *T. aestivum/turgidum/durum*.

All possible cereal crops were added to the dataset, although some of these might be intrusions and erroneous identifications. These are the case of spelt wheat (*Triticum spelta*), rye (*Secale cereal*), broomcorn millet (*Panicum miliaceum*) and foxtail millet (*Setaria italica*), their early appearance in the study area was discussed in the previous section. To ensure the absolute date of such finds, radiocarbon dates should be performed. This was done recently for broomcorn millet (Filipović et al., 2018; Kirleis et al., 2022) and hopefully for the other misplaced cereals in the future.

Table 2.4 Designations of the main species identified in the archaeobotanical studies, with information on the edible parts - source about edible parts from pfaf, and information about the origin of these species from other sources (Bojnanský & Fargašová, 2007, p. 27,367,15; Bundesamt fur Umwelt BAFU, 2019; Popescu et al., 2016; Ronch et al., 2016; Zohary et al., 2012, pp. 135–140))

Taxa /Group (common name)	Original Identification	Common name	Edible parts	Native
Wild edible plants				
Arbutus unedo	*Arbutus unedo*	strawberry tree	fruit (raw or cooked)	Mediterranean
Cornus mas	*Cornus mas*	cornelian cherry	fruit (raw or dried); seeds (oil or ground to a powder)	temperate zones from central to southern Europe and eastwards to Asia Minor
Cornus sanguinea	*Cornus sanguinea*	common dogwood	edible fruit (raw or dried); seeds (oil)	most of Europe, including over 1500 m in the Alps (Switzerland)
Corylus avellana	*Corylus* sp., *Corylus avellana*	hazel	seed (raw, roasted and oil)	Europe, except the extreme north and up to 1200 m elevation
Fagus sylvatica	*Fagus sylvatica*	European beech	seed (raw, cooked and oil)	western and central Europe, 300-1300 m
Ficus carica	*Ficus, Ficus carica*	common fig	fruit (raw, cooked or dried)	The Mediterranean and southwestern Asia
Fragaria vesca	*Fragaria* sp., *Fragaria vesca*	wild strawberry	fruit (raw or cooked)	Eurasia
Juniperus communis/oxycedrus	*Juniperus communis/oxycedrus, J. communis, J. oxycedrus*	common juniper; western prickly juniper, cade juniper	fruit (raw, cooked or for flavouring)	J. communis is native throughout Euroasia while J. oxycedrusis native to Southern Europe with elevations up to 2000 m
Malus/*Pyrus*	*Malus* sp., *Pyrus* sp., *Malus sylvestris, Pyrus pyraster*	crab-apple; wild pear	fruit (raw or cooked); seed (oil)	Europe
Olea europaea oleaster	*Olea europaea oleaster*	wild-olive	fruit (raw and oil)	Mediterranean
Physalis alkekengi	*Physalis* sp., *Physalis alkekengi*	bladder cherry	fruit (raw or cooked)	Europe
Pistacia lentiscus	*Pistacia lentiscus*	mastic Tree	seed (oil)	Mediterranean
Pistacia terebinthus	*Pistacia terebinthus*	turpentine tree	Seed (raw, cooked or oil)	Mediterranean
Prunus avium	*Prunus avium*	wild cherry	fruit (raw or cooked); seed (raw or cooked)	Eurasia and northern Africa
Prunus mahaleb	*Prunus mahaleb*	cherry tree	fruit (raw), seed (raw or cooked)	southern Europe and southwestern Asia
Prunus spinosa	*Prunus spinosa*	blackthorn/sloe	fruit (raw or cooked); seed (raw or cooked)	Eurasia
Quercus sp.	*Quercus* sp.	oak	seed (cooked)	Eurasia
Rosa sp.	*Rosa* sp.	rose	fruit (raw or cooked)	Europe
Rubus sp.	*Rubus* sp., *R. caesius*, *R. fruticosus* agg, *R. idaeus, R. ulmifolius*	raspberries, wild blackberries, and dewberries	fruit (raw or cooked)	Eurasia
Sambucus sp.	*Sambucus* sp., *S. ebulus, S. racemosa, S. nigra*	dwarf elderberry; red elderberry; black elder	fruit (raw, cooked or dried)	Eurasia
Solanum nigrum	*Solanum* sp., *S. nigrum*	European black nightshade	fruit (cooked)	Europe
Sorbus domestica	*Sorbus* sp., *S. domestica*	service tree	fruit (craw or cooked)	southern and southeastern Europe
Trapa natans	*Trapa natans*	water chestnut	seed (raw, cooked or dried ground to a powder)	central and southern Europe, Asia Minor and North Africa
Vitis vinifera sylvestris	*Vitis* sp., *V. vinifera sylvestris*	wild grape	fruit (raw)	Mediterranean region, Central Europe, and south-western Asia

Chapter 3 The archaeobotanical database and data assessment

3.1 Introduction

This chapter focuses firstly on the methodology approach, how the archaeobotanical data was collected and which parameters were used. Secondly, it gives a brief overview of the data collected with a spatial analysis of the data, a description and overview of the results for each parameter used and the results of the assessment of the archaeobotanical data. Finally, the last part will discuss the implications and applications of this data collection.

3.2 Methodology

3.2.1 Data selection

The data synthesised here is the compilation of archaeobotanical data from the study area (NE Iberia, SE France, Northern Italy and Switzerland) focusing on the Neolithic period (5500-2300 BC). This compilation entailed bibliographic searches starting with the primary synthesis papers and checking individual regions and researchers using Google, national and regional journals, GoogleScholar, researchgate, academia, and institutional repositories. For Italian records, the data collection stopped at the end of 2018, and for the others in 2020. The results of the Access Database ArboDat from Integrative Prähistorische und Naturwissenschaftliche Archäologie (IPNA) were combined with individual site publications for a detailed analysis. The Italian data was obtained mainly from published papers in regional journals, while French, Spanish and Swiss data come from published or unpublished reports. Unpublished reports refer mainly to internal reports from IPNA researchers to the Swiss cantons. When necessary, GoogleTranslator was used and verified by a native speaker (e.g. German native). Also, researchers with primary data were consulted, and they shared already published articles with the archaeobotanical data.

All available reports and publications were consulted (Appendix A: List of all sites with archaeobotanical data). The absolute counts of all taxa present were recorded in a Microsoft Excel spreadsheet for each site. These spreadsheets were then introduced to the Arbodat using the Taxa Transfer; this task was initiated by AJ but then done by FA and Anna Müller. In parallel, an excel spreadsheet with all the information per record was done. The recorded information are coordinates, type of site, chronology, number of samples, the volume of sediment, type of preservation, type of sampling, processing, and publishing type, and phases are provided as an electronic file (Appendix C: Data quality) and summarised in Table 3.1.

A total of 354 sites were recorded, of which 59 were excluded from this analysis either because they were not within the Agrichange study area or because they were unpublished (Appendix A: List of all sites with archaeobotanical data and all the bibliography used per site. Highlighted orange is excluded data and blue is the unpublished reports).

Table 3.1 Parameters of data quality used on the archaeobotanical data collected

Type of site	open-air - wet
	open-air - dry
	cave/shelter
	undefined (e.g. mines, frozen mummy or not defined in the report)
Type of preservation	charred
	uncharred
	imprints
Archaeobotanical quantification	Absolute numbers
	Presence/absence
	Range, densities, proportions, estimate
	unclear
	unknown
Date of excavation	≤ 1980 (≤1989)
	1990 (1990-1999)
	2000 (2000-2009)
	2010 (2010-2019)
	unknown
Minimal Mesh size (mm)	2
	1
	0.5
	< 0.5
	unknown
Type of processing	flotation
	wet sieving
	dry sieving
	wash-over sieving, goldwascher, Halbflotation
	Unknown/hand-picking
Type of publication	cultural phase, chronological level, profile level, area level, site level
	sample level, layer level, SU level, structure level, per finding
	unclear

In this chapter, the type of site is classified as open-air dry or wet, cave/shelter and undefined by the authors. The undefined was also ascribed in mines and the frozen mummy cases. 'Records' are subsets of sites, with chronology and distinct cultural sets of data (sensu van der Veen et al., 2007, p. 183). For example, Can Sadurni cave has three phases, which equals one site and three records. Sixteen records were removed because the period only referred to the Neolithic, and no further detail was given.

3.3 Database

The dataset used consists of 419 records and 295 sites. Records from open-air dry sites make up 58 % of the total, and it is the most common type of site in the four regions (Figure 3.1). Cave/shelter sites are found in higher proportions in NE Iberia and SE France, while open-air wet sites predominate in Switzerland. All types of sites are found in all phases (Figure 3.2), with the particularity of open-air wet sites being rare in the first phase (Early Neolithic) and becoming more common in the second phase (Middle Neolithic) and third phase (Late Neolithic). The presence of open-air wet sites known as pile dwellings is a new type of settlement for this period and region. These are prehistoric settlements with wooden houses built on the shores of lakes (Schlichtherle & Rau, 2016). This type of site is primarily found in Switzerland (Figure 3.1). The number of records for NE Spain is two records from one site, SE France is nine, Northern Italy is seven, while Switzerland has 61 records.

Throughout the Circum-Alpine area on lakeshores, the prehistoric wetland settlements span from 4300 to 800 BC (Suter et al., 2009); there is an increase of open-air wetland sites in the study area in the Middle and Late Neolithic period (Figure 3.2).

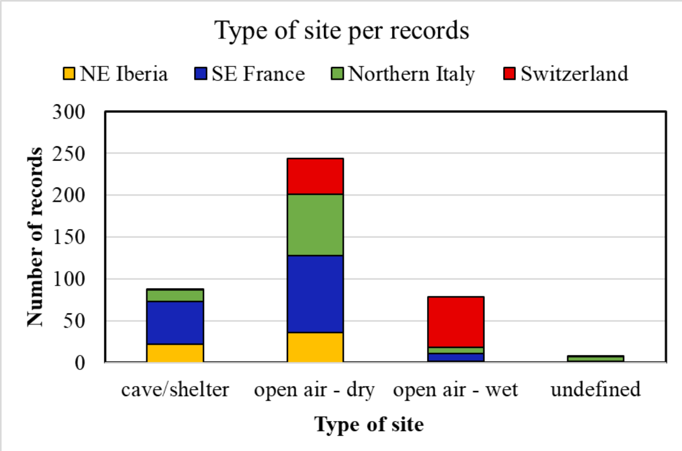

Figure 3.1 Number of records with archaeobotanical studies by site category (n=419 records)

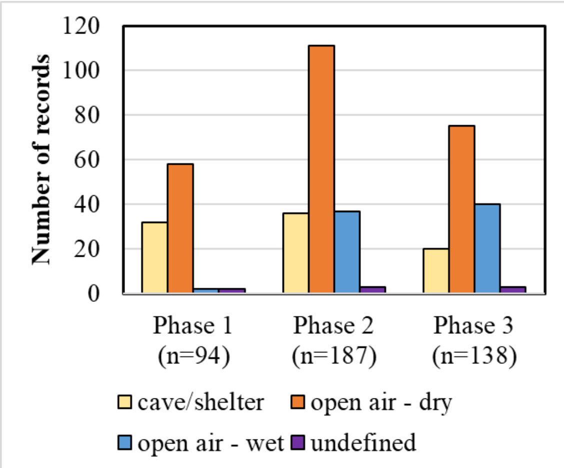

Figure 3.2 Number of records with archaeobotanical studies by phase and site type.

In the Early Neolithic period, inland areas have fewer sites with archaeobotanical evidence (Figure 3.3a). This lack of sites can be related to the Neolithisation process, which took more time to reach mountain areas and inland areas like the Swiss Plateau. Nevertheless, it also can reflect the lack of archaeobotanical studies in those areas.

Regarding Switzerland, the archaeobotanical evidence is present in the two extremities: southwestern and eastern Switzerland, probably not related to each other. In the southwestern part of Valais canton, crops might have been introduced via the Rhone River or Northern Italy (Curdy, 2007). At the same time, the eastern part of Graubünden canton (Switzerland's southeast side) and Alsace (SE France) were probably introduced via the Rhine river (Denaire, Doppler, et al., 2011; Denaire, Jeunesse, et al., 2011).

The distribution of the sites seems concentrated in small clusters, reflecting the favourable conditions in these zones for the early farmers to settle. However, this can be the bias of the state of research. In terms of the type of site (Figure 3.3a), caves and shelters are predominant in NE of Iberia, SE France, along the Rhone river and Liguria (Italy) along the Mediterranean coast. In contrast, the Po Valley or Friuli in-land sites have open-air dry sites that include house plans (Starnini et al., 2018).

In the Middle Neolithic period (Figure 3.3b), there are more records with archaeobotanical studies, especially close to the coast of the Mediterranean up to the Rhone Valley and its adjacent river, Durance (SE France). Evidence of archaeobotanical studies shows the occupation of dry sites in the Po valley, while several pile dwellings (open-air wet sites) are located in the French Jura, South Alps (Northern Italy) and the Swiss Plateau (see blue circles for wet sites in Figure 3.3b). There is also some evidence of sites in higher altitudes, and in general, the sites are more dispersed in the study area, where open-air sites are dominant in several inland areas.

There are fewer records for the third phase, the Late Neolithic period, than for the previous phase; the sites look more dispersed on the map (except in the Swiss Plateau, where multiple records are found around the same lakes). There are also fewer sites close to the Mediterranean coast and more inland. In terms of cave/shelter sites, there are fewer sites with archaeobotanical data (Figure 3.2). However, they seem to predominate in the south-west and west part of the study area, NE Iberia and SE France, while there is one site in Switzerland (map Figure 3.3c).

This geographic coverage shows only the sites with archaeobotanical studies; therefore, it does not give a complete overview of the settlement patterns of these communities or environmental preferences. Comparing the settlement pattern of each phase and assessing its archaeobotanical records would be interesting to understand if the settlement's implementation was in agreement with the type of archaeobotanical assemblage present. This is not in the scope of this thesis, nevertheless this will be done in the future by combining all the proxy results from the Agrichange project that is still ongoing.

3.4 Type of preservation

Plant remains do not usually survive on archaeological sites, as they decompose with time. Only under exceptional conditions will plant remains be preserved and found in the archaeological sites (Boardman & Jones, 1990; Gustafsson, 2000; Märkle & Rösch, 2008; P. Wright, 2003). The most common form of plant preservation is by charring. Charring preserves the plant remains by transforming the plant remains in pure carbon (Wilkinson & Stevens, 2003, p. 149). Another less common form of preservation is waterlogging, where the plant remains are permanently preserved underwater. The waterlogged assemblages from prehistoric sites offer different information on possible foodstuffs than charred remains (Heiss et al., 2017; Jacomet, 2013). Each type of preservation favours different types of plants and plant remains. Waterlogging allows the preservation of high diversity of plant remains, including oily seeds, pods, flower buds, leaves, herb seeds and wild edible fruits (Colledge & Conolly, 2014; Jacomet, 2013; Märkle & Rösch, 2008). While charring process allows for better preservation of cereal grains and pulses (Boardman & Jones, 1990; Charles et al., 2015; Gustafsson, 2000). Other occasional forms of preservation are mineralisation, desiccation and plant impressions.

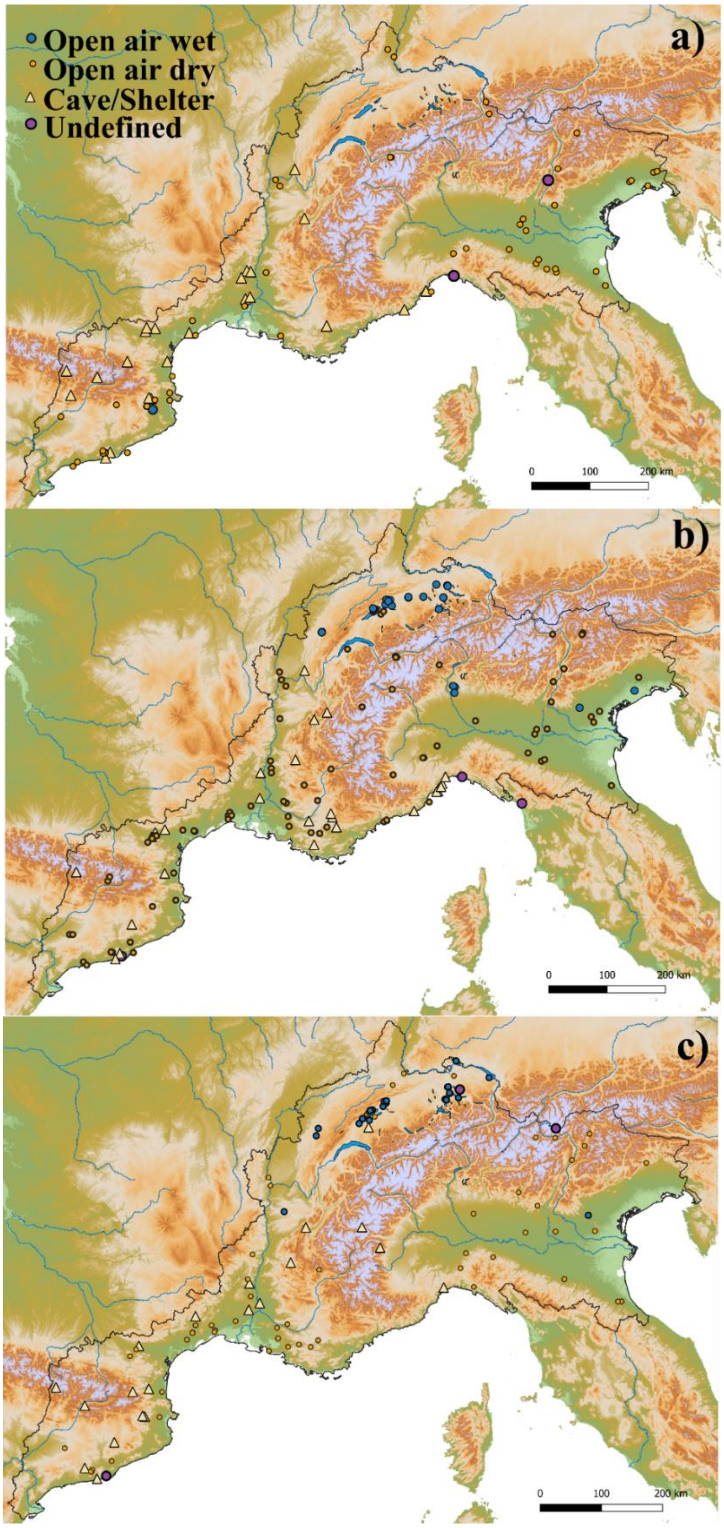

Figure 3.3 Spatial distribution of the archaeobotanical records on the four regions through the three phases. a) Early Neolithic (EN), b) Middle Neolithic (MN), and c) Late Neolithic (LN)

This study's primary type of preservation is charring, with some records having both charred and waterlogged preservation (Figure 3.4). In the Italian region, in four records from caves and four from open-air dry sites, plant impressions were the only plant remains found, especially in Liguria (Arobba & Caramiello, 2006b, 2010; Rottoli & Castiglioni, 2009). Plant impressions were not recorded in our database for other sites since these were not the priority. The addition of the Italian plant impressions was because they are usually added in the regional synthesis and aid in pinpointing the presence of crops in the region when physical seeds are not found or no archaeobotanical studies were conducted (Arobba & Caramiello, 2006b; Rottoli & Castiglioni, 2009). Plant impressions are not as clearly highlighted and are not added to the regional synthesis for the other regions. Moreover, this does not mean plant impressions do not exist in other sites. Equally, mineralised seeds were not systematically recorded in the publications, and as a result, they are not included in this synthesis.

The classification of sites into dry and wetland sites does not mean that they solely yield charred and uncharred remains respectively. In open air-wet sites, besides waterlogged uncharred preservation, charred remains, such as cereal grains and chaff, are well preserved. This type of preservation is frequently observed in the stratigraphy of swiss pile-dwellings, with burnt layers in the house occupation (Jacomet, 2013); this can also be observed in this dataset (Figure 3.4b) with charred remains found in open-air wet sites, especially in pile dwellings in Switzerland.

Similarly, uncharred remains with waterlogged preservation can also occur in particular contexts in open-air dry sites. This phenomenon happens when deep structures, such as wells, reach the groundwater level and are connected with water or the water table is high (Jacomet, 2013). This type of context is represented in the database by three sites that hold archaeobotanical studies from SE France (Figure 3.4a). Chapter 5 and Paper 1 will further discuss the importance of uncharred remains preserved in waterlogged sediments at open air-dry sites.

Recording the type of preservation (charred and uncharred remains) present in the archaeological sites was not always possible. In some cases, where only presence and absence were recorded on the publication, there was no information on which taxa were charred and uncharred. This type of uncertainty happens with some old excavations in the Italian region and in French and Swiss excavations where only taxa counts are recorded.

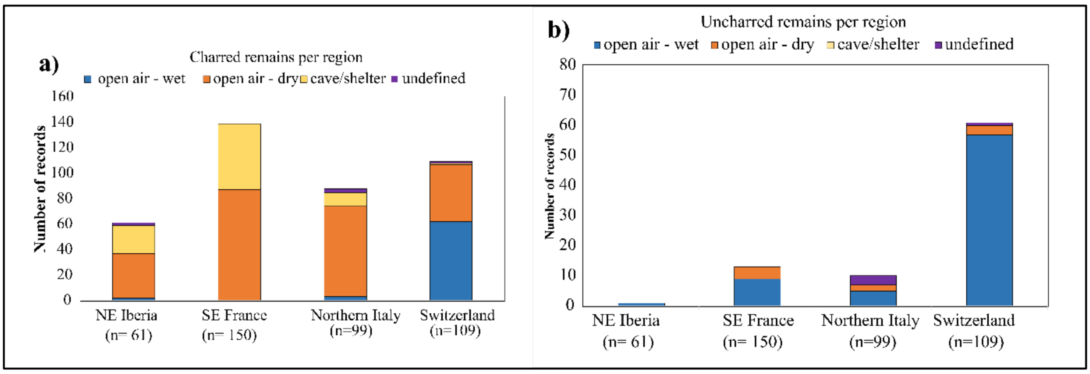

Figure 3.4 Charred and uncharred remains per record per region.

3.5 Number of samples and volume size

Sampling for macroremains depends on the questions investigated by the field archaeologists. The number of samples taken on the field and the size of the samples are crucial to finding plant remains. However, while recording the parameters for the database, it became clear that these two aspects were not systematically included in the published methods. Consequently, it was not possible to record and discuss this information.

The number of samples was not included in this data assessment criterion due to the inconsistency of the data, but added when available. The number of samples in was often not presented along with the plant identifications in the published tables. Therefore, it was unclear which samples were attributed to which structures or stratigraphic units (SU). As standard procedure, when there was one structure or stratigraphic unit (SU), and no information on the sample number, it was assumed to be one.

Nevertheless, this parameter will not be considered in the analysis as it was not possible to record it consistently due to a lack of clear information (see Appendix B: Archaeobotanical metadata). Besides the number of samples, the volume of sediment sampled is also valuable to understand the sampling strategy used, especially when there is no standard sampling volume. The volume of sediment can be used to study the density of the crop remains found in specific structures and types of sites to understand taxa concentrations. The volume is more widely available than the number of samples because it was recorded consistently in the literature.

3.6 Type of sampling and processing

The type of processing is important in order to find archaeobotanical remains. Field archaeologists would hand-pick large fruits such as acorns and hazelnuts visible in the archaeological layer. However, tiny seeds of poppy, pea or even weeds will not be visible. In order to study the uses of plants by humans in the past, it is important to have a precise sampling and processing strategy that targets different structures where macroremains can be found. The most accurate type of sampling is the systematic sampling, where sediment is taken from all excavation contexts, generally with a fixed number of litres, such as 10 or 20 (M. Jones, 1991; Pearsall, 2015, p. 81; Wilkinson & Stevens, 2003, p. 152). This strategy does not generate biases since, during excavation, it is not possible to predict which contexts contain macroremains, so the only way to be sure about it is to take samples from all of them (Pearsall, 2015, p. 74). Other types of sampling recorded are judgement, probabilistic, interval and grab sampling (Antolín, 2016, p. 102; Guedes & Spengler, 2014; M. Jones, 1991).

When researching for this dataset, the type of sampling was not clearly stated; it was recorded in the database when specified and when an interpretation was possible; however, since it was not consistently available in the publications, it was not used as a data quality criterion. Though, it is important to have a clear and systematic sampling strategy. This strategy was observed in the majority of the archaeological reports from companies in SE France, where systematic samples were usually taken of 8/10 litres, using flotation and a fine mesh as standard practice. Another example was the Neuchatel Canton (Switzerland), which took systematic samples of dry sites from the Neolithic period and always used the same mesh and processing method.

Depending on the site type and its soil specificities or even the type of sampling, these will determine the best processing strategy. In the case of the study area, especially Switzerland (Figure 3.5), pile dwellings and waterlogged remains were typically treated with wet-sieving and wash-over/*halbflotation* with fine mesh, smaller than 0.5 mm since the 1970s (see Switzerland bar graph Figure 3.6). However, for systematic sampling of large amounts of sediment at a dry site, flotation would be the quickest and most efficient process. Flotation uses water to separate light organic remains (especially charcoal and carbonised seeds) from heavier archaeological material and sediment (Pearsall, 2015). Flotation is the primary processing type for open-air dry sites in the study area (Figure 3.5). Of note is that the dates in the graphs refer to the excavation date, which means that the processing could have been done several years after the excavation. Also, sometimes the publications do not express which type of processing was done; this happens mainly for the Italian sites.

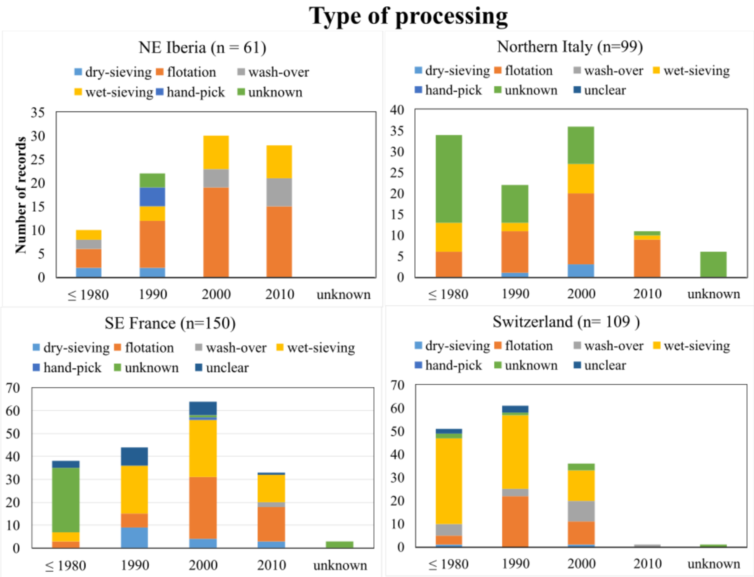

Figure 3.5 Type of processing used through the excavation years for each study region.

Besides the type of processing, the person who processes the sample is also important, and this part is hard to quantify or assess the way sediments are processed. However, this is an integral part of the quality of the archaeobotanical samples, as different sievers, experienced and inexperienced people, can interfere with the success of retrieving seeds and fruits from the sediment soil as well as the state of these macroremains. The effect of different sievers has been tested for the wash-over sieving (Steiner et al., 2015), where the researchers noted differences in the larger fractions (≥ 2 mm) where smaller seeds appear as well, depending on how careful the operator was. Also noted by the same authors, this problem can be avoided if detailed instructions with specific guidelines are given to the sievers (Steiner et al., 2015).

3.7 Mesh size

Mesh size is extremely important for finding plant remains especially tiny seeds such as opium poppy. For waterlogged preservation, the mesh size most commonly used is 0.35 mm, while for dry sites, 0.35 or 0.5 mm are typically used (Buxó, 1997, p. 33; Wilkinson & Stevens, 2003, p. 98). The comparison of the type of mesh used in the archaeobotanical data (Figure 3.6) shows that in the early years (<1980), there were no clear recordings of using mesh in SE France and Northern Italy, which probably would mean it was a grab sample. For Northern Italy, the data is not clearly published; therefore, the graph should be analysed cautiously as many records have unknown mesh type until the 2000s. For the other study areas, there is a clear strategy of using fine mesh starting in the 1990s, and most sites used fine mesh in the 2000s.

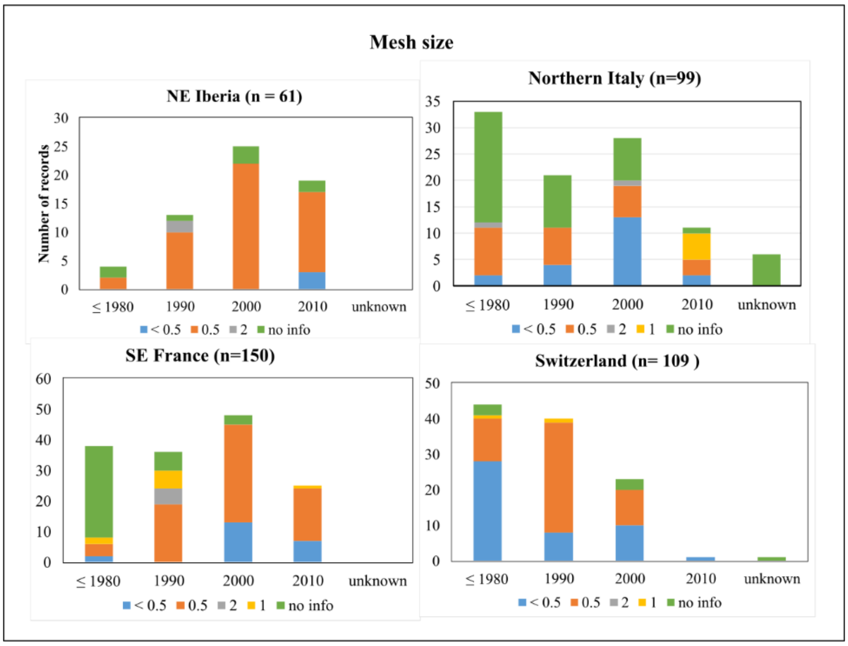

Figure 3.6 Mesh size used through the excavation years for each study region.

3.8 Type of site publication and archaeobotanical publication

The best way to publish an archaeobotanical site would be to publish the raw data per sample or per fraction. Still, such publication requires more time and space for publication; most researchers are unable to do it. After researching for this dataset, some sites were partially published or published as an addendum to another study. No clear description that would stand alone was done for the archaeobotanical records. Thus some publications did not describe the contexts where the seeds were located in the archaeological site.

Of note, the category of "raw data" in the graphs (dark blue colour in Figure 3.7) refers to datasets that may not be fully published, but they were used in this study. Regarding quality, archaeobotanical records from NE Iberia are clearly published at the structure level or even SU. This high quality of the data is because the archaeobotanical studies were done recently with up-to-date methods such as flotation and performed by a few scholars. Another reason could be that the most recent synthesis was done as a PhD and the researcher added the raw data to the IPNA database. On the contrary, SE France, Northern Italy, and Switzerland have more extended archaeobotanical research shared by scholars from different countries and "schools", and this type of investigation started earlier.

There is a clear improvement in these three regions (Figure 3.7). After 2000, the archaeobotanical papers published results per context (SU, layer and structure). In these cases, then comparisons between similar types of contexts are possible. In the case of Northern Italy, the archaeobotanical collection was done mainly from articles published in regional journals. In these publications, archaeobotany was just a small contribution to the paper not having enough space for detailed analysis.

On the other hand, monographic studies in this region include complete archaeobotanical data such as for Aosta and Emilia-Romagna regions (Degasperi & Steffè, 2019; Gattis et al., 2018). Archaeobotanical reports are related to systematic studies of archaeology that include sampling and processing sediments from rescue archaeology. This type of publication (reports for a company, institutional or region) was observed in the SE France region and Switzerland's municipality/canton level (see Appendix A: List of all sites with archaeobotanical data). In this last case, most of the archaeobotanical remains were published in national monographs paid by the cantons/municipalities (Akeret & Geith-Chauvière, 2003, 2006b, 2010; Antolín, Brombacher, et al., 2017; Brombacher, 2000, 2020; Brombacher & Jacomet, 1997; Brombacher & Schlumbaum, 2017; Jacomet, 1987; Jacomet et al., 1989; Leducq et al., 2009).

Publications synthesising a region (site level) do not allow a comprehensive study of the archaeobotanical remains. It does not specify where the remains originate or which deposition formations were present. While the publication at a structure level clearly describes where the samples and seeds were taken, allowing for an independent interpretation of the results.

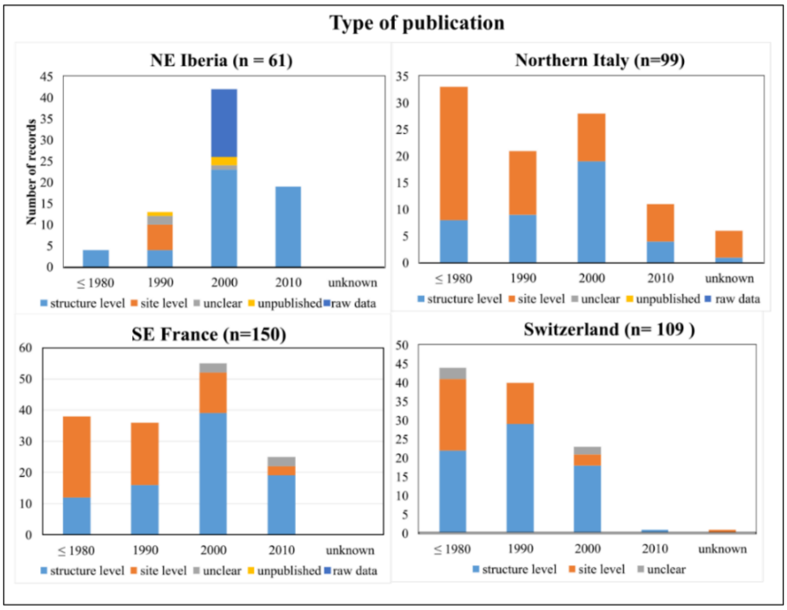

Figure 3.7 Type of publication used through the excavation years for each study region.

Besides the publication type, it is necessary to know how the data was quantified and shared. Ideally, all archaeobotanical data should be published as raw counts and recorded on a sample-by-sample basis (Jacomet & Kreuz, 1999; Pearsall, 2015) with its metadata (sensu Lodwick, 2019, p. 10). A range of quantification methods exists, such as absolute counts, presence analysis, the minimum number of individuals, levels of abundance and weight (Popper, 1988). Different methods were used to quantify the macroremains in the data collected. Before 1990, presence and absence and abundance scales were often used (for more details, check Appendix C: Data quality); after 1990, there was an evident change in the way of publishing archaeobotanical data, and absolute counts are frequently published.

Quantification information is needed to study which food plants were exploited in the past and how they were used (Hubbard & Clapham, 1992; G. Jones, 1991; Pearsall, 2015, p. 147; Popper, 1988). Even though ubiquity can be used to analyse which food plant was used, it is less biased than actual abundance (Marston, 2014; Pearsall, 2015; van der Veen et al., 2013). Nevertheless, quantification data is needed to understand introductions, diffusions, food processing, storage processing, and general social and identity of food in the population from the past (G. Jones, 1991; Popper, 1988).

In the study area (Figure 3.8), Italian archaeobotanical data was mainly published in synthesis papers with presence and absence. It was noted that for some areas in SE France and Switzerland, absolute numbers were sometimes only provided for domesticated crops, but for other species such as weeds or fruits, frequency, range or abundance were given (expressed as "other" in Figure 3.8).

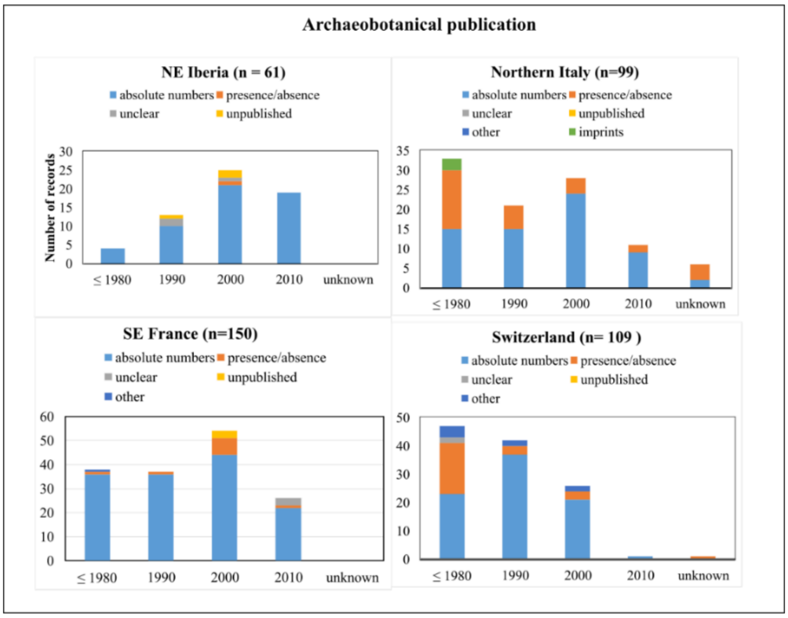

Figure 3.8 Type of quantified data in the archaeobotanical publication used through the excavation years for each study region.

3.9 Date of excavation

Archaeobotanical research in Europe can be found in prehistoric research since the 1850s (Dennell, 1992, p. 73); these were also noted in our gathered data (Figure 3.9). Important studies were published by Oswald Heer on archaeobotany from pile dwellings in the 1800s (Heer, 1866; Jacomet & Schlichtherle, 1984). Later on, in the 1970s, international teams studied Italian archaeobotany (Evett & Renfrew, 1971; Pals & Voorrips, 1979). Maria Hopf, a pioneering archaeobotanist, studied some of the sites in NE Iberia and SE France (Hopf, 1971, 1975). For more details on the different researchers, see Appendix A: List of all sites with archaeobotanical data. In the '70s, there was a clear start of the archaeobotanical sampling in archaeological excavations (Figure 3.9); this is associated with the development of Processual archaeology. This intellectual movement was based on the scientific method and increased interest in studying subsistence, social organisation, technology and ideology (Renfrew & Bahn, 2016, pp. 40–41). At this time, large-scale flotation techniques increased sites with archaeobotanical remains (Figure 3.9 – the 1980s).

In the 2000s (Figure 3.9), archaeology was considered science as itself with recognition of the public and national funds (Demoule, 2012; W. Willems & van de Dries, 2007). Extensive excavations for big public buildings, highways or even small digs within historical areas are subject to archaeologist supervision. This type is known as preventive archaeology. As mentioned before, regulations in this type of archaeology are considered in SE France, where systematic sampling for archaeobotany is performed. In some cantons of Switzerland, sampling for archaeobotany is also done. However, it was unclear if Italy and Spain have national regulations to recover archaeobotanical samples for rescue excavation systematically. This archaeological regulation at the state level is important as it ensures funds for an archaeobotanical study in the archaeological sites. In the present study, the archaeobotanical data comes mainly from preventive excavations in the 2000s and 2010s in the French region, Switzerland and rare cases from NE of Iberia. This was impossible for Northern Italy since the information did not come from reports; therefore, this cannot be assessed. The decrease in the 2010s cannot be assessed entirely as it is assumed to be the possible delay of publications or the lack of access to them because they are a novelty.

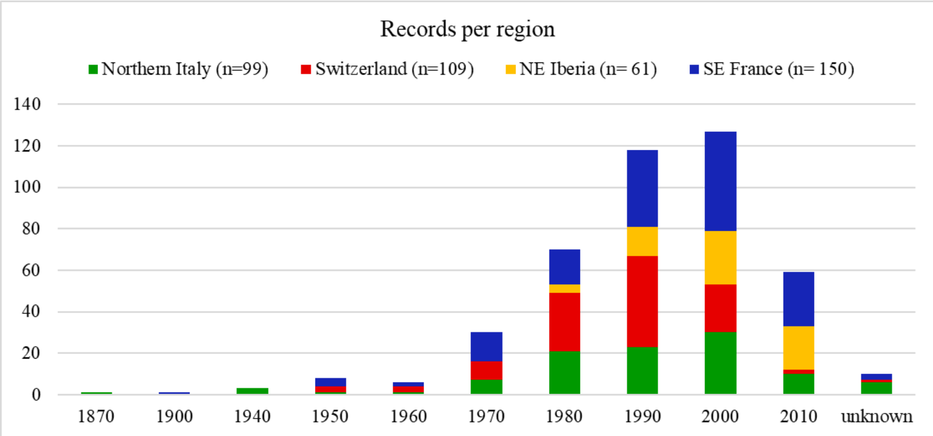

Figure 3.9 Date of excavation (per 10 years ranges given that when multiple dates the most recently is attributed) organised diachronically with each region.

3.10 Assessing archaeobotanical data quality

Archaeobotanical research centres on studying past food-related practices/foodways and past landscapes. A main goal of archaeobotany is to recover evidence for food plants exploited by past populations, where these plants came from, and how they were processed and used. The assessment of the archaeobotanical data collected is based on the information gathered from published literature. The different parameters described before, including site type, preservation, mesh size, and publication type, are considered.

In order to create a measurable assessment, each record was given a grade see Table 3.2. The grading system was inspired by van der Veen et al. (2007, 2013) categories for Britain's Roman and Medieval archaeobotanical assessment. In van der Veen et al. (2007, p. 193), the parameters for quality assessment were the number of samples analysed, the number of plant remains identified, and the level of identification. By level of identification, the authors mean that the *data were quantified (full two-way tables), whether the samples were well-dated, whether contextual information was present, and whether a full analysis of the data was carried out* (van der Veen et al., 2007, p. 193).

In our evaluation of the archaeobotanical data, the parameters used were specific to the data gathered for the study area. The parameters are the ones shown previously: the type of processing, mesh size, if the archaeobotanical data was quantified and if the data was published at a contextual level or not. These criteria are not the same as those used for the UK data. For example, the number of samples is impracticable as it was not recorded for most sites. The number of plant remains was not used either as an assessment measure as some excavations did flotation of high sediment volumes, but few remains were found. Sampling systematically with low chances of finding archaeobotanical remains is also a result, which is considered a good practice. Therefore, sites with no archaeobotanical remains are also included. For more details on the archaeobotanical records, see Appendix B: Archaeobotanical metadata and Appendix C: Data quality for all the criteria.

Table 3.2 Records and sites were evaluated using these three levels of dataset quality (based on van der Veen et al., 2007)

Good	The dataset is quantified, has contextual information and is dated (relative or absolute). Sieving is done with a minimal mesh of 0.5 mm or less. This data can help to make inferences on agriculture, food, culture and diet.
Satisfactory	The dataset was published at the sample /chronological/cultural/site level; archaeobotanical remains are quantified with absolute counts, mesh (up to 1mm);
Poor	The dataset was published at the densities/range/proportions level or presence and absence. No information on sampling, mesh and contexts is provided.

Archaeobotanical publications do not follow any specific standard of systematic format but rather are published to answer specific questions; therefore, some sites graded here unsatisfactory mainly because of the publication itself. A way to overcome this would be to access national or regional databases supported by an institution from the State that would hold all the raw archaeobotanical data together with other archaeological data. Up to this moment, there is no national database of this kind. Other databases exist, such as Inventaire National du Patrimoine Naturel (INPN), where you can search species found by period and region for France and Botanical Records of Archaeobotany Italian Network (BRAIN) for Italy, where it lists archaeological sites with the presence of seeds (Lippi et al., 2018; Mercuri et al., 2015). Other possibilities of open access publication are by data papers or by data archives (Lodwick, 2019; Warinner & Guedes, 2014). Lodwick's paper (2019) reviewed the levels of data sharing of archaeobotanical data published in the primary peer-review papers and whether the published data could be reused. About 56% of the 239 papers shared their primary data, but the way in which it is published, does not allow for it to be reused. She proposes that raw data should be published as data papers with assigned DOI, quality check and recognition by the peer review.

The results of this assessment (Figure 3.10) show that a total of 201 records out of 433 were classified as *Good*, with the NE Iberia dataset scoring the higher representative with 67% and Northern Italy the lowest with 32%. The good results for NE Iberia are related to the fact that the publications and excavations are relatively recent compared with the other regions, as discussed in sections 3.8 and 3.9 but also have fewer records. In contrast, the other three regions have a long history of excavating and continually evaluating old findings. Only 69 records are present for the *Satisfactory* category, and the *Poor* category has 149 records. Italian data has a higher score in terms of Poor data; this results from how the archaeobotanical data is published without quantitative and contextual information (see section 3.8).

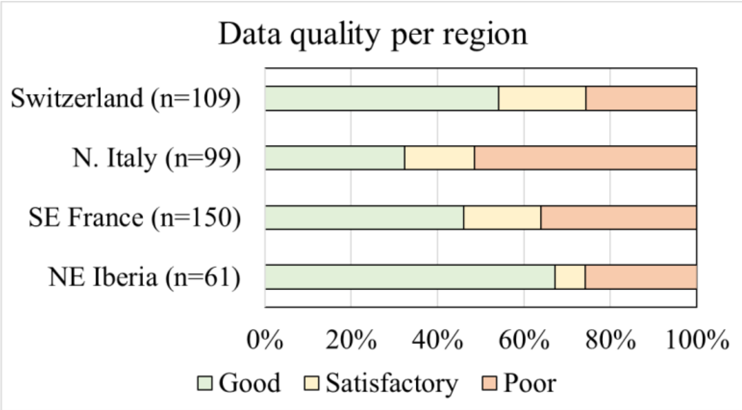

Figure 3.10 Results of evaluating the data quality at the scored level with the number of records and the overall percentage of the dataset collected in this manuscript.

3.11 Implications and problems

The work analysed here is certainly not a complete dataset. Nonetheless, especially these times, more and more grants and money are used to produce all data as open access. Therefore, national or European databases will be updated in the following years and in an open-access format. Hopefully, the grey literature will become open access, such as unpublished reports from companies and institutional and state interventions.

Another problem noted is the lack of connection between archaeological and archaeobotanical data. The archaeobotanical reports lack archaeological information; sometimes, the reports are at the sample level, but no clear explanation of where the samples are coming from or the descriptions are ambiguous such as a pit or well, without referring to which one. Consequently, it is not easy to integrate the interpretation of the structure and the connection to the site with the archaeobotanical record.

Other issues concern the type of site and the chronology of the archaeobotanical data. Sometimes, no precise classification or interpretation was given for the type of site. Also, rarely there are chronological dates associated with the archaeobotanical data. Mainly, the dates are associated with contexts or the site's overall chronology. The chronological ascription of sites is complex and should be done on a contextual basis to connect fully to the archaeobotanical data. For the archaeobotanical data reports, sometimes the dates are added after, and the report becomes obsolete. In other words, since the report was organized in the assumption of the archaeological interpretation, but new evidence was available later on, the analysis of the archaeobotanical contexts should be reorganized. This only happens when papers do not mention specific information, such as the number of samples and structures. If these publications had divided the data in that way, it would be possible to distinguish them instead of chronological groups. Then, the chronology was revised, and that grouping is not accurate. Of course, this results from the constant advance in science; however, it should have an institution or mechanism to update the archaeobotanical dataset. Such a platform should combine information on sites and people involved in updating the new information.

In terms of methodology, defining counting units and recording macroremains might have different meanings across the Agrichange areas, including even in one region. The work is based on multiple researchers with different training and experiences. The data collection of archaeobotanical data had quantified numbers (357 records; see Appendix C: Data quality). When those existed, sometimes it did not clearly state which part of the plant was recovered. The assumption here is that unidentified records should be allocated to seed/grain/fruit as, by the experience of reading these reports, chaff or other parts less common than the grains/seeds are indicated. Another quantification problem is how researchers quantify data; in some cases, precisely defined counting units are proposed (Antolín, Steiner, & Jacomet, 2017; Antolín, Steiner, Akeret, et al., 2017; Steiner et al., 2017). For example, the archaeobotanical database at IPNA, ArboDat ©2018 (Kreuz & Schäfer, 2002), has been used for most Swiss sites. The information in the ArboDat has been added using a specific quantification strategy, recently published by the team (Steiner et al., 2015). For the IPNA team, counting units' examples would be cereal grains with the embryo (charred); for flax capsules, only capsule fragments with apex are counted (charred and uncharred); *Malus/Pyrus* pericarp (waterlogged and charred) when larger than 3x4 mm. Other species counting strategies can be seen in the following papers (Antolín, Steiner, & Jacomet, 2017; Antolín, Steiner, Akeret, et al., 2017; Steiner et al., 2017).

In the study area, methodological studies refer to how the minimum number of individuals was estimated (Neveu & Zech-Matterne, 2016) or how the fragmented seeds/fruits were counted (Antolín, 2016; Antolín & Buxó, 2011b). Most of the reports use specific quantification methods, which are implicit in the tables with numbers for units and fragments. In very few publications and primarily old ones, there was no description of quantification or if the taxa were counted or not. Nevertheless, in old excavations with archaeobotanical remains, remarkable details on the seeds with drawings and seed measurements were also observed (Lundström-Baudais, 1977; Villaret-von Rochow, 1967; Waterbolk & Zeist, 1967).

3.12 Application of this archaeobotanical assessment

The dataset presented here is good enough to brief us on some basic information, such as which crops were grown and maybe consumed. Some areas in the study region lack information, as shown in the spatial coverage (Figure 3.3). This could be related to the fact that no communities were present at the time, but it could also be showing the lack of research in those areas or that this research is not yet published. For example, in Northern Italy, there are new excavations with archaeobotanical studies, but they are not consistently published. Not all data from the ongoing AgriChange project has been published and therefore is omitted in this synthesis.

The results of this database could also be used to select areas or periods where archaeobotanical information is missing. For example, this would be useful to regulate the archaeobotanical sampling for all Early Neolithic sites. This regulation would increase the knowledge of macroremains inland and early sites.

In the next chapter, all 419 records will be used to give a first overview of the archaeobotanical data regarding the plant taxonomic diversity across the different periods. While the "Good" records will be used for picking the sites for paper 1 (5.7 Research paper 1). In Paper 1, a contextual comparison between pits and wells will be made regarding archaeobotanical findings. This selection of "good" sites was also helpful for Paper 3, where only good quality sites were chosen to select opium poppy seeds for geometric morphometric analyses (6.9 Research paper 2).

Chapter 4 The overview of the archaeobotanical data in the NW Mediterranean and North Alps

4.1 Introduction

This chapter reviews the archaeobotanical evidence throughout the Neolithic period (5700-2300 cal. BC) in the NW Mediterranean and its connection to the North of the Alps. This chapter aims to identify any regional and chronological patterns, similarities and differences using archaeobotanical data. The chronocultural framework spans from the first domesticated crop introductions to the appearance of bronze (Antolín, 2016; Bouby et al., 2018; Hafner & Suter, 2001; Rottoli & Castiglioni, 2009; Stöckli et al., 1995; Tecchiati et al., 2013). The area covered is represented by the current regions of NE Iberia, SE France, Northern Italy and Switzerland.

The spread of southwest Asian crops in Europe followed two main routes (Bocquet-Appel et al., 2009; de Vareilles et al., 2020; Salavert, 2017). Domesticated plants spread throughout the Mediterranean Sea, and these were found in Greece around 6400 cal. BC (Reingruber & Thissen, 2009). From here, crops spread up to central Europe via the Danube river, associated with the LBK (*LinearBandKeramik*) culture (Kreuz, 2007; Kreuz et al., 2020; Kreuz & Marinova, 2017; Lüning, 2000; Rivollat et al., 2016). The other route was by seaward, following the Adriatic and Mediterranean coastline, where crops are also found (Bocquet-Appel et al., 2009), spreading to SE France, NE Iberia and Northern Italy (Antolín et al., 2015; Bouby, Marinval, Durand, et al., 2020; Rottoli & Castiglioni, 2009) and from here disperse north overland, north the Alps, via Rhone river (Martin, 2015; Tinner et al., 2007). The beginning of agriculture in the western part of the Mediterranean basin (NE Iberia, SE France, Northern Italy) is associated archaeologically with the Neolithic period. The earliest crop evidence in the western Mediterranean dates around 5800-5600 cal. BC while in the region North of the Alps, in the Valais region, in Switzerland around 5400-5000 cal. BC (Table 4.1). In order to compare the four regions, instead of using local periodizations, only general chronologies were used, allowing to compare contemporaneous records. The broad chronologies were outlined before in section 2.2.

Table 4.1 The earliest crop dates for the study region

North-East of Iberia Peninsula (NE Iberia)	5610-5386 cal. BC	(Oms Arias et al., 2013)
Southern France (SE France)	ca. 5850–5650 cal. BC	(Bouby, Marinval, Durand, et al., 2020)
Northern Italy	5646-5534 cal. BC	(Alemany & Starnini, 2016)
Switzerland	ca. 5400-5000 cal. B	(Martin, 2015)

The first domestic species to reach Europe from the Near East consisted of barley (*Hordeum vulgare*), einkorn (*Triticum monococcum*), emmer (*T. dicoccum*), naked (*T. aestivum/durum/ turgidum*) and Timopheevii wheats (*T. timopheevii*) in terms of cereals. For pulses, these are pea (*Pisum sativum*), lentil (*Lens culinaris*), chickpea (*Cicer arietinum*) and bitter vetch (*Vicia ervilia*). The native origin and wild progenitor of fava bean (*Vicia faba*) are unknown (Zohary et al., 2012); vetch (*Vicia sativa*) and grass pea (*Lathyrus sativus/cicera*) are frequent in the Mediterranean area; however, their cultivation is still poorly understood, and they are regarded as weeds and used for animal feed (Kislev, 1989; Zohary et al., 2012). However, these species are still not well studied in the study area. Peña-Chocarro & Zapata (1999) listed some traditional dishes and preparations linked with saint's days in Spain that included *L. sativus* (e.g. Saint Antón's day, a stew of *L. sativus* seeds is cooked and distributed in the Gamonal square in Burgos). In terms of oil plants, flax (*Linum usitatissimum*) is considered to be one of the crop "founders" domesticated in the Near East and brought to Europe (Zohary et al., 2012). At the same time, the putative wild ancestor of the opium poppy (*Papaver somniferum*) is suggested to be *P. setigerum*, and its main native area is the western Mediterranean area (more details in Section 6.5 Geographic area and habitat).

These crops did not spread at the same speed and time or follow the same routes throughout Europe (Colledge et al., 2005). The spread depends on several factors, such as local environment conditions, how people began cultivating them, and cultural and social aspects.

4.1.1 Early Neolithic (EN) Phase 1 – 5700-4500 cal. BC

A short overview of each region will be given in each section, following a regional order. For the Early Neolithic, in the North-East of the Iberia Peninsula (Bosch & Santacana, 2009; Guerra et al., 2012), crop evidence is mainly associated with communities with Cardial pottery (Antolín, 2016, p. 38), with the earliest evidence from an open-air site with naked wheat, El Cavet, dating 5610-5386 cal. BC (Oms Arias et al., 2013). At the same time, there is evidence of domestic crops such as naked wheat and barley that coincide with temperate and humid climatic conditions (Buxó, 1997, pp. 145–147). The first sites were located close to rivers and marshland areas (Buxó, 2007).

Domesticated crops were first introduced to the coastal areas of SE France by Impressa groups ca. 5850–5650 cal. BC (Guilaine & Manen, 2007; Manen et al., 2019). The Impressa complex in Southern France shows similarities with Italian Impressa ceramic and lithic systems (Manen et al., 2019). The presence of obsidian from Palmarolla and Sardinia on French sites suggests that domesticated plants were brought from Italy (Bouby, Marinval, Durand, et al., 2020; Guilaine et al., 2007; Manen et al., 2019). The oldest sites with crops are Pont de Roque Haute and Peiro Signado (France), respectively, dated 6002-5758 cal. BC and 5964-5721 cal. BC (Bouby, Marinval, Durand, et al., 2020). After these first pieces of evidence, more sites are found associated with the Cardial group, starting around 5400 cal. BC and Epicardial groups, starting around 5250 cal. BC are found inland and not only at the coast, as it happens with Impressa communities (Bouby, Marinval, Durand, et al., 2020; Hamon & Manen, 2021; Manen et al., 2018).

In Northern Italy, on the Liguria coast, the first domestic crops are found at Arene Candide and San Sebastiano di Perti, dating 5646-5534 cal. BC (Alemany & Starnini, 2016). Unlike NE Iberia and SE France, in Northern Italy, there is a higher local diversity in terms of pottery styles such as the Isolino, Vhò, Fiorano, Diana, Danilo and Gaban (Pessina & Tiné, 2008). Around 5200-5000 BC in Liguria, the first potteries of Square Mouth Vases (VBQ1) appear (Binder et al., 2008). In terms of other Neolithic characteristics, Italian sites have clear delimitations of the archaeological sites with palisades and ditches, examples of Lugo di Romagna and Lugo di Grezzana, and larger sites with several pits found (Cavulli, 2003; Cavulli & Pedrotti, 2001; Degasperi & Steffè, 2019; Salzani et al., 2015).

In Switzerland, the first Neolithic evidence was found in canton Valais (Baudais et al., 1990; Curdy, 2007). Gallay (2008, p. 99) suggests that the first farmers came from Northern Italy and settled in the plain of the Rhône after 5500 BC. The first crop evidence comes from the open dry site of Sion-La Planta (Martin, 2015). Shortly after 5000 cal. BC, cereals, oil plants, and pulses appear in two other sites in Sion (Valais), 2 km from the Sion-La Planta site, in Sion-La Gillière and Sion-Tourbillon (Martin, 2015). Also, these two sites show Mediterranean influences, visible by the type of ceramic and the presence of Mediterranean plant species. The pottery assemblage from the Tourbillon site shows similarities with the Isolino group in Northern Italy (Müller 1995 in Martin, 2015). Mediterranean species such as *Scleranthus annus*, *Papaver dubium* and *Buglossoides arvensis* (Martin, 2015) suggest a Mediterranean connection. The south area of Switzerland could be connected via exchanges with communities living in the French regions using the Rhone river and Lake Geneva, and other routes might have existed connecting to the North of Italy (Baudais et al., 1990; Curdy, 2007). The lack of sites in this area and period does not enable a better interpretation (Denaire, Doppler, et al., 2011).

Eastern Switzerland and the Alsace (France) are influenced by the continental spread of domesticates by the Linearbandkeramik (LBK) culture (Denaire, Jeunesse, et al., 2011). LBK appeared around present Hungary ca. 5500 cal. BC rapidly diffused westward to the Rhine River, also called Rubané (Denaire, Jeunesse, et al., 2011). At the end of the sixth millennium, successive cultures deriving from the LBK/ Rubané, such as Hinkelstein culture, ca 4950 cal. BC, followed by Grossgartach culture ca. 4750 cal. BC and then this culture evolved into the Roessen culture ca. 4450 cal. BC (Denaire et al., 2017; Denaire, Jeunesse, et al., 2011). In the Hinkelstein period, domesticated seeds were found in Zizers-Friedau, canton Graubünden in the Alpine Rhine Valley (around 4800 BC). Another site with archaeobotanical remains is Sevelen-Pfäfersbüel, situated in the same valley but from an earlier period and attributed to Roessen culture (Rigert, Ebneter, et al., 2005). It took almost six hundred years to find another site with archaeobotanical data, this time located in the Swiss plateau associated with the pile-dwellings of Egolzwil 3 and Zurich-Kleiner Hafner (Bollinger, 1994; Jacomet, 2007, 2014; Suter & Jacomet, 1987), dating from the Middle Neolithic period.

4.1.2 Middle Neolithic (MN) Phase 2 – 4500-3300 cal. BC

The Middle Neolithic is a period where regionalism is more dominant, illustrating the increase of identity and social differentiation in all regions (Burri-Wyser & Winiger, 2016; Manen & Hamon, 2018; Perrin, 2016; Pessina & Tiné, 2008). This regionalism visually shows the different pottery styles and lithic objects and the multiplicity of mortuary practices (Chambon & Leclerc, 2003; Léa, 2005; Mottes et al., 2009; Perrin, 2016; Pessina & Tiné, 2008). To clarify, starting at 4500 cal. BC, the material culture attested for specific groups (Sepulcres de fossa group in NE Iberia; Chassen and St Uze group in SE France; Square Mouth Vase and Lagozza in Northern Italy; and Cortaillod in Switzerland) indicates the development of homogenous local groups. Since these local styles are well defined, it is easier to identify exchanges when these specific objects, such as potteries, are found in other regions (Gernigon, 2016a; Molist et al., 2016). More structures made of stone, earth and wood appeared during this period, suggesting sedentarisation (Burri-Wyser & Winiger, 2016; Garcia & Montaña, 2009; Gernigon, 2016b; Giligny & Sénépart, 2018). Clear evidence of an exchange network within the study area is visible, with similar objects appearing in all regions (Denaire, Doppler, et al., 2011; Gernigon, 2016a; Perrin, 2016).

In NE Iberia, the *Sepulcres de fossa* group are known from this region (Bosch & Santacana, 2009). The beginning of the importance of mortuary goods is also noted with the extraction of variscite in Gava mines. This mineral was used to make personal adornment objects such as beads for necklaces (Borrell et al., 2013) and was present inside the burials. Another type of site present in NE Iberia and SE France is known as the caves-sheepfolds (Alonso-Eguíluz et al., 2016; Angelucci et al., 2009; Brochier et al., 1999). Cave-sheepfold is a site where deposits known as *fumiers* are found. These sediments are made of burnt herbivore dung and are commonly interpreted as the product of depositional actions related to animal husbandry, stabling and stock-keeping (Angelucci et al., 2009). This type of site was also present in the early period in Northern Italy, e.g. Arene Candide (Angelucci et al., 2009; Nisbet et al., n.d.).

Middle Neolithic in SE France is divided into two periods, MN1 and MN2 (Denaire, Doppler, et al., 2011); for more details, see Chapter 5. Pottery styles are mainly known as Chasséen, and its groupings, such as Prechasséen and the ancient Chasséen, developed in Provence and the middle Rhône valley (Willigen et al., 2011). Saint-Uze is localised in the French Rhone basin and the southern Jura (Beeching et al., 1997). The "Caves-sheepfolds" are located in the plains on the alluvial terraces and high altitudes related to pastures in SE France (Beeching, 2011; Brochier et al., 1999). For the Middle Neolithic 2, between 4100 and 3500 BC, there were five “cultural” groups present in SE France: Sepulcres de fossa in the east, the recent Chasséen in the west, the Burgundian Middle Neolithic (NMB) in the centre, Cortaillod and Pfyn to the North and Lagozza to the southeast of the SE of France (Martin, 2010; Perrin, 2016).

In Northern Italy, the culture of Lagozza is located on the shores of the lakes of the Lombard alpine foothills (Lake Maggiore, Lake Lugano, Lake Como, Lake Garda), a continuity of VBQ, with influences of Chasséen groups from SE France (Borrello, 2014; Borrello & van Willigen, 2013). In the Middle Neolithic period 2, cultural affinities are visible in material culture throughout the western Alps and the western Po plain, denoting the extent of the contacts established through the Alps (Affolter & Suter, 2017; Stöckli et al., 1995).

In the South of Switzerland, the MN is also divided as in SE France (Denaire, Doppler, et al., 2011). In the Middle Neolithic 1, in the Valais Proto-Cortaillod, sites are found in low and medium altitudes. There are elements of Saint-Uze, Egolzwil and VBQ showing influences from the North and the East (Piguet, 2011). Mortuary practices indicate a unique identity in the Middle Neolithic 1 (Jeunesse et al., 2019). Cists burials of the “Chamblandes” type are mainly known in the Lake Geneva basin, the Valais and the Aosta Valley (Jeunesse et al., 2019). This type of burial constitutes a cultural dynamism typical to the Western Alps; these types of funeral practices in the middle Rhône valley where cists are unknown (Moinat & Chambon, 2007).

At the end of the Middle Neolithic 1, the first pile dwellings were built in the Swiss Plateau (Schlichtherle et al., 2013). In these sites, rich objects reflecting the day-to-day Neolithic communities are found, such as textiles, boats, houses, plants and food remains, craft objects and complete tools (Menotti, 2015; Menotti & O’Sullivan, 2013; Schlichtherle et al., 2013). For Egolzwill 3 site, there are Mediterranean influences (Schlichtherle et al., 2013) like the flint objects from Southern France (Gibaja et al., 2017). Another interesting influence regards the harvesting tools and techniques. The oblique insertion of the blades and the two-stage reaping action are similar to the two-stage La Draga-type reaping (Palomo et al., 2011). These knives are also associated with the site of Samardenchia in northeast Italy (Gibaja et al., 2017; Schlichtherle et al., 2013). These authors argue that Egolzwil 3 reaping knives are related to the La Draga implements. The presence in Switzerland of naked wheat (*Triticum durum/turgidum)* suggests links between Swiss Neolithic groups and the Mediterranean area (Jacomet & Schlichtherle, 1984; Maier, 1996). In the Middle Neolithic 2, Cortaillod pottery is found in Valais, next to Petit-Chasseur and Saint-Léonard types (Besse & Piguet, 2011). In the Swiss Plateau, the number of pile dwellings increased during this period (Burri-Wyser & Winiger, 2016).

Megalithic monuments appear during this phase in NE Iberia, SE France, Northern Italy, and Switzerland (Schulz Paulsson, 2019). The megaliths practices' origin and social structure are unknown but are usually associated with farming communities (Sánchez-Quinto et al., 2019). Many megaliths were used for collective burials (Midgley, 2008; Sánchez-Quinto et al., 2019). It has been suggested that these societies were patrilineal as there are more males than females in some megalithic graves. In contrast, a recent study in North Europe shows that female kindred members were not excluded as evidence found that three of five kinship relationships involve females (Sánchez-Quinto et al., 2019).

4.1.3 Late Neolithic (LN) Phase 3 – 3300-2300 cal. BC

There are fewer archaeobotanical remains from dry sites in this phase, which could be related to a lack of research on settlements for this period. Few sites are found, and fewer are sampled for archaeobotanical records. It could also be related to possible climatic deterioration (Arbogast et al., 2006; Schibler & Jacomet, 2010). In the case of NE Iberia, Antolín et al. (2015, p. 91) state that sites with macroremains decrease, indicating a preservation problem. Evidence on settlement dynamics from this region shows that Late Neolithic before Bell Beaker sites are found in valleys and less on plains and hillsides, while the sites associated with Bell Beakers are primarily in plains (Caraglio, 2018, p. 43). For SE France, a recent publication (Bouby, Marinval, & Rovira, 2020) does not show a decrease in domestic crops; in the sites analysed, the majority were cereals with an increase of presence einkorn and some frequency of wild plants. In Northern Italy, there is a decrease in sites with archaeobotanical data (Rottoli & Castiglioni, 2009). However, it is clear that cereals are more frequent than wild plants (Tecchiati et al., 2013, fig. 2). For Switzerland, an increase in the usage of wild resources was suggested, both plants and animals, for a specific period prior to 3400 cal. BC (Schibler et al., 1997; E. Wright, 2021). These changes are attributed to possible climatic deterioration, probably due to a wet phase, between ca. 3550 and 3250 B.C. and around 2900 BC are also the phases in which there is less archaeological information (Arbogast et al., 2006, p. 409). The correlation between climatic deterioration and the increase in the exploration of wild resources, such as hunting and gathering, is not always straightforward. An example of that is observed between 3200 and 3100 BC, where wild animal bones were present up to 70 % in the swiss sites and during this period, no climatic deterioration was observed (Arbogast et al., 2006, p. 414).

Aside from the human subsistence evidence, there was a substantial diversity of groups when studying the archaeological assemblages; this suggests a more diverse social identity. In NE Iberia, the pottery of the group Vérazien (from SE France) and Bell Beakers are found (Caraglio, 2018). For SE France, in the middle Rhône valley, as in Languedoc, these are the Ferrières and Fontbouisse groups; the Fraischamps group in Vaucluse and the Charavines group is present in the Rhône-Alpes region (Jallot & Gutherz, 2014; Martin, 2010). For Switzerland, Horgen, Lüscherz and Auvernier-Cordé groups are present in the Swiss Plateau and in the Valais canton, while the Clairvaux and Chalain groups remain in Jura canton (Hafner & Suter, 2003; Martin, 2010; Stöckli, 2009). In northern Italy, a style of ceramics called White Ware spreads around Lake Garda in Piedmont and Liguria (Aspes et al., 2002; Pessina & Tiné, 2008). After 3000 BC, the Remedello type followed and showed affinities with Languedoc Fontbouisse, followed by the Campaniform/Bell beakers period (Guilaine, 2004; Pessina & Tiné, 2008).

Burial practices are also varied but typically occur in collective burials, where the preservation of bones is not good (Siebke et al., 2020). However, when the preservation of the bones is good, stable isotope data (δ 13C, δ 15N, δ 34S) can be used to understand the human and animal diet. In a recent study (Siebke et al., 2020, p. 26) for the Middle-Late Neolithic and Early Bronze Age, conducted in 21 sites in Switzerland, the results show no nutritional differences between males and females, suggesting an equal social status of animal protein consumption was an indicator. This study also argues that females were more mobile than men suggesting that the society was patrilocal. Diverse sulphur values in a woman are seen as an indication of mobility (Siebke et al., 2020).

4.2 Material and methods

Data was collected from 419 records (*Neolithic* records with no precise date were excluded). Some sites have several records as they were occupied during several local periodisations. According to the archaeobotanical reports, all data was divided into records in specific chronological and different phases. The number of records was divided into the Agrichange project phases (Phase 1 – 5700-4500 (EN); Phase 2 – 4500-3300 (MN), and Phase 3 – 3300-2300 (LN) see Section 2.2). For the Early Neolithic, 94 records (22%) are present, the Middle Neolithic has 187 records (45%), and 138 records (33%) are attributed to the Late Neolithic period (Table 4.2 and Figure 4.1). The predominant type of site is open air-dry sites (58 %), followed by cave/shelter (21%) and open air-wet sites (19%). These open-air–dry sites are mainly sites with pits, hearths, ovens and wells and rarely with clear house plans or ritual assemblages. In this chapter, the focus will be on the overall archaeobotanical data, and this will be divided into records coming from dryland and wetland (Table 4.2). This entails that all charred remains from all dryland sites (open-air dry and wet, cave/shelter, mines and undefined) were analysed together. While for, the case of the uncharred remains from waterlogged deposits (open-air wet, undefined and well structures) were analysed together. A clear overview of the difference in records between the number of sites per type of preservation and phase can be seen in Figure 4.1. This distinction was made because of the taphonomic origin, as oil plants and edible plants such as berries are better preserved in waterlogged conditions than in dry sites with carbonisation conditions (Brombacher & Jacomet, 1997; Colledge & Conolly, 2014; Märkle & Rösch, 2008).

Table 4.2 Table with all the records per type of site and phase

	Type of sites	
	dryland	**wetland**
Phase 1 (n=94)	92	2
Phase 2 (n=187)	150	37
Phase 3 (n=138)	98	90

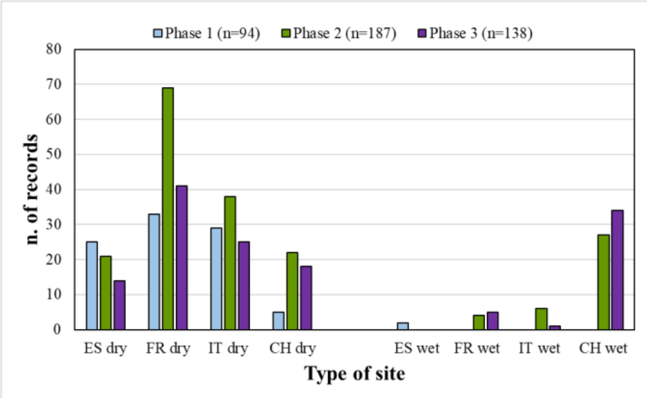

Figure 4.1 Number of records per type of preservation and per phase

Information on the type of sampling, processing technique, mesh size, and volume of sediment can be found in Appendix C: Data quality, and for details, check Chapter 3. In order to overcome such disparities, findings were recorded as presence/absence of taxa per record. Therefore, the rise of the ubiquity score does not translate to an increase in the absolute number of finds of a taxon. The use of ubiquity allows exploring the spatial-temporal patterns in the distribution of taxa across broad areas. This approach has been used successfully in other papers (Colledge et al., 2004; Coward et al., 2008; de Vareilles et al., 2020; Gaastra et al., 2022) with similar issues such as reports with the sample to sample descriptions and no information about the context or mere presences at the site level. The analysis will be done using bar charts representing ubiquities, the total presence of taxa divided by the total number of records per phase. For each species present, "1" was given regardless of data quantification. Absences were recorded with "0" values (see Appendix B: Archaeobotanical metadata_Table 2 Archaeobotanical dataset, presence/absence data). The edible wild plants were selected and described in Chapter 2.

All data was divided into four regions for the first level of analysis – the regional analysis and presented by period using bar charts. The data were analysed according to their type of preservation. The bar charts were produced using Microsoft Excel (MicrosoftCorporation, 2018), and images were improved using Inkscape (Harrington, 2005). Colours per period and country were used consistently to aid the reading of the graphs. All cereal grains and pulses categories were plotted in one graph (showing only charred preservation), oil plants in another (considering only uncharred preservation), and finally, another with all the wild edible plants separated for each preservation type.

Of note is that there are some sites without information on counts or if the remains were charred or uncharred. That is why the sites were divided into dry and wet sites, assuming that wet sites would have both charred and uncharred but can be counted as "waterlogged" due to preservation. This assumption was only used for the wild edible plants (some of which would not survive in charred conditions and are less frequent in dry sites). For the uncharred remains of the wells found in the dry sites, it was added to the "wet sites". Only charred cereal grains were counted as present from both dry and wet sites for the charred material. However, in some sites where only presence and absence are quantifiable, there is no clear explanation if the identification refers to grains or chaff. In exceptional cases such as Northern Italy, the impressions of grains were also added, as has been done in the most recent synthesis (Arobba et al., 2017; Arobba & Caramiello, 2006a; Mottes et al., 2009; Rottoli & Castiglioni, 2009).

The second level of analysis, the chronological comparison, is between percentages of the presence of different taxa per period in all regions combined. These are shown by two bar charts comparing the following categories grains, pulses and oil plants chronologically in one graph and wild edible plants in another graph; only charred material was counted. The excellent preservation of the waterlogged state would overshadow the primary trend, and the two types of preservation should not be compared. Therefore, waterlogged remains were removed from the chronological comparison. The wild edible plants presented here are the ones determined in Chapter 2, Section 2.4.

4.3 Results and Discussion

4.3.1 Phase 1 (5700-4500 cal. BC)

Archaeobotanical data from the Early Neolithic period (5700-4500 cal. BC) comes from 94 records from cave/shelter sites, open-air dry sites and one wetland site. Figure 4.2 combines a region map with four bar-charts showing the ubiquity of fourteen crops for each region. While Figure 4.3 shows the ubiquity of the wild edible plants per region, charred and uncharred. The uncharred was added despite there were only two records highlighted in yellow. This means that the ubiquity values obtained are just orientative.

In NE Iberia, in 27 records, barley and naked wheat (70%) are the most common cereals, followed by emmer wheat (41%), and less common are einkorn and Timopheevii wheat (11-7%). In SE France, in 33 records, barley is the most predominant (61%), followed by naked wheat (55%), emmer wheat (42%) and einkorn wheat (36%). In Northern Italy, in 29 records, barley (86%) is the main crop, followed by emmer (62%), einkorn (48%), naked (45%) wheats, and Timopheevii wheat (7%) is rarely present. In five records, the main crop in Switzerland is naked wheat (100%), appearing in all sites. Barley (80%) was the second predominant crop, followed by emmer and einkorn (40%) wheats.

The main regional difference in charred cereal grains ubiquities is that in NE Iberia, there is less percentage of glume wheats (<38%), and Northern Italy has fewer naked wheat ubiquities than glume wheats. The new glume wheat (Timopheevii wheat) is identified only in NE Iberia and Northern Italy. Barley and naked wheat are the main crops for NE Iberia, SE France, and Switzerland.

Glume wheats (emmer and einkorn) are the first domesticated wheats in the Near East and the two main crops to spread to Europe. Results from areas beyond our study area, such as the LBK area, indicate that einkorn, emmer, pea, lentil and flax were the most common crops in central Europe during this period (Kreuz, 2007; Salavert, 2011). Although not visible in our gathered data (Figure 4.2), glume wheats were predominant in the early sites of NE Iberia, SE France and Switzerland. In Can Sadurni oldest phase, emmer was the most important crop, but there was a shift to naked wheat (Antolín, 2016). Impresa sites from SE France, like Peiro Signado, Ponte Roque and Pedimoun (Bouby, Marinval, Durand, et al., 2020), glume wheats were dominant. This changed with the cardial/epicardial groups, where naked wheat became predominant. While in the case of Northern Italy, there is a clear predominance of glume wheats (Rottoli & Castiglioni, 2009). For Eastern Switzerland, in Zizers site (around 4800 cal. BC), barley and emmer were the main crops, with little evidence of einkorn and naked wheat (Brombacher & Vandorpe, 2012), while in the South part of Switzerland, at the early site of La Planta, only five grains of naked wheat are present (Martin, 2015). Only later, in the other sites in the same region, such as Sion-La Gillière 2, naked wheat is predominant in relation to barley and emmer grains (Martin, 2015). Naked wheat also belongs to the founder crops of the Near East Neolithic; however, its spread seems to be more cleared and accepted across central Europe from 5thmillennium cal. BC (Kirleis & Fischer, 2014).

In terms of pulses (Figure 4.2), in NE Iberia, the main legume is pea (19%), and less present are chickpea, lentil, bitter vetch and fava bean (4%). In SE France, pea (21%) is as well the most predominant pulse, followed by grass pea and lentil (9%) and fava bean (6%). In Northern Italy, pea is present in 21% of the records, followed by lentil and fava bean (17%), and less present are grass vetchling and bitter vetch (7%). In Switzerland, only pea is present with 40 % frequency.

The high diversity of legumes is only visible in some regions of Europe, such as Greece and Bulgaria, where a combination of pea, lentil, grass pea, bitter vetch and chickpea appear in the Early Neolithic (Marinova & Valamoti, 2014). While for LBK sites, there are only two legumes, lentil and pea (Kreuz, 2007). In our study area from seven species, only one is recorded in Switzerland, pea, which is the most frequent legume in all regions. Bitter vetch appears in NE Iberia and Northern Italy but does not appear in the records of SE France. For the other species present, fava bean and lentil have the same highest ubiquity (17%) in Northern Italy and the other species, grass pea and bitter vetch, show very low ubiquity. This region shows a large diversity in legumes (Rottoli & Castiglioni, 2009) compared to the central Europe area. The low quantity of pulse species in the Neolithic period has been explained by differences in regional climate, which would not allow some crops to grow in central Europe (Colledge et al., 2005, p. 148). This might explain why pulses are absent in the archaeological record, especially at the beginning of the Neolithic period.

Oil plants such as flax and poppy are present in the study area during this period (Figure 4.2). Only poppy is present in NE Iberia and SE France in these regions (4-6%). However, when considering the wetland records from NE Iberia, in two records, there is only one with poppy (50%). In Northern Italy, flax (10%) is more predominant than poppy (3%). In contrast, in Switzerland, poppy (60%) is more predominant than flax (20%).

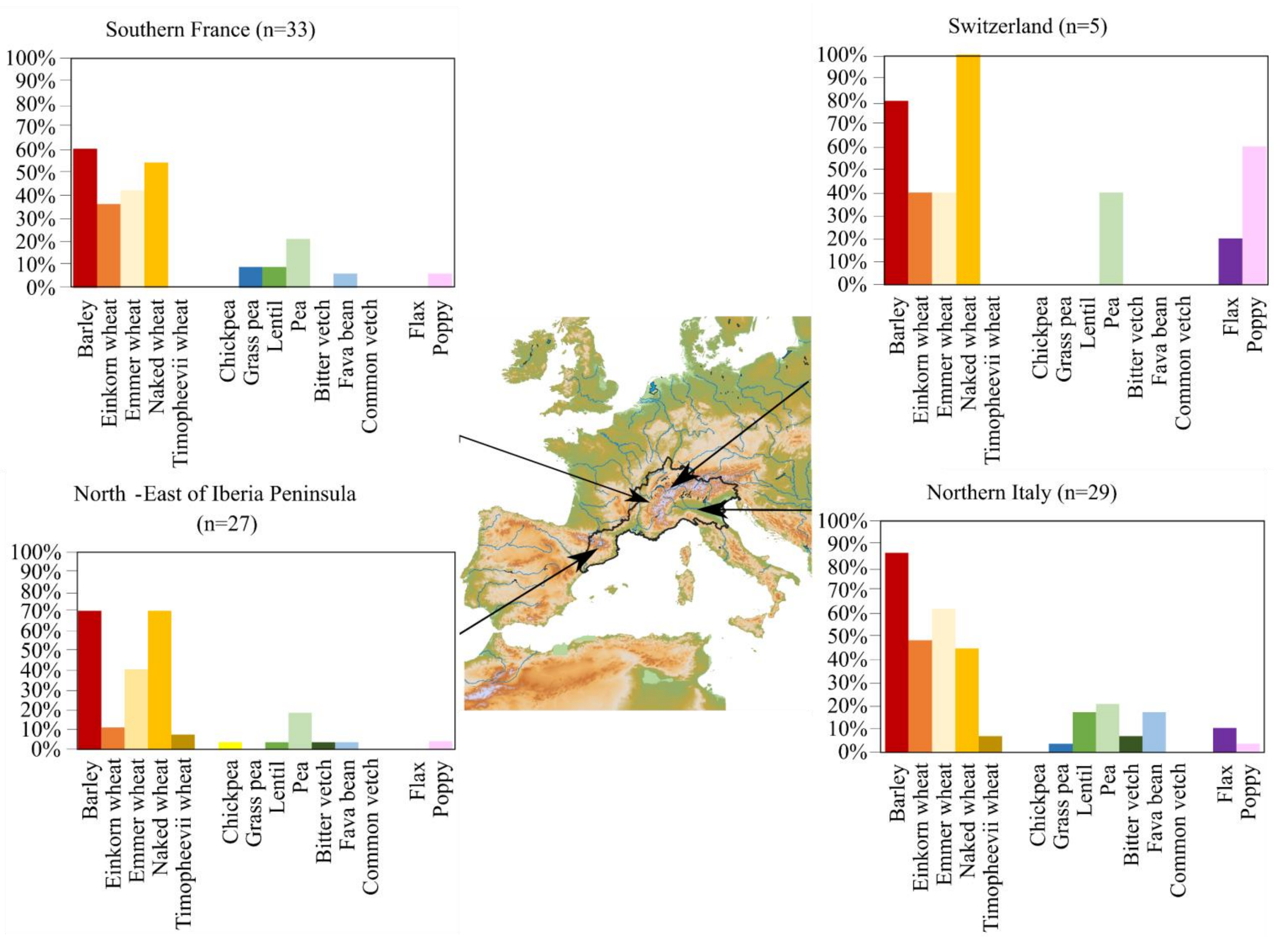

Figure 4.2 Bar chart of cereal grains, legumes and oil plants percentages from records in NE Iberia, SE France, Northern Italy, and Switzerland dates to the Early Neolithic period 5700-4500 cal. BC. Only charred seeds were used.

Flax seeds are an important source of oil and fibre; several seeds were recovered from PPN sites in Near East (Zohary et al., 2012). Earliest finds in Europe dated to the sixth millennium in Bulgaria and Northern Italy (Marinova & Valamoti, 2014; Rottoli & Castiglioni, 2009) and later in LBK sites (Jacomet, 2014; Kreuz, 2007), and it is absent from the NE Iberia and SE France (Antolín, 2016; Bouby, Marinval, Durand, et al., 2020). Poppy seeds are absent from the Near-eastern sites and the only exception of two Pre-Pottery Neolithic sites in Körtik Tepe 10400-9250 cal. BC (Rössner et al., 2018) and Attlit Yam, dating 8000–7500 BP (Kislev et al., 2004). Sites with the poppy seeds are known in all the regions in the study area and have larger ubiquity in Switzerland (Figure 4.2). Poppy seeds appear in both charred and uncharred preservation in NE Iberia. The uncharred remains are only present in one of the records of the La Draga site, an open-air-wet site. Poppy seeds appear in several LBK sites in France, Belgium and Germany (Herbig et al., 2013; Salavert, 2011). Poppy seeds were used for food; for more details about this species' presence and use, see Chapter 6 and Chapter 7.

Charred remains from wild edible plants are also scarce in the study area (Figure 4.3). In NE Iberia, in the dryland records, acorn (*Quercus* sp. - 36%) is the main wild plant found, followed by hazel (*Corylus avellana* - 32%), common dogwood (*Cornus sanguinea* - 24%), elderberry (*Sambucus* - 20%) and wild grape (*Vitis* - 12%). While the other species, strawberry tree (*Arbutus unedo*), mastic tree (*Pistacia lentiscus*), turpentine tree (*P. terebinthus*), wild cherry (*Prunus avium*), blackthorn (*P. spinosa*), rose (*Rosa* sp.), berries (*Rubus* sp.) and black nightshade (*Solanum nigrum)* are sporadically present (8-4%). For the two wetland records (NE Iberia, represented in yellow in Figure 4.3), the presence of common dogwood (*Cornus sanguinea)*, hazel (*Corylus avellana*), wild pear/apple (*Malus*/*Pyrus)*, bladder cherry (*Physalis alkekengi)*, wild cherry (*Prunus avium*), blackthorn (*Prunus spinosa*), oak (*Quercus* sp.), berries (*Rubus* sp.), elderberry (*Sambucus* sp.) and wild grape (*Vitis* sp.) (50%) were present in one record.

In SE France, in the dryland records, acorns (*Quercus* sp.) and hazel (*Corylus avellana*) (30%) are more frequent present, followed by common dogwood (*Cornus sanguinea*) and wild grape (*Vitis* sp.) (24%). Less than 10 % of the records had juniper (*Juniperus communis/ oxycedrus*), wild apple/pear (*Malus/Pyrus*), blackthorn (*P. spinosa*), and berries (*Rubus* sp. and *Sambucus* sp.). While the other species are strawberry tree (*Arbutus unedo*), mastic tree (*Pistacia lentiscus*), turpentine tree (*P. terebinthus*), rose (*Rosa* sp.), and elderberry (*Solanum nigrum*), which are sporadically present (6-3%). In Northern Italy, the most predominant wild edible fruit is wild grape (*Vitis* sp. - 83%), followed by elderberry (*Sambucus* sp.) and berries (*Rubus* sp.) (76%), hazel (*Corylus avellana* - 59%), wild apple/pear (*Malus/Pyrus* - 55%), common dogwood (*Cornus sanguinea* - 48%), blackthorn (*P. spinosa* - 41%), oak (*Quercus* sp. - 34%) and bladder cherry (*Physalis alkekengi* - 21%). While black nightshade (*Solanum nigrum*), cornelian cherry (*Cornus mas*), wild strawberry (*Fragaria vesca*), rose (*Rosa* sp.), and water chestnut (*Trapa natans*) are scarcely present (14-7%). In Switzerland, hazel (*Corylus avellana*) was present in all five sites (100%), followed by common dogwood (*Cornus sanguinea* – 60%) and wild strawberry (*Fragaria vesca*), juniper (*Juniperus communis/oxycedrus*), wild apple/pear (*Malus/Pyrus*) and oak (*Quercus* sp.) scarcely present in 20% of the records.

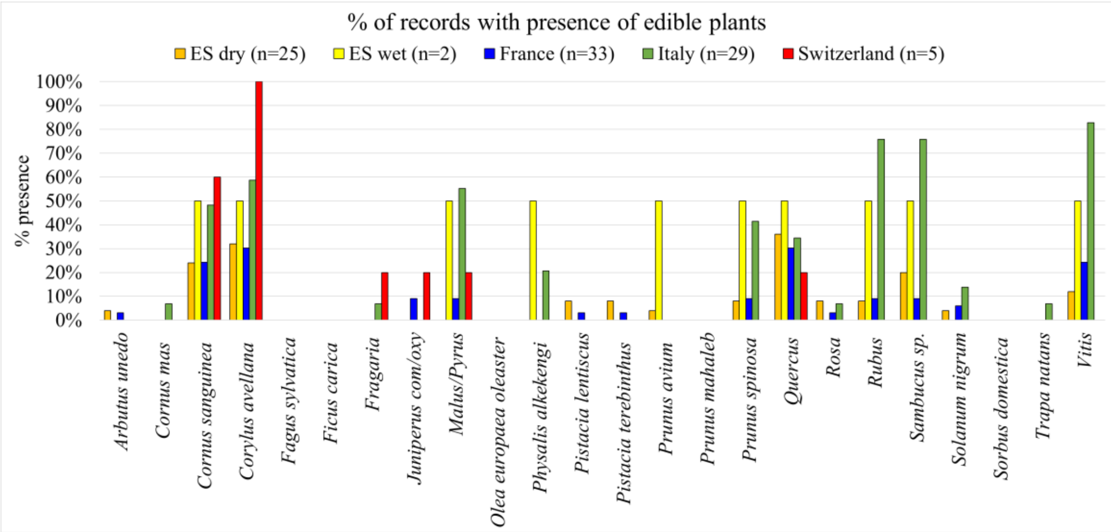

Figure 4.3 Bar chart of wild edible plant percentages from NE Iberia, SE France, Northern Italy, and Switzerland dates to the Early Neolithic period. Charred and uncharred remains were separated; see ES dry and ES wet.

Due to taphonomic issues, the consumption of wild edible plants and evidence of gathering activities may not be easy to identify. Therefore, the role of wild plants in the human diet is vastly underestimated when interpreting the archaeobotanical data from dryland sites. The results (Figure 4.3) indicate that there is a clear difference in the number of species appearing in Switzerland (only 6) compared with the other regions, France and Italy (14) and Spain (16). Nevertheless, this low diversity of wild edible plants might be related to the nature of the context and the fact that only five records had archaeobotanical data with a specific group of plants; for example, for one site, La Gillière had more domestic remains (ca. 24.000) than wild remains (ca. 900). On this site, more than 7000 charred poppy seeds were found (Martin, 2015). The type of context and its formation process play a part in taxa surviving in the archaeological site (van der Veen, 2007). It has been suggested that wild fruits are better represented in caves and rock shelters, and their importance might be related to animal husbandry (Bouby, Marinval, Durand, et al., 2020; Pérez-Jordà et al., 2017).

Besides opium poppy, most crops were domesticated in the Fertile Crescent (Zohary et al., 2012). Therefore, these crops were brought into the study region. Looking at Figure 4.2, the Italian region holds the highest crop diversity, especially pulses and the different types of wheat. This type of crop assemblage is similar to the Balkan areas (Reed & Rottoli, 2014), such as Croatia (Reed, 2015). The process of Neolithisation in this region is also distinct when considering the architecture and house plans existence in Northern Italy and the lack of house plans and scarce evidence of huts from the other regions in the study area (Gernigon, 2016b).

NE Iberia has 11 of the 14 crops analysed here, including chickpea, which is not found in any other study regions during this phase, and still few findings in other regions are rare (Kreuz & Marinova, 2017). In this region, one lakeshore site with two records (La Draga) had one record with uncharred poppy seeds suggesting that this plant was used for food.

Perhaps because the Neolithisation occurs later in Switzerland (Baudais et al., 1990; Curdy, 2007; Tinner et al., 2007), there are only five sites with archaeobotanical data (Brombacher & Vandorpe, 2012; Martin, 2015; Rigert, Ebneter, et al., 2005). In one area, in the North of Switzerland, close to the Rhine river, rare finds of cereal grains and poppy seeds are present from a Hinkelstein site (5000-4800 cal. BC) and a Rössen site (4700-4400 cal. BC) (Brombacher & Vandorpe, 2012; Rigert, Ebneter, et al., 2005). At the same time, rich findings of naked wheat, flax, poppy and pea were found in the south of Switzerland in the Valais Canton (Martin, 2015).

Concerning wild edible fruits, the ubiquity is high in all regions for hazelnut, dogwood and acorns. Only two records had waterlogged remains (Figure 4.3 - yellow bar), and the same species appear equally in the different regions with charred preservation. This suggests that if the species are systematically used, they will appear only in small quantities in the charred record and larger quantities in the uncharred record, especially if present within archaeological features (Dietsch, 1996).

4.3.2 Phase 2 (4500-3300 cal. BC)

For the following phase, the Middle Neolithic period (4500-3300 cal. BC), there are 187 records Figure 4.4 shows a map and bar charts with information on charred remains for each region for this period. The charred and waterlogged materials are going to be shown in different graphs. Figure 4.5 shows only the uncharred crop seeds (oil plants). For wild edible plants, Figure 4.6 shows the bar charts for charred remains and Figure 4.7 for the uncharred remains.

In NE Iberia, in 21 records, naked wheat (67%) and barley (62%) are the most predominant crop, followed by emmer (24%), einkorn (19%) and Timopheevii (14%) wheats. In SE France, in 73 records, barley is the most predominant (60%), followed by naked (46%), emmer (32%), einkorn (33%) and Timopheevii (1%) wheats. In the 44 records in Northern Italy, barley (70%) and emmer wheat (68%) are the main crops, followed by einkorn (43%) and naked (36%) wheats. In Switzerland, from 49 records, the most common crop is barley (76%) and naked wheat (71%), followed by emmer (57%) and einkorn (43%) wheats.

The main regional difference in ubiquities is that in NE Iberia, there is less percentage of glume wheats (<40%) and greater ubiquities of naked wheat. At the same time, Northern Italy has lower ubiquities of naked wheat compared with glume wheats, emmer (68%) being almost equal in ubiquity to barley (70%). Barley and naked wheat are the most recurrent crops in NE Iberia, SE France and Switzerland. A small percentage of Timopheevii wheat is recorded in NE Iberia and SE France. The presence of this wheat in SE France had only been recorded during Bronze Age (Toulemonde et al., 2015); but it was recently identified in the Neolithic period site – Les Bagnoles (Jesus, Prats, et al., 2021; van Willigen, Bailly, et al., 2020). These results were presented in Research paper 1. Other regional syntheses in the Middle Neolithic period point to a decrease of naked wheat around 4000 cal. BC and an increase in glume wheats (Antolín, 2016; Bouby, Marinval, Durand, et al., 2020; de Vareilles et al., 2020; Martin et al., 2016). The reason for a preference for glume wheats could be associated with the uses of the by-products of the plant, for its dense nutrition and taste, and it usually is more resistant to fungi, and harsh weather and can be kept longer if stored in spikelet form (Jesus, Prats, et al., 2021).

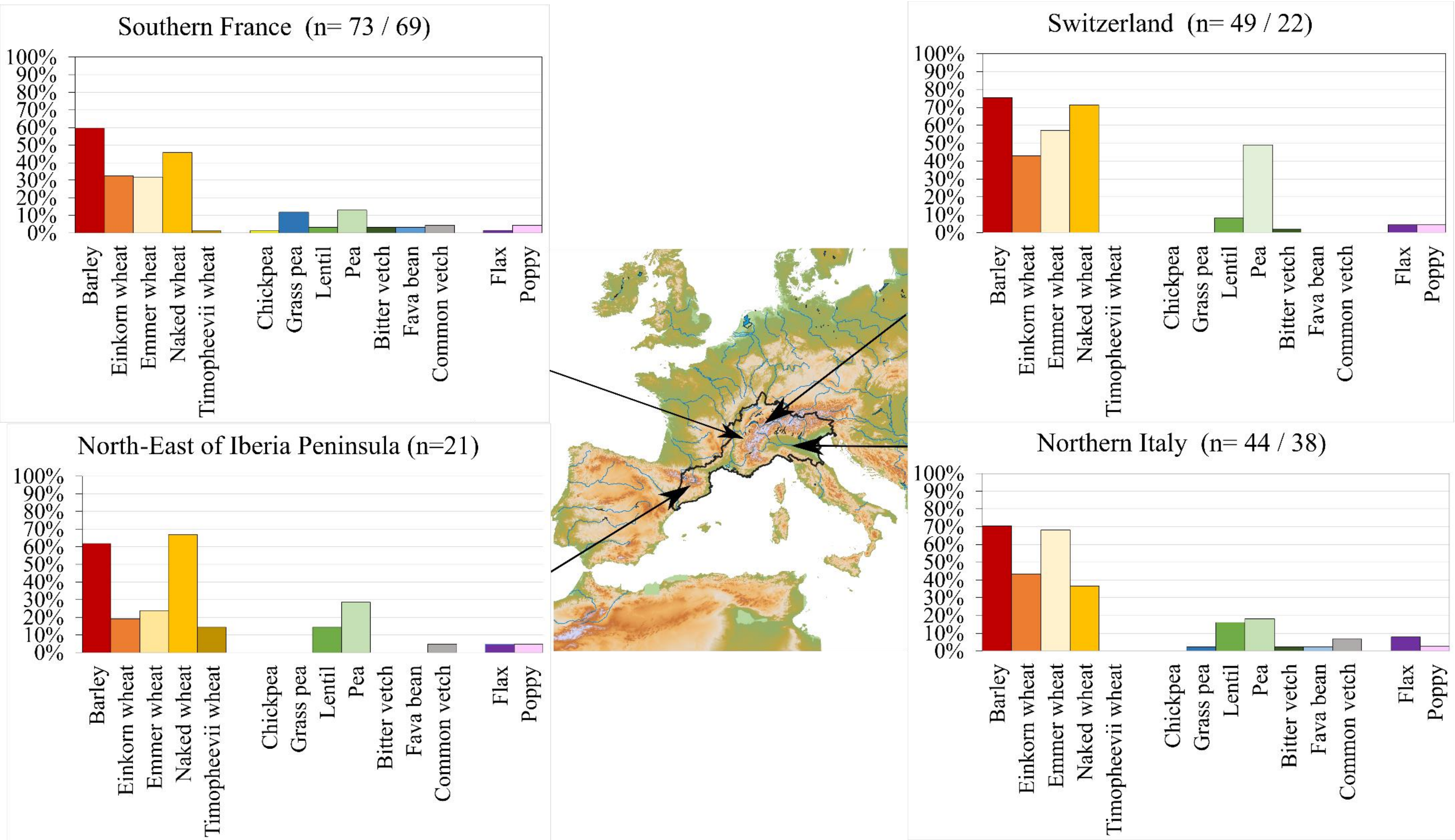

Figure 4.4 Bar chart of cereal grains, legumes and oil plants percentages from records in NE Iberia, SE France, Northern Italy, and Switzerland dates to the Middle Neolithic period - 4500-3300 cal. BC. "n" denotes the number of records, the first is the total number, and the second is the total dry sites. Only charred seeds were used.

Pulses are present in all the regions (Figure 4.4). In NE Iberia, the main predominant legume is pea (29%), and less present are lentil (14%) and common vetch (5%). In SE France, pea (13%) and the grass pea (11%) are the most present pulse, followed by common vetch (4%), lentil (3%), bitter vetch (3%), fava bean (3%) and chickpea (1%). In Northern Italy, pea and lentils are the most present pulse (18-16%), followed by common vetch (7%), grass pea, bitter vetch and fava bean (2%). In Switzerland, only pea is present with 49% frequency, while lentil (8%) and bitter vetch (2%) are infrequent.

In the case of legumes, the pea is the most common legume in all regions. However, in SE France, grass pea is as frequently recorded as pea; this legume could be used for animal feed (Zohary et al., 2012). It could have also been used for human consumption, eaten raw as a green snack or dried and cooked in a stew or milled into flour and cooked as a gruel as traditional preparations of these sorts still exist today in Spain (Peña-Chocarro & Zapata, 1999, p. 51). Among the other species, lentil is the second most common. NE Iberia and Switzerland only have pea, lentils, and bitter vetch, while SE France and Northern Italy have a higher diversity of legume species.

Charred seeds of flax and poppy are present in dryland sites from all regions (Figure 4.4), and uncharred seeds are present in wetland sites from SE France, Northern Italy and Switzerland (Figure 4.5). In NE Iberia, poppy and flax seeds are only present in 5 % of the dryland sites in charred preservation. In SE France, charred poppy seeds are present in 4 % and flax in 1% of the records. In Northern Italy, charred seeds of flax (8%) and poppy (3%) appeared sparsely. In Switzerland, charred seeds of poppy and flax appear in 5 % of the records in the drylands (Figure 4.4). In SE France, in the four wetland and four dryland sites with wells, uncharred seeds of flax appear in 63% and poppy in 88% of the records. In Northern Italy, in the six wetland sites, uncharred poppy seeds appear in 50% and flax in 33% of the records. While in the 27 wetland records of Switzerland, as uncharred seeds, both species appear in 85% of them (Figure 4.5).

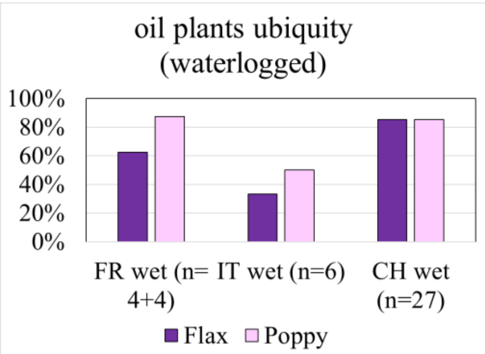

Figure 4.5 Bar chart of oil plants ubiquities with uncharred preserved in waterlogged condition for records located in SE France, Northern Italy and Switzerland in the Middle Neolithic period; "n" denotes the number of records.

As noted in the previous figure (Figure 4.2), flax seeds were absent from the west side of the study area. Flax seeds appear for the first time in the 5th millennium in Greece (Marinova & Valamoti, 2014), NE Iberia (Antolín, 2016; Rovira, 2007; Stika, 2005) and SE France (Bouby, Marinval, Durand, et al., 2020; Martin et al., 2016). According to our results, oil plants, poppy and flax, appear in all regions during the Middle Neolithic period in equal ubiquities, except poppy, which is higher in SE France and flax in Northern Italy. In terms of waterlogged preservation (Figure 4.5), flax is less represented than poppy in SE France and Northern Italy and equal ubiquity in Switzerland. Both species appear in the wetland sites in Switzerland, 80% of the 27 records, but only in 5 % of the 22 dry sites.

According to a morphometric study done on flax seeds, dating ca 4000-3700 cal. BC from Switzerland, these seeds are larger than flax seeds from 2900 cal. BC (Herbig & Maier, 2011). These authors suggested that the seeds were important maybe for their oil and food uses as the smaller seed was attributed to the interest of the fibre over the seeds. Evidence of linen in eastern Switzerland is already present around 3700 BC (Leuzinger & Rast-Eicher, 2011).

Charred remains of wild edible plants are found in the four regions of the study area, as can be seen in the bar graph (Figure 4.6). In NE Iberia, in the dryland records, acorn (*Quercus* sp. – 38%) is the main crop, followed by mastic tree (*Pistacia lentiscus* – 29%) and hazel (*Corylus avellana* – 24%). Others also present were berries (*Rubus* sp.), elderberry (*Sambucus*), black nightshade (*Solanum nigrum*) and strawberry tree (*Arbutus unedo*) (19-14%). While the other species, common dogwood (*Cornus sanguinea*), wild olive (*Olea europaea oleaster*), bladder cherry (*Physalis alkekengi*) and service tree (*Sorbus domestica*), appear only in 5% of the records. In SE France, in the dryland records, acorn (*Quercus* sp. – 29%), hazel (*Corylus avellana*), wild grape (*Vitis* sp.) and elderberry (*Sambucus* sp.) (23-22%) are the main present wild plants. Followed by other 13 plants such as berries (*Rubus* sp. – 16%), common dogwood (*Cornus sanguinea* – 9%) and strawberry tree (*Arbutus unedo* – 1%) that appear less frequent. In Northern Italy, the most predominant wild edible fruit is hazel (*Corylus avellana* – 50%), followed by elderberry (*Sambucus* sp.) and acorn (*Quercus* sp.) (42–39%), wild grape (*Vitis* sp. – 34%). While the other plants, 11 plants are less frequent. In Switzerland, hazel (*Corylus avellana* – 77%) was the main wild plant, followed by common dogwood (*Cornus sanguinea* – 50%) and elderberry (*Sambucus* – 45%), rose (*Rosa* sp. – 41%). Other plants, like wild apple/pear (*Malus/Pyrus* – 18%), blackthorn (*P. spinosa*), berries (*Rubus* sp.), elderberry (*Solanum nigrum*) (14%) and bladder cherry (*Physalis alkekengi* – 5%), are less frequent.

In terms of waterlogged sites, the uncharred seeds of wild plants are present in SE France, Northern Italy and Switzerland (Figure 4.7). In Southern France (eight sites with uncharred seeds), berries were the predominant wild fruit (*Rubus* sp. – 75%), followed by hazel (*Corylus avellana*), bladder cherry (*Physalis alkekengi*) and acorn (*Quercus* sp.) (63%). While in half of the records, the presence of wild strawberry (*Fragaria vesca*), elderberry (*Sambucus* sp.) and elderberry (*Solanum nigrum*) (50%) were recorded. Little present are common dogwood (*Cornus sanguinea*), wild apple/pear (*Malus/Pyrus*), blackthorn (*P. spinosa*) and rose (*Rosa* sp.) (38%), but also European beech (*Fagus sylvatica*) and fig (*Ficus carica*) (25%). Rarely present are cornelian cherry (*Cornus mas*), turpentine tree (*Pistacia terebinthus*) and the cherry tree (*Prunus mahaleb*) (13%). In the Northern Italy, in the six wetland records, hazel (*Corylus avellana*) and wild grape (*Vitis* sp.) are present in 83% of the records. Bladder cherry (*Physalis alkekengi*) and berries (*Rubus* sp.) appear in 67% of the records.

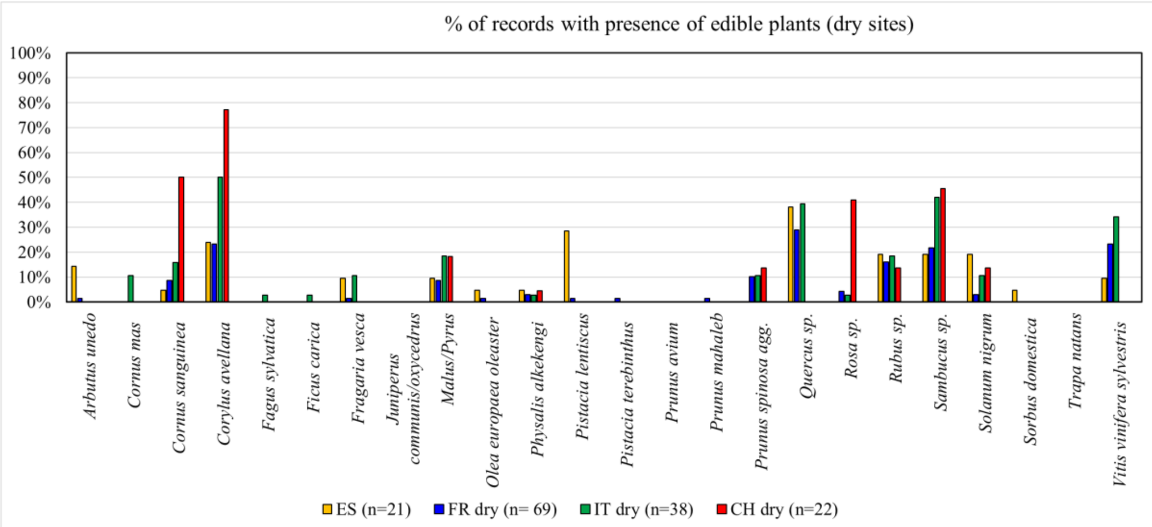

Figure 4.6 Bar chart of wild edible plants percentages from dry sites and charred preservation NE Iberia (ES), SE France (FR), Northern Italy (IT) and Switzerland (CH) dating to the Middle Neolithic period - 4500-3300 cal. BC

Cornelian cherry (*Cornus mas*), wild strawberry (*Fragaria vesca*), wild apple/pear (*Malus/Pyrus*) and acorn (*Quercus* sp.) were present in half of the records. Common dogwood (*Cornus sanguinea*) and fig (*Ficus carica*) appear in 33% of the records, followed by wild cherry (*Prunus avium*), blackthorn (*Prunus spinosa*), elderberry (*Sambucus* sp.) and water chestnut (*Trapa natans*) in 17% of the records. Switzerland has 27 wet records with wild edible plants where the main plants are elderberry (*Sambucus* sp. – 85%), wild apple/pear (*Malus/Pyrus* – 81%) and berries (*Rubus* sp. – 81%), hazel (*Corylus avellana* – 78%), wild strawberry (*Fragaria vesca* – 74 %*)*, and bladder cherry (*Physalis alkekengi* – 74 %), acorn (*Quercus* sp. – 70%) and rose (*Rosa* sp. – 70%). Followed by common dogwood (*Cornus sanguinea* – 56%), elderberry (*Solanum nigrum* – 56%), blackthorn (*Prunus spinosa* – 52%) and European beech (*Fagus sylvatica* – 44%). Rarely present (4%) are cherry tree (*Prunus mahaleb*), service tree (*Sorbus domestica*) and water chestnut (*Trapa natans*).

Most fruit remains and evidence of gathering are not available in dry sites apart from common findings of hazelnut and acorns; its overrepresentation can be related to the excellent conservation of this type of remains when in contact with fire (Bishop, 2019). Since most fruits would be discarded and decay without ever being in contact with fire, they are only rarely recovered in dryland sites.

The most notable feature in the Middle Neolithic archaeobotanical data is thus the presence of waterlogged remains from the pile dwellings. The waterlogged remains allow us to understand another part of the human diet that was not enough recorded in the Neolithic period. The variety of taxa present in the wetland sites is more extensive than in the dry sites. Typically fruits (e.g. wild strawberry) are not well preserved (e.g. charred) or would not be in contact with fire, therefore not being preserved. We can assume that human-plant consumption would be more diverse than the records show by having wet and dry records from the same period and the same region or even the same site.

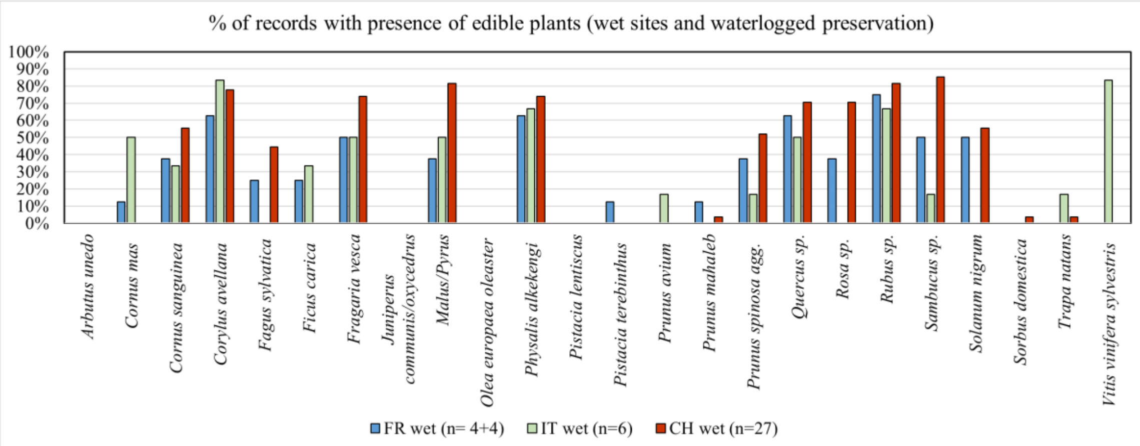

Figure 4.7 Bar chart of wild edible plants percentages from wet sites and uncharred waterlogged preservation, SE France (FR), Northern Italy (IT) and Switzerland (CH) dating to the Middle Neolithic period 4500-3300 cal. BC.

For the wild edible plants (Figure 4.6 and Figure 4.7), there are some regional differences, strawberry tree (*Arbutus unedo*) and mastic tree (*Pistacia lentiscus*) appear mainly in NE Iberia, wild cherry (*Prunus avium*) only appears in Northern Italy in wet preservation and St. Lucie cherry (*Prunus mahaleb*) appears in SE France and Switzerland. The presence of wild plants is greater in frequency in waterlogged sites; this is visible when comparing charred records (Figure 4.6) and uncharred ones (Figure 4.7). In Figure 4.7, where species have over 60% of ubiquity appearance, unlike the dry sites where the ubiquity is lower than 30 % in an overview (Figure 4.6).

At the dry sites with charred preservation (Figure 4.6), hazelnut (*Corylus avellana*), dogwood (*Cornus sanguinea*), acorns (*Quercus* sp.), black elder (Sambucus) and wild grape (*Vitis*) are well represented. In contrast, for the wet sites (Figure 4.7) with waterlogged preservation (and the four open-air dry records with wells), a greater diversity of berries and fruits are represented, such as figs (*Ficus carica*), wild strawberry (*Fragaria vesca*), Crab-apple (*Malus/Pyrus*), bladder cherry (*Physalis alkekengi*), Rose (*Rosa* sp.), elderberry (*Sambucus* sp.), European black nightshade (*Solanum nigrum*) and water chestnut (*Trapa natans*).

4.3.3 Phase 3 (3300-2300 cal. BC)

As explained before, there are fewer archaeobotanical remains from dry sites in this phase, which could be related to a lack of research or preservation problems as occurs in NE Iberia (Antolín et al., 2015). For SE France, the synthesis results are mainly cereal grains with some frequency of wild plants (Bouby, Marinval, & Rovira, 2020). In NE Iberia and Northern Italy, there is a decrease in sites with archaeobotanical data (Antolín, 2016; Rottoli & Castiglioni, 2009), but it is clear that cereals are more frequent than wild plants (Tecchiati et al., 2013, fig. 2). For Switzerland, an increase in the usage of wild resources was suggested, both plants and animals (Schibler & Jacomet, 2010).

For the Late Neolithic (3300-2300 cal. BC), Figure 4.8 shows greater ubiquities concerning cereal grains. In NE Iberia, in 14 records, barley (79%) and naked wheat (57%) are the most predominant, followed by emmer (29%) and einkorn (21%) wheats. In SE France, in 46 records, barley is the main cereal present (87%), followed by naked (61%), einkorn (50%) and emmer (39%) wheats. In the 26 records of Northern Italy, barley (62%) and emmer wheat (50%) are the main crops, followed by einkorn (38%) and naked (23%) wheats. In Switzerland, from 52 records, the most common crops are barley (62%) and naked wheat (60%), followed by emmer (58%) and einkorn (38%) wheats.

In terms of regional comparison, barley and naked wheat are predominant in NE Iberia and SE France, while glume wheat is predominant in Northern Italy. In Switzerland, barley (60%), naked wheat (58%) and emmer (57%) are more common. Glume wheats are becoming more frequent in SE France (Figure 4.8). Einkorn was more common than emmer, especially in Hérault valley and the Languedoc region (Bouby, Marinval, & Rovira, 2020) and in the inner alpine valleys such as at Balmes, in SE France (Martin, 2010). Einkorn was also found inside the frozen mummy - Ötzi's intestine (3370-3100 BC) and it was the main grain present at the site (Bonani et al., 1994; Festi et al., 2011; Heiss & Oeggl, 2009). Reasons to prefer einkorn wheat in these phases could be related to the fact that this species is resistant to frosting and can grow in poor soils (Zohary et al., 2012).

In terms of pulses, as can be seen in the bar graphs (Figure 4.8), in NE Iberia, pea and lentil appear in 19% of the 14 records. In SE France, pea is present in 9% of the records, followed by grass pea, bitter vetch and fava bean (2%). In Northern Italy, pea appears in 8% of the records, followed by grass pea, lentil, bitter vetch, fava bean and common vetch (4%). In Switzerland, pea is the dominante pulse with 33%, lentil (12%), common vetch (4%) and bitter vetch (2%).

Only two pulses species are recorded in Spain, pea and lentil, from the seven species analysed here (Figure 4.8). Lentil is the second important pulse in Switzerland and Northern Italy but is absent from French records. The other crops are sporadic everywhere. It has been suggested that besides being underrepresented in dry sites due to taphonomic reasons and lower chances of being charred during the processing of the crop (Butler et al., 1999; Fuller & Harvey, 2006), it could be that the pulses did not play an important role (Bouby, Marinval, & Rovira, 2020) as the ubiquity values are low.

Both oil plants are absent from NE Iberia (Figure 4.8). Only flax is present in 2% of the 41 dryland records in SE France. In the five wetland records of SE France (Figure 4.9), flax and poppy seeds appear in all records (100%). In Northern Italy, in the 25 dryland records, flax is present in 8% of the records and poppy in 4% (Figure 4.8), while in the only wetland record, there are no oil plants (Figure 4.9). In the 18 dryland records from Switzerland, only charred flax is identified in 8% of the records (Figure 4.8). In contrast with 34 wetland records where uncharred seeds of poppy and flax appear in 82% of the records (Figure 4.9).

Flax is better represented in the dryland records than poppy (Figure 4.8), whereas the waterlogged remains have equal ubiquity (Figure 4.9). For the Swiss region, where there are 34 wet sites and only 18 dry sites, 80 % of the sites have both oily species in the waterlogged records (Figure 4.9) but not in the dry sites with charred preservation (Figure 4.8).

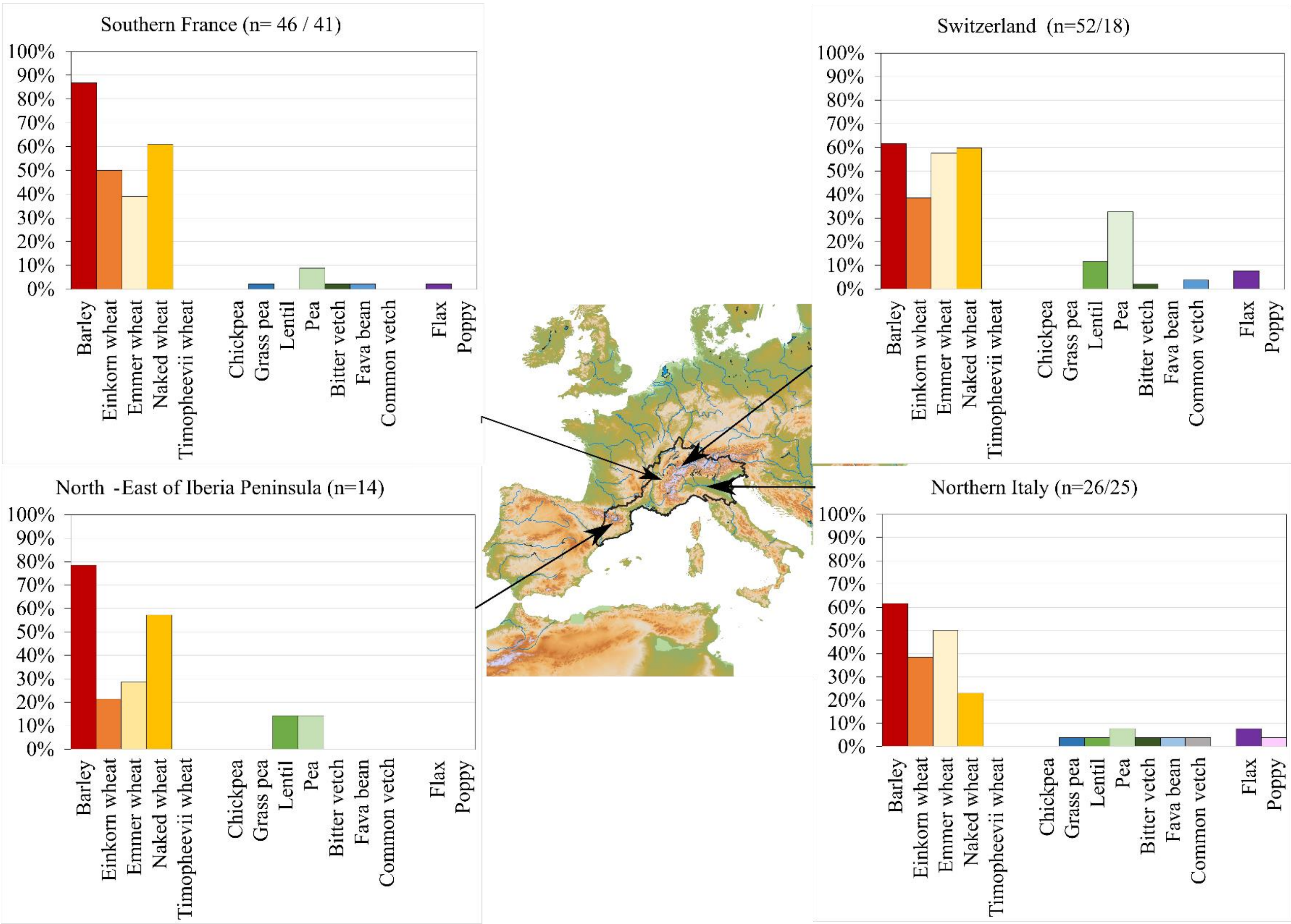

Figure 4.8 Bar chart of cereal grains, legumes and oil plants percentages from records in NE Iberia, SE France, Northern Italy, and Switzerland dates to the Late Neolithic period 3300-2300 cal. BC. "n" denotes the number of records, the first is the total number, and the second is the total dry sites. Only charred seeds were used.

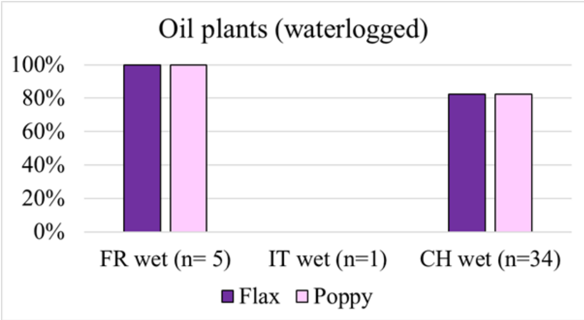

Figure 4.9 Bar chart of oil plants ubiquities with uncharred seeds preserved in wet conditions for records located in SE France (FR), Northern Italy (IT) and Switzerland (CH); "n" denotes the number of records.

Evidence of the uses of oil plants in this period are oil and fibre. Evidence of oil for tool maintenance is present at the Zürich-Parkhaus Opera site, Switzerland (Jesus & Antolín, 2021; Spangenberg et al., 2014). More detail on poppy finds and uses can be seen in Chapter 7. Especially in Switzerland, rich samples with flax and poppy are found in Horgen communities occurred around 3000 BC cal. According to Herbig and Maier research (2011), flax seeds are smaller, suggesting that the flax plant was used for its fibre. Besides the morphometric study, there is also evidence of linen threads and textiles (Leuzinger & Rast-Eicher, 2011).

Wild edible plants appear in all regions, as shown in Figure 4.10. In NE Iberia, in the 14 dryland records, acorn (*Quercus* sp. – 29%) and wild grape (*Vitis* sp. – 21%) are the common edible fruits. While hazelnut (*Corylus avellana* – 14%), strawberry tree (*Arbutus unedo* – 7%), wild pear/ apple (*Malus*/*Pyrus* – 7%), wild olive (*Olea europaea oleaster* – 7%), mastic tree (*Pistacia lentiscus* – 7%), blackthorn (*P. spinosa* – 7%), berries (*Rubus* sp. – 7%) and elderberry (*Sambucus* sp. – 7%) are less present.

In SE France, in the 41 dryland records, wild edible plants are not commonly present. The percentages are all lower than 50%. Acorn (*Quercus* sp. – 34%) is common, while the other plants are scarcely present. Other plants are wild grape (*Vitis* sp. – 17%), hazelnut (*Corylus avellana* – 15%), blackthorn (*P. spinosa* – 12%) and elderberry (*Sambucus* sp. – 12%), juniper (*Juniperus communis/oxycedrus* – 7%), strawberry tree (*Arbutus unedo* – 5%), common dogwood (*Cornus sanguinea* – 5%) and berries (*Rubus* sp. – 5%), cornelian cherry (*Cornus mas* – 2%), European beech (*Fagus sylvatica* – 2%), figs (*Ficus carica* – 2%), wild pear/apple (*Malus*/*Pyrus* – 2%), bladder cherry (*Physalis alkekengi* – 2%), wild cherry (*Prunus avium* – 2%), rose (*Rosa* sp. – 2%) and black nightshade (*Solanum nigrum* – 2%).

In Northern Italy, in 25 dryland records, hazelnut (*Corylus avellana* – 36%), cornelian cherry (*Cornus mas*), and acorn (*Quercus* sp.) (24%) are the most common edible plants present in the archaeological sites. While less present are elderberry (*Sambucus* sp. – 20%), wild pear/apple (*Malus*/*Pyrus* – 16%) and wild grape (*Vitis* – 16%), bladder cherry (*Physalis alkekengi* – 12%) and blackthorn (*P. spinosa* – 12%), common dogwood (*Cornus sanguinea* – 8%), wild cherry (*Prunus avium* – 8%), berries (*Rubus* sp. – 8%), figs (*Ficus carica* – 4%), rose (*Rosa* sp. – 4%) and black nightshade (*Solanum nigrum* – 4%).

In Switzerland, in 18 dryland records, hazelnut (*Corylus avellana* – 67%) and common dogwood (*Cornus sanguinea* – 50%) are commonly present, while minor present are berries (*Rubus* sp. – 44%), blackthorn (*P. spinosa*) and elderberry (*Sambucus* sp.) (39%), rose (*Rosa* sp. – 33%), wild pear/apple (*Malus*/*Pyrus* – 28%). Moreover, even lesser present are black nightshade (*Solanum nigrum* – 11%), cornelian cherry (*Cornus mas*), European beech (*Fagus sylvatica*) and acorn (*Quercus* sp.) (6%).

In terms of waterlogged sites, the uncharred seeds of wild plants are present in SE France, Northern Italy and Switzerland (Figure 4.11). In Southern France, hazelnut (*Corylus avellana*), wild strawberry (*Fragaria vesca*) and elderberry (*Sambucus* sp.) appear in all the five records, followed by common dogwood (*Cornus sanguinea*), bladder cherry (*Physalis alkekengi*), blackthorn (*P. spinosa*) and berries (*Rubus* sp.) that appear in 4 sites (80%). Less commonly found in the archaeological sites are acorn (*Quercus* sp.) and rose (*Rosa* sp.) (60%), European beech (*Fagus sylvatica*), wild pear/apple (*Malus*/*Pyrus*) and black nightshade (*Solanum nigrum*) (40%).

Our study has only one record in Northern Italy, where bladder cherry (*Physalis alkekengi*), berries (*Rubus* sp.) and elderberry (*Sambucus* sp.) are present. In Switzerland, with 34 wet records, the most commonly present fruits are berries (*Rubus* sp. – 85%), hazel (*Corylus avellana*) and bladder cherry (*Physalis alkekengi* – 79%), rose (*Rosa* sp. – 76%), wild strawberry (*Fragaria vesca*) and elderberry (*Sambucus* sp. – 74%), wild apple/pear (*Malus/Pyrus*), blackthorn (*P. spinosa*), and acorn (*Quercus* sp. – 71%). Less found in the records are black nightshade (*Solanum nigrum* – 68%), common dogwood (*Cornus sanguinea* – 59%), European beech (*Fagus sylvatica* – 47%), wild grape (*Vitis* sp. – 9%), wild cherry (*Prunus avium*), and water chestnut (*Trapa natans*) (6%), cornelian cherry (*Cornus mas*) and the cherry tree (*Prunus mahaleb*) (3%).

At the dry sites, wild edible plants with charred preservation (Figure 4.10), dogwood (*Cornus sanguinea*), hazelnut (*Corylus avellana*), blackthorn (*Prunus spinosa*), acorns (*Quercus* sp.), black elder (*Sambucus*) and wild grape (*Vitis*) are well represented. In SE France, the presence of high quantities of acorn (Quercus sp.) in the Causses area has been noted, and evidence of storage is detected in stored products burnt by accident (Bouby, Marinval, & Rovira, 2020, p. 15). In Switzerland, it was noted that an increase in wild resources (Schibler & Jacomet, 2010) is also visible in Figure 4.11. In this figure, there is a great frequency of different species. Bladder cherry (*Physalis alkekengi*), berries (*Rubus* sp.), and elderberry (*Sambucus* sp.) appear in almost all waterlogged records in SE France, Northern Italy and Switzerland. Both types of cherries appear in both charred and uncharred preservation.

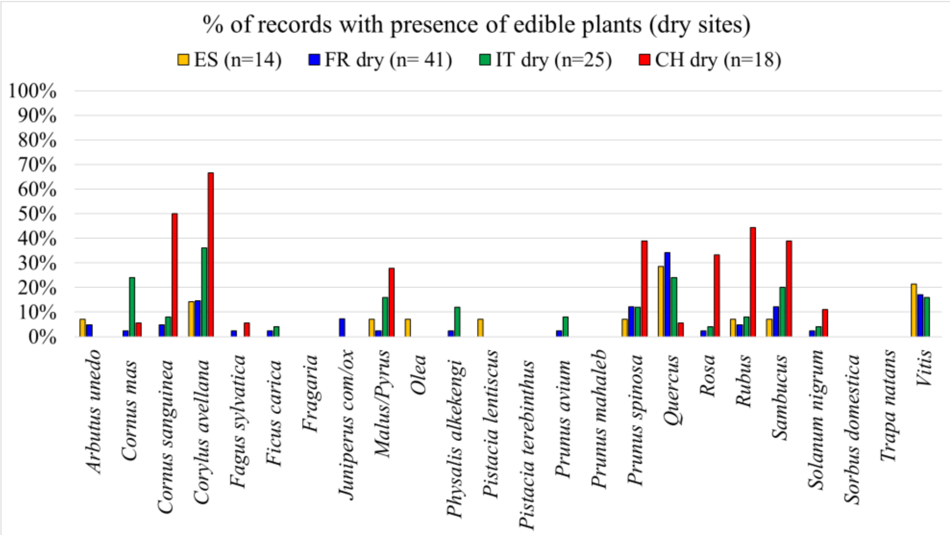

Figure 4.10 Bar chart of wild edible plants percentages from dry sites and charred preservation NE Iberia (ES), SE France (FR), Northern Italy (IT) and Switzerland (CH) dating to the Late Neolithic period 3300-2300 cal. BC BC, "n" denotes the number of records.

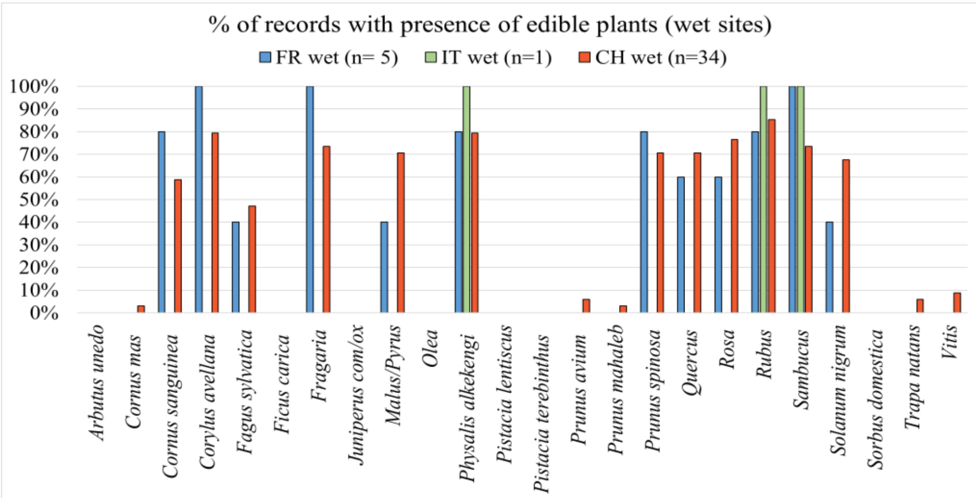

Figure 4.11 Bar chart of wild edible plants percentages from wet sites and uncharred waterlogged preservation, SE France (FR), Northern Italy (IT) and Switzerland (CH) dating to the Late Neolithic period 3300-2300 cal. BC, "n" denotes the number of records.

4.3.4 Chronological overview

The 419 records are not evenly distributed between the 3 phases analysed, especially between EN and MN; there is a difference of 100 sites. Discrepancies are also visible in geographic distributions with the absence of sites with archaeobotanical data from inland regions of Switzerland and Italy during the Early Neolithic period (Figure 3.3). For the Middle and Late Neolithic, it is better distributed, as shown in Figure 3.3b and 3.3c. Regarding the type of preservation, only one site with uncharred remains from the wetland site at NE Iberia during the Early Neolithic period. In later periods, wetland sites are present in SE France, Northern Italy, and Switzerland. However, the number of wetlands sites is discrepant when comparing Switzerland with the other regions, with almost 60 records against ten or fewer records in SE France and Northern Italy (Figure 3.4b and Figure 4.1).

Regarding chronological comparison, the results (Figure 4.12) show that charred cereal grains are well represented in all periods, with over 70 % of the records. Charred legumes and oil plants are recorded in less than 30 % and 10 % of the sites.

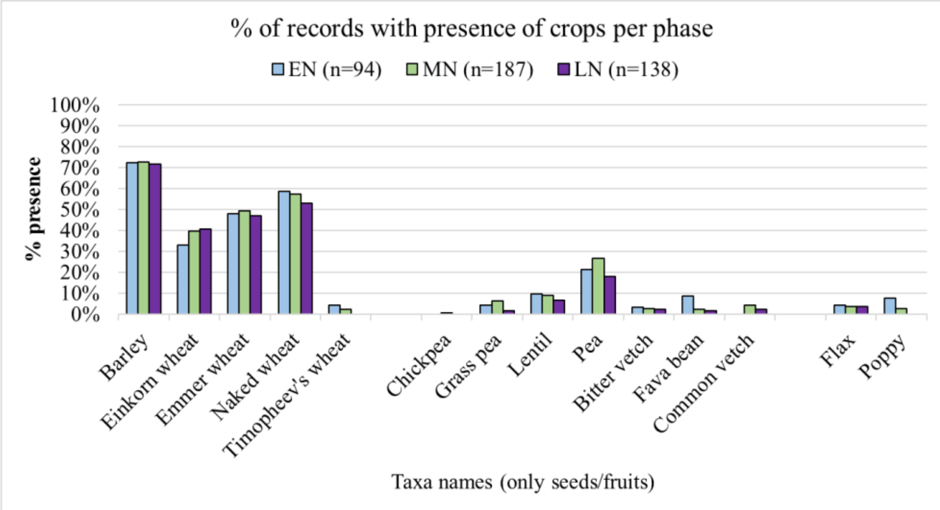

Figure 4.12 Bar chart of the % of ubiquities (percentage of presences) per phase with the presence of cereal grains, legumes and oil plants, "n" denotes the number of records—only charred remains.

Barley is the most common grain in all periods, followed by naked wheat, but different chronological and regional were observed (Figure 4.2, Figure 4.4 and Figure 4.8). Naked wheat seems to be of great importance for the NE Iberia and SE France, and the spread of this crop in central Europe is linked to Mediterranean influences (Jacomet, 2007; Kreuz et al., 2014). This crop decreased slightly (less than 10%) from the Middle to Late Neolithic period (Figure 4.12); this can be observed in the graphs of the Swiss region (see Figure 4.8).

Einkorn increased almost 10 % from the Early Neolithic to Middle Neolithic; this is not as pronounced in the regional overview (Figure 4.4). While in Northern Italy, the predominance of emmer and low frequency of naked wheat mark the difference between NE Iberia, SE France and Switzerland during the Early Neolithic period. However, noted at the end of the Middle Neolithic (Jesus, Prats, et al., 2021; Martin et al., 2016) and more predominant in the Late Neolithic periods (Bouby, Marinval, & Rovira, 2020), glume wheats gained more importance and are quantified in large numbers than naked wheat. In contrast, Timopheev's wheat presence might be underestimated as its current identification status (Czajkowska et al., 2020). Its classification is based mainly on glumes that occurred less frequently in the archaeobotanical assemblages (G. Jones et al., 2000). There is no presence of this grain dating from the Late Neolithic period in the study area.

In the case of legumes, pea is the most common legume in all phases, increasing during the Middle Neolithic period. It is followed by lentil, representing 10 % of the records in the Early Neolithic period and having a slight decrease in the other phases. Chickpea is present in one site in the Early Neolithic period, in Can Sadurni cave (Antolín & Schäfer, 2020), and one site is dating from the Middle Neolithic period in SE France, Grote G (Courtin & Erroux, 1974, p. 329). The chronology of the latter might be dubious since the excavation was done in the '70s. The seed was not directly dated but also had identification issues and should be reviewed due to its old classification. The three types of vetch are less common than the other pulses in all phases with a small percentage (5%). Fava bean is present in 8% of the records during the Early Neolithic period, but ubiquities are low during the later phases.

In terms of oil plants, the presence of poppy was more prominent than flax during the first phase. Flax occurred with slightly lower values during the Middle and Late Neolithic periods, while poppy was absent during the Late Neolithic period (Figure 4.12). The dryland sites show a decrease in oil plants (underrepresented in charred preservation).

In contrast, oil plants increased during the Middle and Late Neolithic period in waterlogged sites see Figure 4.5 and Figure 4.9 related to Switzerland's food, oil and textile production (Herbig & Maier, 2011; Leuzinger & Rast-Eicher, 2011; Spangenberg et al., 2014). The frequency levels of both flax and poppy are 80 %, corresponding to 24 records in the Middle Neolithic and 29 sites in the Late Neolithic. The appearance of wet sites with waterlogged preservation allows oily seeds to be preserved. In the dry sites, the seeds decay or are easily destroyed by fire (Märkle & Rösch, 2008).

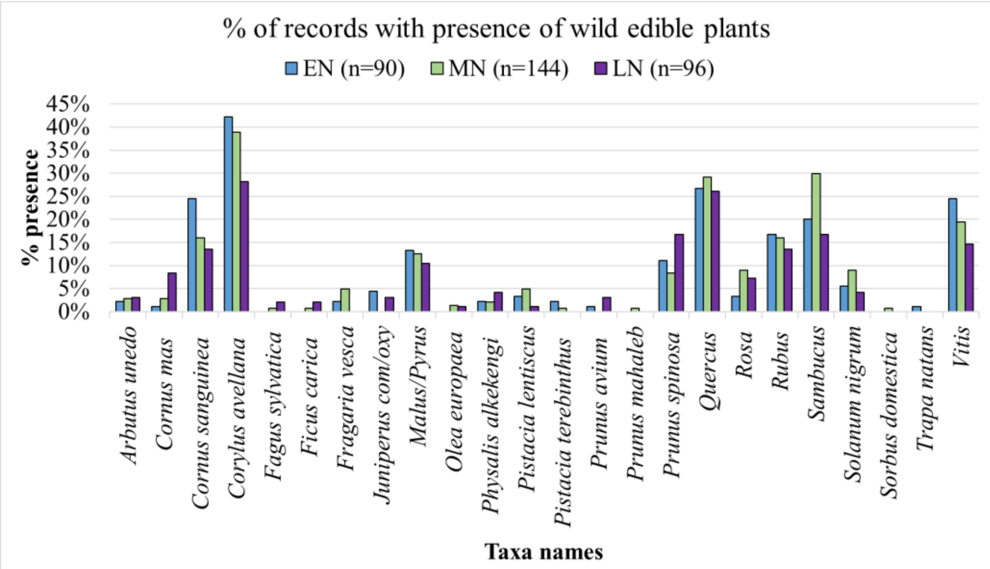

Figure 4.13 Bar chart of the % of records per phase with the presence of possible edible plants, "n" denotes the number of records. Only charred remains from dry sites are included. Charred remains from waterlogged preservation (open-air wet sites, undefined and sites with wells). are excluded

Edible wild plants (Figure 4.13) are well represented in the archaeobotanical assemblages, especially in cases of hazelnut (*Corylus avelana*), which can go up to 40%, similarly to acorns (*Quercus*) and elderberries (*Sambucus*) with 30 % presence. Of note is that these - hazelnut and acorn - are overrepresented in open-dry sites due to the lack of sampling and fine sieving during the old excavations (further see Chapter 3). The importance of hazelnuts, acorns and wild apples as gathered food resources in the Neolithic period in the study area was already noted by researchers in NE Iberia (Antolín, 2016; Antolín & Jacomet, 2015; Zapata et al., 2008) SE France (Marinval, 1988a, 1988b, 2008), Northern Italy (Rottoli & Castiglioni, 2009; Tecchiati et al., 2013) and Switzerland (Jacomet, 2006b, 2007).

Other fruits commonly present are grape (*Vitis* sp.), berries (*Rubus* sp.), blackthorn (*Prunus spinosa*), wild apple/pear (*Malus/Pyrus*), and dogwood (*Cornus sanguinea)*. Dogwood (*Cornus sanguinea*) occurs recurrently in the study area. Ethnographic sources indicate that this wild plant can be cooked in combination with other food and used as a colouring substance or soap (Tolar et al., 2020). Also, its wood was appreciated as fuel and for making tools, like the arrow found on Ötzi (Karg & Märkle, 2002). In some places, it occurs in large quantities and charred state, like in the Concise site (Karg & Märkle, 2002). In the Late Neolithic period, there was an increase of cornelian cherry (*Cornus mas)* (Figure 4.13); this is well represented in Northern Italy but also occurs in SE France and Switzerland (Figure 4.10 and Figure 4.11). Of note is that cornelian cherry (*Cornus mas)* is native to western and south Switzerland (Ronch et al., 2016), but one fruit stone shaped into a bead was found in eastern Switzerland at Arbon Bleiche 3 site (Hosch, 2004, p. 73). Another site where this species is found is on the other side of Lake Constance in Germany, at Hornstaad Hörnle IA (3917-3905 BC) (Hoffstadt & Maier, 1999). In this site, 59 fruit stones were found together with flint from Lessinian Alps (Northern Italy) and assumed they were exchanged together from the Mediterranean area (Hoffstadt & Maier, 1999; Hosch & Jacomet, 2001).

Other fruit stones of particular connotation are cherries, wild cherry (*Prunus avium*) and mahaleb cherry (*Prunus mahaleb*). They are native to most of the study area, including most parts of Switzerland (Popescu & Caudullo, 2016; Welk et al., 2016). In the Early Neolithic period, at La Draga pile dwelling (NE Iberia), several stones of wild cherry was transformed into beads (Antolín & Buxó, 2011a, fig. 16). At the Late Neolithic site, Arbon Bleiche 3, the fruit stone of mahaleb cherry (*P. mahaleb*) was used as well for beads (Leuzinger, 2000). Other beads made of fruit stones were also found on this site, such as blackthorn (*Prunus spinosa)* (Leuzinger, 2000).

The putative use of wild plants is usually based on their properties known from ethnographic and historical sources. Thus, it is challenging to prove human transport and manipulation. Dietsch (Dietsch, 1996) gives five main criteria. First is an ecology study that shows the presence of the taxa in the area outside of their native environment. The number of plant remains is also a good indication of its gathering. Being charred and or fragmented suggests a connection to anthropogenic activities. Lastly, the spatial distribution in the archaeological site, for example, within a pit connected with pottery, shows human intentionality. The recurrent presence of the specific taxa described above provides evidence of their consumption and use in the study area. Although to get more detail on their specific uses, a contextual analysis should be performed and is not in the scope of this thesis.

4.4 Synthesis and perspectives

The archaeobotanical data available for the four study regions are difficult to compare due to the different methodologies in sampling, processing, quantification techniques and data published as discussed in the previous chapter. However, these biases can be partly overcome by using presence and absence data. The results highlighted the regional differences instead of chronological patterning in the dataset, with continuity in plant assemblages for each region over time. The Neolithisation process was distinct for each region. The initial bar charts clearly distinguish between Early Neolithic records from NE Iberia, SE France, Switzerland and records from Northern Italy. In Northern Italy, the recurring presence of glume wheats in all phases, especially in the Early Neolithic, separates this region from the other analysed here, where naked wheat is more frequent. The Northern Italy archaeobotanical assemblage, material culture and house plans are similar to the Balkan areas suggesting an influence from the eastern side of the study area (Gernigon, 2016b; Reed & Rottoli, 2014). Wild edible plants are gathered and present in all phases; it was not noted any increase or decrease in this type of fruit. Some species appear more frequently in wetland sites associated with their unique preservation.

In the study area, the social structure changed during the Middle Neolithic period, with the increased local regionalisation assumed by the different styles of pottery and mortuary practices (Burri-Wyser & Winiger, 2016; Chambon & Leclerc, 2003; Manen & Hamon, 2018; Mottes et al., 2009; Perrin, 2016; Pessina & Tiné, 2008). This regionalisation is noted in the material culture. Different pottery styles, raw materials, stone objects and plants were attributed to the specific group was found in other places from other prehistoric groups (Denaire, Doppler, et al., 2011; Gernigon, 2016a; Léa, 2005; Perrin, 2016). Examples of these exchanges are the presence of Chassey pottery (SE France) and artefacts in the Sepulchres de Fossa communities in NE Iberia, demonstrating exchange between these two groups (Mestre & Tarrús, 2016), the presence of pearls made of variscite (a phosphatic mineral) from Gavà Mines (NE Iberia) in Middle Neolithic burials in south-eastern France (Vaquer, 2014, p. 2). Further examples of exchanges in the Middle Neolithic can be found in the conference proceedings edited by Perrin (2016). This regionalisation can also be seen in the archaeobotanical assemblage, where NE Iberia displays high ubiquities of naked wheat and barley and low glume wheats. In the other regions, SE France and Switzerland, ubiquities suggest glume wheats are more frequent when compared to the Early Neolithic period. Concerning oil plants, flax appears in NE Iberia and SE France for the first time during the Middle Neolithic (Figure 4.8. and Figure 4.9). While in Switzerland, because of the type of preservation, waterlogged, flax and poppy are found in large quantities and are frequent in wetland sites (Figure 4.5 and Figure 4.9).

Legumes were present in the study area, suggesting the particular importance of lentil and pea, but ubiquities are very low for the other pulses in all phases (Figure 4.12). The low presence of pulses in the study area is not clearly understood; it could reflect the delay of the spread of these crops, or it could be related to taphonomic reasons and lower chances of being charred during processing (Butler et al., 1999; Fuller & Harvey, 2006). It has also been suggested that differences in regional climate might not allow the same crops to grow in Central Europe (Colledge et al., 2005, p. 148).

NE Iberia has fewer archaeobotanical records than the previous periods, and no oil plants are present in the Late Neolithic period. At the same time, for the other areas, SE France, Northern Italy and Switzerland, a preference for hardy cereals such as emmer and einkorn (Bouby, Marinval, & Rovira, 2020; Jacomet, 2009, 2014; Tecchiati et al., 2013) might indicate a crop change related to cultural preferences, or it might be due to climatic deterioration (Arbogast et al., 2006) or a combination of other factors. However, when looking at the ubiquity levels of the wild edible fruits, it does not show an increase in gathered plants during the Late Neolithic period. Gathered plants formed part of the diet during the Neolithic period; however, their carbonization due to "kitchen accidents' (sensu van der Veen, 2007) is unlikely, as they are usually eaten raw. In waterlogged sites, berries and other fruits are commonly found, and we could assume that these fruits were also consumed in dryland sites but were not preserved. In dryland sites, the presence of *Quercus*, *Corylus avellana*, *Cornus*, and *Vitis* charred remains reinforces that they were gathered. According to Colledge and Conolly (2014), the results of the loss of edible wild taxa diversity due to charring is around 65%. Aside from consumption, *Prunus* and *Cornus's* fruit stones were transformed into beads (Hosch & Jacomet, 2001; Leuzinger, 2000). Although this type of finding is still rare in early periods of prehistory, and their actual use (as a bead for jewellery or other adornments) is still poorly understood, they suggest another use for fruit stones other than food.

Research on agriculture and food activities requires numerous transdisciplinary studies and archaeobotany has now a variety of new methods that can infer diet and type of agriculture in a complementary way with isotopic studies on human and animal bones, function weed ecology, usewear analysis on harvesting tools and other subjects. Therefore, this study should be combined with those studies in the future.

This overview is the first one that combines the ubiquities of cultivated and useful plants in archaeobotanical assemblages from the north and south of the Alps. This study allows a better overview of the archaeobotanical data present. It is also relevant to have charred and uncharred materials and dry and waterlogged sites in the same synthesis. Combining all information makes it clear that more wetland sites are needed in the Mediterranean region. Sites with this type of preservation would give us a better understanding of the plant diversity used by prehistoric communities. Even though not many sites exist due to the type of local environment, exceptions and specific structures exist and should be excavated and sampled to give a better archaeobotanical overview. Specific structures such as wells are found in SE France, where uncharred seeds are recovered (Figueiral & Séjalon, 2014; Martin, 2012; van Willigen, Bailly, et al., 2020). The plant remains found in the wells offer a different perspective of the plants used and present in archaeological sites. Fragile plant parts and small oily plants are less likely to survive charring and preserve better in the waterlogged state, as discussed in Chapter 5. The fact of having excellent preserved seeds can help us study domestication.

This is the case of opium poppy seeds, where it was assumed it was domesticated and that it happened during the Neolithic period, in the Mediterranean region, but no criteria existed to verify it (Fritsch, 1979; Hammer & Fritsch, 1977). Now, using geometric morphometrics on uncharred poppy plants will allow us to identify different morphotypes of poppy and try to understand the ongoing domestication process. For this, uncharred seeds were needed. These sites with waterlogged preservation and adequate sampling strategies, as it was the case in Les Bagnoles, made it possible to analyse poppy seeds and understand their development, as seen in Chapters 6 and 7 and research papers 2 and 3.

Chapter 5 The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal. BC)

5.1 Introduction

This chapter analyses the botanical material recovered from two wells, 990 and 994, from Les Bagnoles. There is another well from the same site with archaeobotanical remains – well 250. This well was not added to this chapter because it is dated to the Middle Neolithic1, that is to say it is dated earlier date than the other wells. The objective of this chapter is to focus on the the Middle Neolithic 2 and on the waterlogged remains found in the wells. However, a complete overview of the three wells (including well 250) and other Middle Neolithic sites from SE France was presented in research paper 1 at the end of the chapter.

Previously, in Chapter 3, this site was mentioned because it has two types of preservation, charred and uncharred. Consequently, this site has a unique insight into the farming practices as it preserved material that otherwise would not be preserved. This type of result is unique in the dry sites in SE France as there are not many sites with waterlogged depositions sampled for archaeobotanical data and sampled correctly for archaeobotanical analyses. As outlined in Chapter 1, the following question will be addressed in this chapter: a) Are there differences or similarities between the two types of preservation. The importance of this question relies upon that different type of preservation gives a different type of remains. There is a taphonomic bias concerning archaeobotanical remains (Colledge & Conolly, 2014; Jacomet, 2013); therefore, this issue will be addressed in this chapter. This question assumes that there will be a considerable lack of species diversity (wild species and small or oily seeds that would not be preserved by charring) and plant parts (e.g. cereal chaff) when considering charred preservation when comparing with waterlogged preservation. As waterlogging allows for the preservation of high diversity of plant remains, including oily seeds, pods, flower buds, leaves, herb seeds and wild edible fruits (Colledge & Conolly, 2014; Jacomet, 2013; Märkle & Rösch, 2008), as mentioned in section 3.4

Concerning the other two questions: b) What crops are present on this site, and how different is it from the other Middle Neolithic sites in the region? These are addressed at the end of the chapter in the paper comparing archaeobotanical studies from wells and pits from different open-air sites in SE France.

5.2 Les Bagnoles

The archaeological site of Les Bagnoles is located 2.5 km southwest of L'Isle-Sur-la-Sorgue, on alluvial soils (Sargiano et al., 2010). The site was found in 2006 and excavated in a scientific excavation between 2012 and 2015 by the Swiss National Museum and the Universities of Basel and Aix-Marseille (van Willigen, André, et al., 2020). Several occupations were detected dated to the Middle Neolithic, the Bronze Age, Iron Age, Gallo-roman and modern periods, mainly as negative structures, such as pits, silos, post holes and wells (Denaire & van Willigen, 2020).

The archaeobotanical remains were studied by different researchers and supported by different grants (Antolín, Delefosse, et al., 2020; Antolín, Jesus, et al., 2020; Antolín, Schimitt, et al., 2020; Follmann, 2017; Jacomet, 2020; Jesus, Prats, et al., 2021). Considering that detailed identifications of the remains are still ongoing, the results are not definitive. In this chapter, the focus is on the waterlogged material from the wells. First, we will focus on the two best-preserved wells and the findings in terms of depth of these remain to analyse its possible human deposition and the importance of analysing the wells in a waterlogged context. Then we will compare with other wells from the Middle Neolithic 2 (4100–3500 cal. BC) found in this region that presented waterlogged materials, such as Clos de Roque (Martin, 2012) and Mas de Vignoles IX (Figueiral & Séjalon, 2014). This analysis will compare charred and waterlogged densities and put some findings into context using the wells profile sketch.

In the Les Bagnoles site, several pits, silos, some post holes and three wells were identified (Sargiano et al., 2010). It does not hold any house structure or clear indication of a settlement. The interpretation of the site is of a large open site with remains of some domestic and wild animals and plants as well as several shards of vases and some sandstone querns (van Willigen, 2020).

The site is near the Sorgues river, which today enclosures the town named L'isle Sur la Sorgue. Close to the site (8.7 km) is a larger river, Durance, connecting to the Rhone river. Thus, the site was not depleted of water resources, and it was in a well-connected zone to exchange products with other communities that would travel by land or by rivers. The wells do not look like permanent structures, as there are no support structures such as wood lining or apparent preparation for the deep negative structure. Two wells, 990 and 994, are close to each other in the South part of the site, while the other, well 250, is in the upper part. The other negative features (pits, silo and a few postholes) are dated using pottery typology as few charred remains were found (Antolín, Delefosse, et al., 2020, fig. 245).

5.3 Archaeobotanical analyses of Les Bagnoles

Sediment samples were pre-treated with a water softener Calgon - if samples were sieved in the field - or by freezing, following IPNA guidelines (Vandorpe & Jacomet, 2007). These were sieved using the wash-over technique (see description in Steiner et al., 2015), and the different fractions (4, 1 and 0.35 mm) were sorted under the stereomicroscope. The 0.35 mm fraction was normally subsampled with the grid method (van der Veen & Fieller, 1982), and ca. 10ml of residue were sorted. The resulting data was introduced into the database ArboDat 2018© (Kreuz & Schäfer, 2002). Cereal identification criteria followed available literature (Jacomet, 2006a). This study uses the traditional nomenclature of Zohary et al. (2012) for domestic taxa. Only grains with embryo ends were counted (G. Jones, 1990), nodes regarding free-threshing rachis remains or glume bases for glume wheats (Hillman et al., 1996). Possible pea (cf. *Pisum sativum*) pod fragments were counted if the fragments were larger than 12 mm^2 (see description of these remains in Antolín and Schäfer (2020).

5.4 Well 990 (4050-3980 cal. BC)

Structure 990 was deeper than 3.3 meters, and it was possible to identify two parts, one dry and one wet part; this last one was below the groundwater table. The dry part started with a pit (SU 1, 2, 3 and 4). Bones were found in these SU, but no pottery or charred remains to date. Then the other identified SU 5, 6, 7 and 9 appear to form a trunk shape more characteristic of a well. However, when reaching the groundwater level (see well profile: Figure 5.1), the excavation was done by splits. No lining was found. The radiocarbon dates performed on charred macroremains show similar dates, 4219–3969 cal. BC and 4048–3968 cal. BC (Martínez-Grau et al., 2020), coming from the spit sample Pr70 and Pr25 from the same level, Figure 5.1.

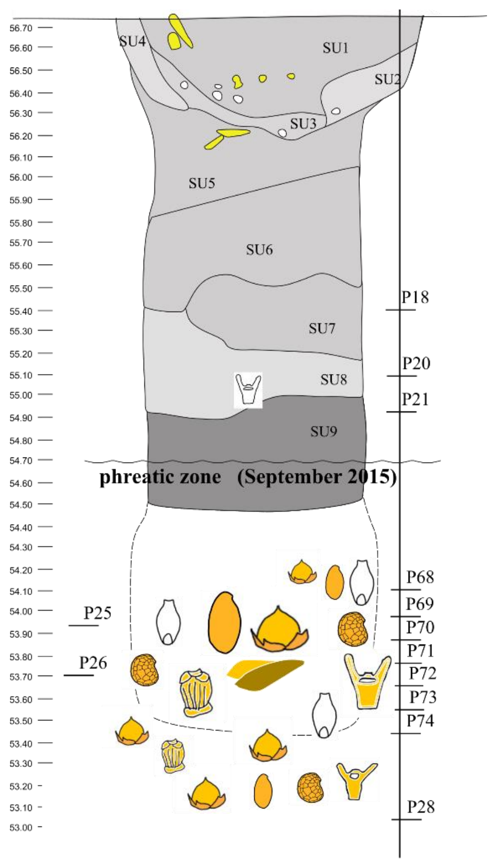

Figure 5.1 Well 990 with some of the most common species. (yellow colour for uncharred and white for charred remains)

Overall, this well was rich in animal remains (Antolín, Delefosse, et al., 2020, p. 247) and had fragments of pots and one quern fragment. The animal bones are relatively well preserved; 59% are identifiable, including remains of weasel, caprine and cattle, dogs and small ruminants (Antolín, Delefosse, et al., 2020, p. 255).

A total of 13 samples were analysed from well 990 (Table 5.1), and a total of 17898 uncharred remains and charred remains 967 were identified. Three samples were above the water level (Pr18, Pr20 and Pr21) and ten samples were below the water level see Figure 5.1.

Table 5.1 Detail information of the samples from well 990

Sample number_ArboDat	Total remains	Spit number	Laboratory sample number	Analysed vol. of sediment	Item/liter	Type of finding	Total remains (un)	Taxa (un)	Total remains (ch)	Taxa (ch)
ISBA15_612_St900_Pr18	1	Pr18	612	0.5	2	dry			1	1
ISBA15_611_St900_Pr20	1	Pr20	611	0.5	2	dry	1	1	0	0
ISBA15_610_St900_Pr21	4	Pr21	610	0.9	4	dry			4	3
ISBA15_613_St900_Pr68	63	Pr68	613	8	8	wet	56	15	7	4
ISBA15_614_St900_Pr69	1066	Pr69	614	7	152	wet	1002	43	61	9
ISBA15_603_St990_Pr25	1117	Pr25	603	0.9	1241	wet	1011	40	106	5
ISBA15_615_St900_Pr70	2174	Pr70	615	9	242	wet	1966	39	184	8
ISBA15_616_St900_Pr71	4622	Pr71	616	7	660	wet	4350	56	249	11
ISBA15_609_St900_Pr26	239	Pr26	609	0.4	598	wet	221	31	18	7
ISBA15_617_St900_Pr72	1404	Pr72	617	8	176	wet	1343	41	61	8
ISBA15_618_St990_Pr73	3799	Pr73	618	9	422	wet	3738	45	61	5
ISBA15_619_St990_Pr74	4268	Pr74	619	9	474	wet	4061	59	207	9
ISBA15_608_St900_Pr28	157	Pr28	608	0.4	393	wet	149	19	8	3

The first three spit samples (Pr18, Pr20 and Pr21), coming from the dry part of the well, did not contain much material because they were not preserved in a wet environment. It might be that these layers were underwater in the past, but today being dried. Four macroremains (Figure 5.1) were mainly charred and not identified except for einkorn chaff. The sample volume was small from these first splits, and the type of finding was in dry sediment and not wet (1.9 L. Table 5.1).

For the waterlogged samples, there was a much higher density of plant remains of waterlogged and charred remains (Figure 5.2). The highest material concentration comes from Pr71, with 660 items per litre and a total of 4622 remains (Table 5.1).

The last artificial layer Pr28, and the first four splits had less than 20 different taxa, with the first three only one or three taxa. The highest number of charred taxa – 11 and 9 – is present in Pr71 and Pr74, the same for the uncharred taxa, 56 and 59, respectably Table 5.1b.

Spit Samples Pr70 and Pr71 show large numbers of uncharred flax capsule fragments (106 fragments). These fragments are present in 90 % of the wet samples. In comparison, only two charred examples of flax capsule fragments were recovered (Appendix D : Les Bagnoles). Also, in sample Pr71, there is a concentration of 100 fragments of possible pea pods (uncharred). Uncharred flax seeds also appear in the most upper levels (70 % of the samples). Poppy seeds appear in 90 % of the waterlogged samples (Appendix D : Les Bagnoles). Nevertheless, the overall number is low, with 36 uncharred seeds for flax and 24 for poppy seeds. A rare find was a charred *Vicia faba* seed that appears in Pr69.

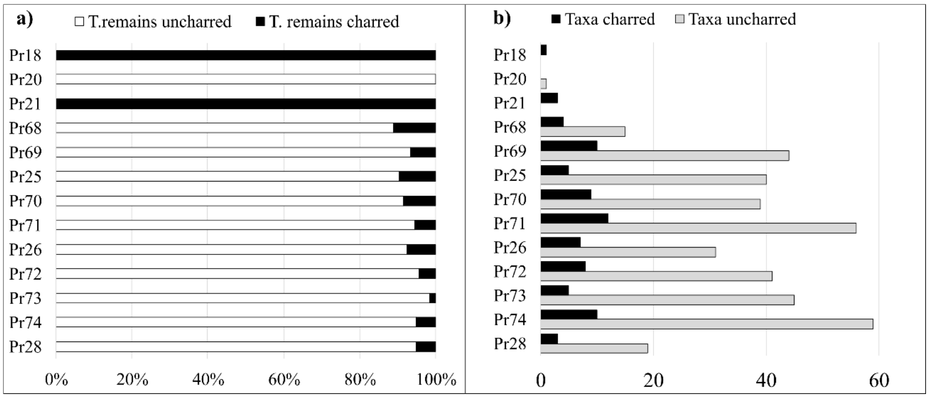

Figure 5.2 Results of the analysis of well 990. a) Proportion of total of remains (T. remains) uncharred (white bars) and charred remains (black bars) and b) differences between taxa found charred and uncharred

The bar chart (Figure 5.3) shows species from 17 different ecological groups following the classification by Jacomet (2020). The most common ecological groups are annual summer crop (yellow), wetland plants, perennial ruderals, grassland species and cultivated. The charred remains were few when compared with uncharred ones. The cultivated species were found in an uncharred form more than in charred preservation.

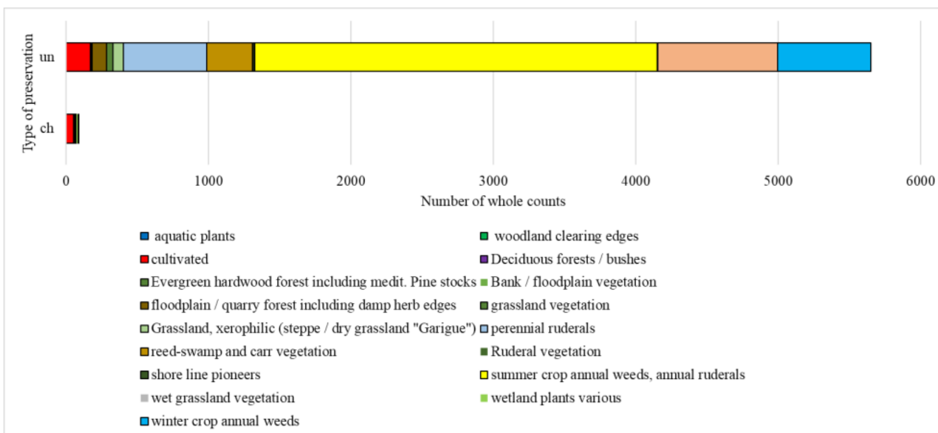

Figure 5.3 Horizontal bar chart showing the whole counts of seeds/fruits of both charred (ch) and uncharred (un) plants from the dry and wet area (Varia and no group taxa were removed)

5.5 Well 994 (3940-3780 cal. BC)

The structure 990 was deeper than 3.1 meters, and it was possible to identify three stratigraphic units (SU), which appear to form a square mouth of the well. This first SU might indicate some support for this structure. The second stratigraphic unit has a more complex shape as it opens on both ends (Figure 5.4). Pottery shards were found in the upper layers of this structure. Starting with the SU 3, the structure shape is more of a trunked profile, more characteristic of a well. Below this zone, the excavation method was done by spits below this zone due to the impossibility of distinguishing between the different SU. No lining was found. The radiocarbon dates on charred macroremain show two sets of dates from samples Pr42 and Pr45: 3943–3714 cal. BC and 3966–3800 cal. BC (Martínez-Grau et al., 2020). However, one of the three samples, Pr44, gave an old date and was considered contamination or an error, 4796–4693 cal. BC (Jesus, Prats, et al., 2021).

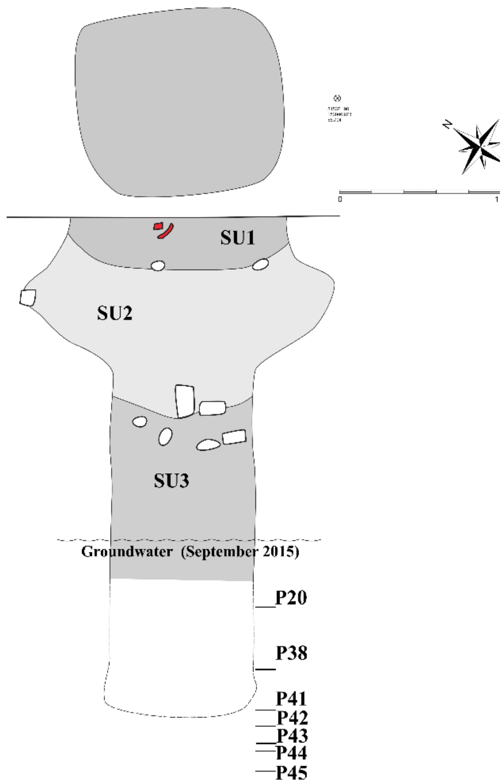

Figure 5.4 Well 994 Profile and section.

This well had ten fragments of querns and hand stones and several sherds of vases. The material coming from this structure was in worse condition than the well 990. Concerning archaeozoological data, only 6 % of the bone remains were identified as cattle, caprine and ruminants (Antolín, Delefosse, et al., 2020, p. 267).

The carpological samples came from seven different spits from well 994 (Table 5.2); unlike the other well, two samples from the same spit were analysed, summing to 13 samples at the end. In this well, a total of 3959 uncharred remains and 664 charred remains were present. All samples were below the groundwater. In addition, two samples of Pr38 were identified as large dung, probably from a large animal.

In terms of taxa, a lower number is found in sample Pr44, indicating a moment where the well was not open or not used. However, it is clear that sample Pr42 is the one with the larger concentration of plants (Table 5.2) as well the diversity of charred and uncharred taxa (Figure 5.5b).

Table 5.2 Detail information of the samples from well 994

Sample number_ArboDat	Total remains	Spit number	Laboratory sample number	Analysed vol. of sediment	Item/liter	Type of finding	Total remains (un)	Taxa (un)	Total remains (ch)	Taxa (ch)
ISB15_St994_Pr20	32	Pr20		0.2	160	wet	25	10	7	5
ISB15_620_St994_Pr38_1	0	Pr38_1	620	0	0	wet	1	0	0	0
ISB15_620_St994_Pr38_2	0	Pr38_2	620	0	0	wet	1	0	0	0
ISB15_621_St994_Pr41_1	349	Pr41_1	621	7.5	47	wet	282	27	66	10
ISB15_621_St994_Pr41_2	394	Pr41_2	621	8.5	46	wet	339	34	54	10
ISB15_622_St994_Pr42_1	1707	Pr42_1	622	8	213	wet	1358	49	315	16
ISB15_622_St994_Pr42_2	1200	Pr42_2	622	8	150	wet	1097	36	102	15
ISB15_623_St994_Pr43_1	494	Pr43_1	623	8	62	wet	435	30	56	9
ISB15_623_St994_Pr43_2	207	Pr43_2	623	9	23	wet	188	28	19	4
ISB15_624_St994_Pr44_1	30	Pr44_1	624	9	3	wet	23	5	7	2
ISB15_624_St994_Pr44_2	31	Pr44_2	624	9	3	wet	23	8	8	4
ISB15_625_St994_Pr45_1	66	Pr45_1	625	9	7	wet	59	15	7	2
ISB15_625_St994_Pr45_2	153	Pr45_2	625	8	19	wet	130	19	23	9

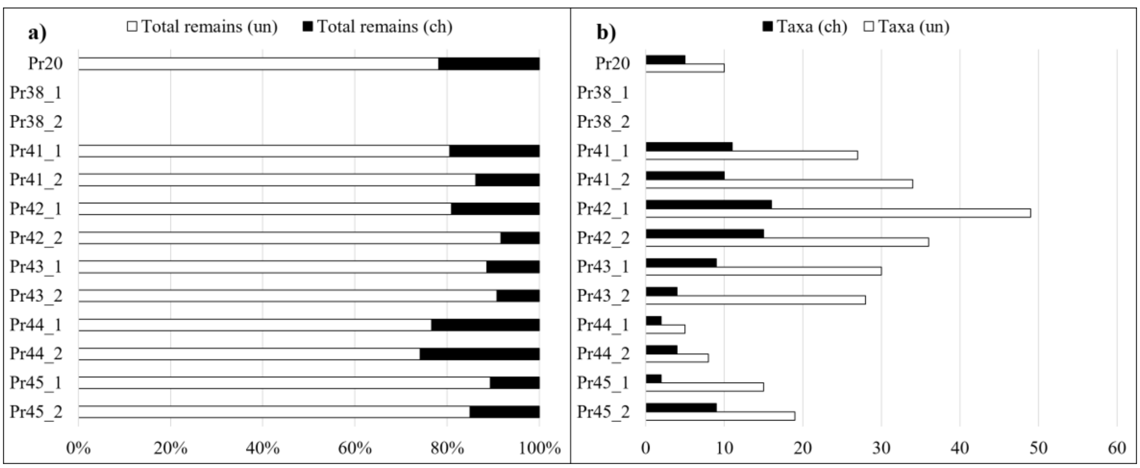

Figure 5.5 Results of the analysis of well 994. a) Proportion of total of remains uncharred (white bars) and charred remains (black bars) and b) differences between taxa found charred and uncharred

Unlike well 990, this structure has only one sample with possible pods of a pea on Pr42_1 uncharred and one charred remain from Pr43. In terms of oil plants, the quantity is less than the previous well. Flax seeds and capsule fragments were present with four items of each in four samples. Low numbers of poppy seeds (15 seeds) were found. A total of 177 grains are present in this well and over 600 fragments of chaff. Overall the material is less fragmented in this well than well 990. In terms of charred material, this well is more predominant Figure 5.2a) than well 990 Figure 5.5a**)**. The number of charred chaff is 328 fragments for 297 uncharred. This quantity is not comparable with the other well, where thousands of fragments of barley and naked wheat chaff were recovered uncharred against decimals of charred ones.

As can be seen in the bar chart for the ecological groups of the archaeobotanical assemblage Figure 5.6, summer crop annual weeds are dominant, followed by grassland, floodplain and wetland, and cultivated species. It is clear that most wild species are uncharred and preserved by waterlogged while the cultivated species are better preserved in a charred state.

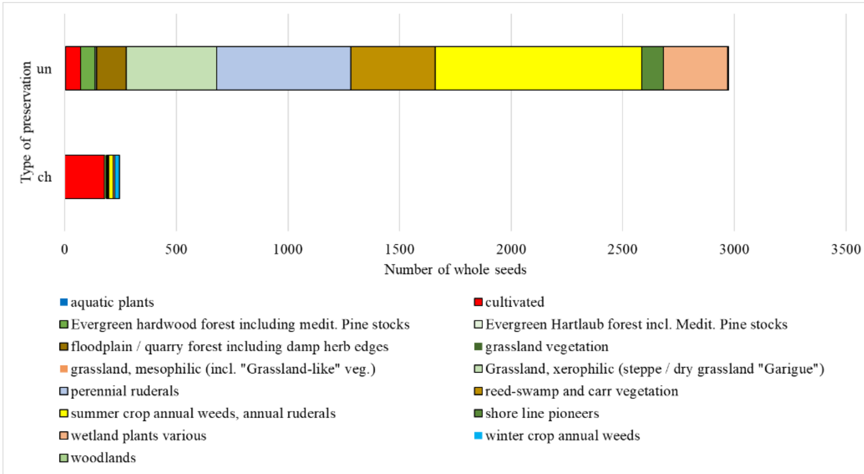

Figure 5.6 Proportion of seeds and fruits classified by ecological groups on well 994 and divided by charred (ch) and uncharred (un) (Varia and no group taxa were removed)

5.6 Discussion

5.6.1 Importance of water

Water is essential for drinking and cooking; temporary and non-temporary dwellings are settled near water sources. These water sources can be rivers, streams, or even human-made constructions such as wells, water reservoirs, or other forms of water supply (collecting and channelling rainwater). Evidence of human-made constructions is related to a more sedentary life. Settling in the land and animal and plant husbandry requires a more stable water income. This way of life seems to occur during the Middle Neolithic period, where activities resulted from a sedentary life, such as livestock, farming, pottery making, preparing fibres for textiles, or even making the day-to-day life washing and cleaning, water was needed (Brozio et al., 2014; Figueiral & Séjalon, 2014; Martin, 2012; Tegel et al., 2012; Thirault & Remicourt, 2014). Innovations in tool manufacture and woodwork techniques might have been developed at this time (Brozio et al., 2014; Tegel et al., 2012; Thirault & Remicourt, 2014). Recent studies show woodwork tools innovations such as corner joints and log construction to make massive wooden well lining (Tegel et al., 2012).

Activities such as agriculture are dependent on the amount of water present on the site and precipitation. There is little evidence of human-made constructions to store or channel water during the Middle Neolithic. Except well making, in the LBK, there are several cases. Tegel (2012) analysed different wells and defined two types of well-linings. The process was described as first making pits until reaching the groundwater level. This pit preparation was apparent in both profiles of wells 990 and 994. LBK wells could go down to 7 meters below the surface. The two types of wells are a chest-like well lining (using timber logs) and a tube-like well lining (using hollowed trunk sections) (Tegel et al., 2012).

However, it was not possible to find any lining on the wells of Les Bagnoles, and the excavation stopped at ca. 3 meters. Other researchers in Southeast France (Figueiral et al., 2013) suggested that unlined wells could be used for less than 50 years while lined wells made of wood and stone are used for longer than 75-100. This type of well might be the case of the ones at Les Bagnoles since no lined was found and no clear indication of permanent activities.

Although these wells did not have linings, they presented an excellent case study to analyse taxa that do not appear in other dry contexts like pits. A large quantity of chaff was identified as well as pea pods. When comparing these results to the other two wells published before Clos de Roque (Martin, 2012) and Mas de Vignoles IX (Figueiral & Séjalon, 2014), the results are insufficient as the number of samples, the total number of remains and sediment is not the same, and comparison can be biased.

For Mas de Vignoles IX, for two samples each of 20 litres, only 115 macroremains were found, which is a very reduced number for waterlogged preservation. Nevertheless, five seeds of opium poppy were found and three seeds of fig (Figueiral & Séjalon, 2014) which rarely appear due to their small size and inability to survive during charring (Märkle & Rösch, 2008). At Clos de Roque, structure 2096, one single sample from SU 16 had several poppy seeds (Martin, 2012). These findings were only at the bottom of the well. Two other samples were recovered; however, possibly these were grab samples as there are no counts for the seeds, and the finds are large, like hazelnut and wild grape (Pr189 and Pr191). The sampling and excavation of the Les Bagnoles show that more effort should be made when excavating wells as they are an archive of the above environment, human activities and are in a closed context. As shown in the well 990 sketch (Figure 5.1), most plant remains in the different layers (Figure 5.2) are found in the deeper layers beyond the groundwater level. This site will soon have a critical interdisciplinary overview with the publication of the final results of the project Agrichange.

5.6.2 Taphonomy of well filling

The formation processes of well deposits have both wet and dry sites deposition characteristics. Lakeshore deposits are the typical representative of the wet site where domestic waste is deposited under the houses and natural depositions of the surrounding flora (Jacomet, 2013). While for dry sites, daily waste and accidents are dumped on negative structures such as pits (Fuller et al., 2014; van der Veen, 2007). The wells deposits translated into a unique vision into the plants from the natural deposition of the environment and refuse waste from the up part of the wells or intentional drop-in. The list of taxa presented here reflects anthropogenic and natural processes.

Neolithic well fillings can go from a layer of complete ceramics (Tegel et al., 2012) to only broken pieces to a burial deposit like the case of Villeneuve-Tolosane, Haute-Garonne (Clottes et al., 1980). Deposit of whole animal bones is well known from Neolithic times (Jesus, 2016) and other periods, in Lattara dating 1st and 2nd century AD with whole dogs and rabbits (Figueiral et al., 2013). After being out of use, wells can be used as a latrine; an example of that is the well identified at Sa Osa Bronze Age site in Sardinia (Sabato et al., 2015). The macroremains from this Bronze age well look like they had passed through the intestinal tract, and it was possible to identify intestinal parasites (Sabato et al., 2015).

The reason Les Bagnoles wells end up with waste, making their content inappropriate for drinking, is unknown. The hypothesis could be that they do not need that water at a given time; there is no need for drinkable water, or the water was used for other purposes. However, this provides unique preservation of organic material. Waterlogging preserves certain types of plant tissues, such as woody material. However, other plant material does not survive, such as the endosperm of cereal grains (Wilkinson & Stevens, 2003, p. 162), but fragments of grain pericarps do survive. Softer tissues such as cereal chaff, oil plants, leaves and twigs survive in waterlogged conditions. In some cases, it is not understood if the less preserved and numbered remains are connected with the sampling method, oscillations of groundwater or the archaeological sites were not of permanent use. Figueiral (2013, p. 88) suggested an example of this about Mas Vignoles IX site where the wells (PT1157 and PT1051) had very few plant remains, suggesting that the site was not a permanent habitat.

Lodwick (2017, p. 204) compiled all previous work on well formation processes and created a well deposit type classification scheme in order to identify if the deposits were primary, gradual accumulation, non-organic dump and organic dump giving stratigraphic descriptions and bulk findings to each deposit type as well the references. This section will apply this classification to the two wells analysed to understand their filling better. In Les Bagnoles, it is not possible to compare macro-remains from the wells with other structures. The reason is that charred remains found outside of the wells are scarce and not studied. Within the wells, 990 and 994, mainly wild species, reflect the surrounding environment (Jacomet, 2020). They also present some cultivated plants like cereals, such as barley, emmer, einkorn, timopheevii and naked wheats, and oil plants like flax and poppy. From pulses, pea and fava bean were found. Well 990 has a higher presence of waste from pulses pods, cereal chaff and flax capsule. For well 994, the quantity is smaller, but the number of charred remains is higher than well 990 and the presence of cultivated species (see Figure 5.5). These types of remains suggest, using Lodwick classification scheme, for both wells an organic dump deposit types. Especially in well 990, it looks more like by-products of processing of flax, poppy, pea and cereals were processed within the exact moment, probably during the summertime. The processed by-products, such as chaff and crop summer weeds, were deposited on the well. For well 994, the numbers are fewer, indicating that the well might have had a lid related to the well's unusual square mouth. Both wells had charred chaff and some grains but mainly had seeds of annual summer crop weeds. This species' presence might be related to activities practised near the well, such as harvesting, cleaning the field and preparing the soil for the next sowing (Jesus et al., 2020), which would explain the mix of charred and wet remains of flax capsules, grains and wild seeds such as *Sambucus* sp.

Since the number of grains is relatively low, maybe the clean product was transported to another site, or it might not have been preserved, or it was consumed and not left behind in the other negative structures within the Les Bagnoles site. The high number of chaff remains in well 990 could also indicate that these remains were used for fodder related to the number of dung found. For well 994, the second top layer in the wet area was only the dung of a large animal, which also attested to animal husbandry.

In terms of oil plants, the proportion of flax remains indicates maybe by-products than food consumption. There are more capsules than seeds; if the seeds had been in the well, they would be preserved better in an uncharred state and better than the capsules. Around 4000 BC, a palaeoclimatic model suggests lower mean annual temperatures and lower rainfall (Contreras et al., 2018, fig. 2). This dry climate could have affected the cultivation of flax, even though the large quantity of flax remains still visible in well 990 and there is less material in 994, but it could be that this well had a lid; therefore, less material would fall inside the well. It is unclear which purpose the flax was used for as no seed measurements were taken to distinguish the different varieties (Herbig & Maier, 2011), no textile was found, and no clear indication of textile processes.

The carpological results from Les Bagnoles are just a tiny piece of the puzzle for the understanding of the activities that were happening, and the integration of different disciplines will bring more insights into the life of communities living in these areas during the Middle Neolithic period (van Willigen, Bailly, et al., 2020).

5.7 Research paper 1

The archaeobotanical data collected and assessed for the study area (discussed in section 3.10) is used to compare negative features from open-air sites in the Middle Neolithic period in Southern France. The preliminary results and discussion on the Les Bagnoles site are published in an article in the Vegetation History and Archaeobotany journal attached at the end of this chapter. Furthermore, the paper aims to use archaeobotanical data from wells, pits and silo-pits and storage analysis to understand the change in crop assemblages between MN1 and MN2, specifically after 4000 cal. BC, where researchers highlighted a reduction of naked wheat and an increase of glume wheat (Jesus, Prats, et al., 2021). Therefore, it was essential to understand if there was an increase in storage space due to the change from naked wheats to glume wheats in the second phase of the Middle Neolithic. Although, the main result does not support an increase in silo capacity regardless of the archaeobotanical evidence.

Jesus, A., Prats, G., Follmann, F., Jacomet, S., & Antolín, F. (2021). Middle Neolithic farming of open-air sites in SE France: new insights from archaeobotanical investigations of three wells found at Les Bagnoles (L'Isle-sur-la-Sorgue, Dépt. Vaucluse, France). *Vegetation History and Archaeobotany*, *30*(4), 445–461. https://doi.org/10.1007/s00334-020-00793-z

Vegetation History and Archaeobotany
https://doi.org/10.1007/s00334-020-00793-z

ORIGINAL ARTICLE

Middle Neolithic farming of open-air sites in SE France: new insights from archaeobotanical investigations of three wells found at Les Bagnoles (L'Isle-sur-la-Sorgue, Dépt. Vaucluse, France)

Ana Jesus[1] · Georgina Prats[1] · Franziska Follmann[1] · Stefanie Jacomet[1] · Ferran Antolín[1]

Received: 27 January 2020 / Accepted: 19 June 2020

Abstract

Previous reviews of Middle Neolithic agricultural practice (4400–3500 cal BC) in southern France have highlighted a change in crop assemblages after 4000 cal BC, with a reduction of naked wheat and an increase of emmer and partly of einkorn. The recent investigation of three wells from the site of Les Bagnoles (4250–3800 cal BC) in the periphery of the southern Rhône valley yielded an unprecedented amount of waterlogged uncharred and charred plant macro remains that offer new insights into crop diversity and its changes over time. The results from the wells at Les Bagnoles were compared with other dated sunken features from open-air sites (in contrast to caves and rock shelters), with the aim of identifying patterns suggesting changes in the crop spectra between the early (MN1) and late (MN2) Middle Neolithic phases from taphonomically comparable contexts. The results from Les Bagnoles demonstrate that oil crops and pulses are underrepresented in dry sites and that they were a significant part of Middle Neolithic agriculture. They also indicate an increase in the representation of einkorn (instead of emmer) during MN2 that is also visible in other open-air sites. The comparison of the archaeobotanical results with silo storage capacity values as a proxy for average production capacity per household leads us to propose a possible drop in naked wheat productivity and opens new questions in factors affecting crop choice at the beginning of the 4th millennium cal BC.

Keywords Pits · Neolithic storage · Crop diversity · Wells · Waterlogged preservation

Introduction

Middle Neolithic farming practices in southern France have received the attention of archaeobotanists in the last decades, either as site publications, reports or as reviews at a site scale (Phillips 1982; Marinval 1988a, b, 2003; Heinz et al. (1992; Beeching et al. 2000; Savard 2000; Thiébault et al. 2004; Vital et al. 2007; Martin et al. 2016; Bouby et al. 2018; Antolín et al. 2020b), but large-scale detailed analyses at a context level have not been undertaken to date. One of the reasons that explain this broad-scale approach is the existence of much data in old reports resulting from grab or non-systematic sampling, sieving with large mesh sizes, and/or works where the methodology is not clearly presented. However, efforts are being made to undertake a more accurate regional study of the Middle Neolithic period in south-eastern France (Martin 2014). The last review by Martin et al. 2016 suggests important changes in the crop spectrum which occurred at a site scale after 4000 BC, with a reduction of naked wheat in favour of glume wheats, particularly emmer. One of the questions raised in that paper concerns the type of naked wheat that was grown in the Mediterranean areas of France, whether the tetraploid or the hexaploid type. The lack of chaff remains at the investigated sites made it impossible to characterise this crop to its ploidy level. The second question is about the reasons for the changes in crop choice. According to several authors (Delhon et al. 2009; Beeching and Brochier 2011, pp 146–150),

Communicated by C.C. Bakels.

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00334-020-00793-z) contains supplementary material, which is available to authorized users.

✉ Ana Jesus
anaclaudia.sousajesus@unibas.ch

[1] Department of Environmental Sciences, Integrative Prehistory and Archaeological Science (IPAS), University of Basel, Spalenring 145, 4055 Basel, Switzerland

Published online: 18 September 2020

Springer

the expansion of farming before 4000 BC may be due to a climatic stabilisation. Conversely, several hypotheses have been proposed for the period after 4000 BC, such as increased soil erosion due to the possible human use of fire or natural fires; or a period of global cooling and hydrological changes (Magny and Haas 2004; Delhon et al. 2009, p 62) along with a regional demographic decline (Beeching 2002; Berger et al. 2019). At this juncture, a site with excellent preservation of archaeobotanical remains brought a new perspective to the existing dataset. Les Bagnoles (L'Isle-sur-la-Sorgue, Dépt. Vaucluse, Provence-Alpes-Côte d'Azur) revealed three wells with waterlogged deposits that contained charred and uncharred plant remains from three different time spans during continuous occupation within the Middle Neolithic period, hence being the perfect site to target both of the questions posed above.

The Middle Neolithic of southern France is usually divided into two phases: Middle Neolithic 1 (MN1) 4400–4000 cal BC and Middle Neolithic 2 (MN2) 4100–3500 cal BC (van Willigen et al. 2020b). MN1 is composed of different groups of communities defined by pottery styles such as pre-Chassey or early Chassey culture (Gernigon 2014), with sites such as Pendimoun (Binder et al. (1993), Giribaldi (Thiébault et al. 2004) and Fontbrégoua (Savard 2000). Another group is Saint Uze, with sites such as Plateau Raverre (Beeching et al. (1997), Gardon (Bouby 2009) and Chenet des Pierres (Martin et al. 2008); another pottery typology group is Montbolo, with the site Montou as one example (Buxó 2006). In this period, the open-air sites are close to alluvial terraces and open areas, sites such as Plots, Abri Font Juvenal, Le golf Auriac, Le Crès, Encombre, Saint Antoine and Le Pirou (Martin et al. 2016). The Middle Neolithic 2 period (4100–3500 cal BC) includes pottery style groups attributed to Late Chassey, La Roberte (van Willigen et al. 2014) and Neolithic Moyen Bourguigon (Sénépart et al. 2014), from different sites such as ZAC Saint Antoine II and Le Moulin (Martin et al. 2016). All the sites mentioned above have provided archaeobotanical data.

Over 70 Middle Neolithic sites with archaeobotanical data are known from the whole of France, among which the most frequent ones are open-air sites followed by cave sites (Martin et al. 2016). In this paper, we will focus on the open-air sites since the Les Bagnoles site is included in this category, while cave sites were excluded from the analysis due to their different taphonomy and uses (Martin 2014; Jacomet 2020). Open-air sites of this period in southern France have no clear evidence of structures that define the extent of the site, and they are mainly composed of negative (sunken) features in the subsoil such as pits, silos (storage pits) and wells (Thirault and Remicourt 2014; Giligny and Sénépart 2018). Evidence of water management, such as wells, starts to be more frequent during the Neolithic period, and is normally associated with a more sedentary life and a more fixed economy such as agriculture and animal husbandry. Several Early Neolithic wells have been found in more northern parts of Europe (Tegel et al. 2012) and in southern France (Thirault and Remicourt 2014, p 236), and their archaeobotanical investigation has provided important additions to the available information on farming practices in those areas (Herbig et al. 2013).

Underground silo pits are the most common type of storage technology found archaeologically around the Mediterranean (Sigaut 1988). Therefore, they are the only features that allow large-scale quantitative analyses of volumetric capacity informed by consideration of silo shape, to provide insight into the cultural, technological and economic organisation of agricultural societies (Prats et al. 2020). There have been few systematic silo studies on Neolithic sites, although pioneer research was done in our study area by Beeching et al. (2010). A systematic study of prehistoric silo pits was done in previous work focused on Catalonia, north eastern Iberian Peninsula (Prats 2017), and we are currently expanding it to other areas including southern France (Antolín et al. 2018). During this work, it was observed that silo capacities in the Neolithic are significantly lower than in later periods in prehistory and that there is a progressive increase in their mean volume from 580 L in the Early Neolithic to 800 and 950 L in the Middle and Late Neolithic respectively. Archaeological and ethnographic research has tended to establish a direct relationship between storage capacity and immediate field production, that is to say, the yield of each harvest and the area which was cultivated (for example, Sharples 1991).

Consequently, we decided to work with the mean storage capacities per period as a proxy for productivity, thus avoiding the interpretation of single values. The results from Catalonia were interpreted as an increase in production capacity of households during the Neolithic period (Prats et al. 2020). Nevertheless, this interpretation is never straightforward, since the stored volume always depends on the type of crops and the form in which they were stored, so that naked wheat was usually stored as a cleaned product, but glume wheats usually as spikelets, which makes them more pest-resistant (Jones et al. 1986). Whole spikelets occupy at least double the volume of cleaned grain, as experiments suggest (Alonso et al. 2013; Cappers et al. 2013) and hence the storage space needed is larger for the same amount of grain. Since a change in crop assemblages toward more glume wheats has been detected in our study area according to previous work, the mean capacity values of underground storage pits may show a consequent increase in volume during phase MN2, if household productivity and the organisation of storage stayed constant during this change.

In this paper, the archaeobotanical data from the three wells at Les Bagnoles are presented and these results are then integrated into a regional contextual comparison of archaeobotanical evidence from taphonomically comparable features such as pits/silos and wells. The goals of this comparison are to reflect on the representativeness of the data generated by the wells at Les Bagnoles; to understand if there is any pattern of distribution between the various crops at the structure level and to see if there was any change with time between MN1 and MN2. In order to discuss potential causes for changes in farming practices during the Middle Neolithic period, we will include an evaluation of underground storage capacity as a proxy for productivity.

Materials and methods

The Les Bagnoles site

The archaeological site of Les Bagnoles is located 2.5 km southwest of L'Isle-sur-la-Sorgue, Dépt. Vaucluse (Fig. 1), on alluvial soils (Sargiano et al. 2010), within a mosaic of plant communities that go from woods by rivers to wet and dry grasslands as well as ruderal vegetation connected to human impact on the landscape (Jacomet 2020). The site was found in 2006 and excavated scientifically between 2012 and 2015 by Landesmuseum Zürich (Swiss National Museum) and the Universities of Basel and Aix-Marseille (van Willigen et al. 2020a). Several phases of occupation were detected, dated to the Middle Neolithic, Bronze Age, Iron Age, Gallo-Roman and modern periods, mainly as negative structures, such as pits, silos, post holes and wells (site plan, ESM Fig. 1, well 250, ringed in red, above, and wells 990 and 994 below; Denaire and van Willigen 2020). In this paper, we will focus on the three Middle Neolithic wells (structures 250, 990 and 994) dated between 4250 and 3700 cal BC because they offer a unique record of crop remains (well sections, ESM Fig. 2). All wells lacked any sort of lining.

The wells were dug in spits (artificial levels) of 20 to 10 cm. Structure 250, more than 3 m deep, was excavated in two halves (ESM Fig. 2a). The southern half was dug first, in spits of 15–20 cm, while the northern half was dug in spits of ca. 10 cm. Due to the higher precision of the sampling, the northern half was prioritised. Additionally, samples from a test core were also investigated. Permanently waterlogged deposits were reached at a depth of 2.5 m, although the water table could have been often much higher in the past. Structure 990 was 3.3 m deep and the lower part of the well was sampled in spits of 10 cm for the whole well, but not in halves, due to the difficulty of working at such a depth (ESM Fig. 2b). A core sample was also taken. Finally, Structure 994 was more than 3.1 m deep and sampled in the same way as well 990 (ESM Fig. 2c). The archaeobiological sampling of wells 990 and 994 concentrated on the waterlogged layers, and all the sediment was kept for further scientific analyses. The wells contained large amounts of pottery, flint, animal bones and dung, suggesting daily refuse deposits (Antolín et al. 2020a, c).

Well 250 is radiocarbon dated to ca. 4250–4050 cal BC, well 990 to 4050–3980 cal BC and well 994 to 3940–3780 cal BC (Table 1; Martínez-Grau et al. 2020).

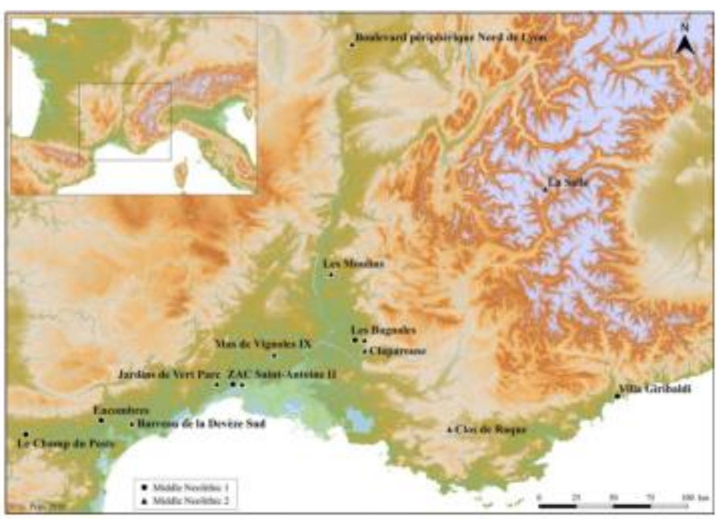

Fig. 1 Map showing all the sites in southern France discussed in the paper

Table 1 Dates on seed and fruit remains from the wells at Les Bagnoles by ETH, Zürich

Lab.code	Sample No	Taxon dated	Age (yrs BP)	cal BC (2σ)	References
ETH-60868	Str 250 P11	*Corylus avellana*	5,306 ± 27	4233–4048	Martínez-Grau et al. (2020)
ETH-60867	Str 250 P11	Cerealia	5,331 ± 27	4252–4051	Martínez-Grau et al. (2020)
ETH-60870	Str 250 P12	*Triticum* sp.	5,302 ± 31	4237–4042	Martínez-Grau et al. (2020)
ETH-60871	Str 250 below P13	Cerealia	5,323 ± 31	4252–4047	Martínez-Grau et al. (2020)
ETH-88901	Str 990 P70	*Triticum aestivum/durum/turgidum*	5,226 ± 25	4219–3969	Martínez-Grau et al. (2020)
ETH-88904	Str 990 P25	*Triticum aestivum/durum/turgidum*	5,213 ± 25	4048–3968	Martínez-Grau et al. (2020)
ETH-88902	Str 994 P42	*Triticum monococcum*	5,027 ± 26	3943–3714	Martínez-Grau et al. (2020)
ETH-96173	Str 994 P45	*Triticum* cf. *monococcum*	5,096 ± 28	3966–3800	Unpublished
ETH-88903*	Str 994 P44	*Triticum aestivum/durum/turgidum*	5,874 ± 25	4796–4693	Martínez-Grau et al. (2020)

Calibrated with OxCal v. 4.3.2 (Bronk Ramsey 2017) and IntCal13 atmospheric curve (Reimer et al. 2013)

*Interpreted as an error or a contamination

Archaeobotanical analyses from Les Bagnoles

The sediment samples were pre-treated with a water softener (Calgon) if samples were sieved in the field or by freezing and thawing (Vandorpe and Jacomet 2007). The latter method was used particularly for the waterlogged sediments. These were then sieved with the wash-over technique (Steiner et al. 2015) and the different fractions (> 4 > 1 and > 0.35 mm) were sorted under a stereo microscope. The 0.35 mm fractions were subsampled with the grid method (van der Veen and Fieller 1982) and ca. 10 ml of residues were sorted. The resulting data were added to the ArboDat 2018 database (Kreuz and Schäfer 2002). Cereal identification criteria follow available literature (Jacomet 2006). This study uses the traditional nomenclature of Zohary et al. (2012) for crops. Only grains with embryo ends were counted (Jones 1990) and only nodes of free-threshing rachis remains or glume bases for glume wheats (Hillman et al. (1996). Cf. *Pisum sativum* (pea) pod fragments were counted if the fragments were larger than 12 mm^2 (Fig. 2k) (description of these remains in Antolín and Schäfer 2020). Wild plants are not the object of study of this paper and are not included here, but the preliminary results were recently published (Antolín et al. 2020a, c; Jacomet 2020).

All in all, 65 samples from the three wells were analysed, adding up to more than 500 L of sediment. For most spits in the permanently waterlogged parts of each well, up to eight buckets (8 L each) of sediment were sieved, although only one or two of these were analysed. The analyses presented here are only a fraction of the total contents of the wells, and the screening of the remaining samples in the future may provide additional interesting finds such as extra cereal grains, charred seeds of pulses or large-seeded fruits. This paper therefore focuses on the general trends of the main crops. Each well is presented here as one feature since the samples were relatively homogeneous and no internal stratigraphy was observed in the waterlogged deposits (Table 1).

Regional comparison of archaeobotanical data and silo pits

Data from a total of 48 Middle Neolithic sites in southern France were included in the on-going AgriChange project database (Antolín et al. 2018). Of these sites, 27 are open-air sites, 15 caves, two shelters and three lakeshore settlements. All the sites yielded charred material but only three provided waterlogged plant remains, always from well contexts, Les Bagnoles, Clos de Roque and Mas de Vignoles IX. For this paper, we will focus on the open-air sites (Fig. 1) with pits, silos and wells as long as the data are available at a feature level, along with a clear chronology, either from radiocarbon dating or by pottery typology (Table 2). The data are organised according to the type of structure (well, pit/silo) and comparisons are made between each type of feature per phase and between the two phases of the Middle Neolithic period. The sites of Clos de Roque and Mas de Vignoles IX are both dated later than the MN2 period (ca. 3500 BC). They were, however, included in our analyses since there are only a few wells with waterlogged material, and they contributed significantly to the purposes of the paper. These sites are often integrated into syntheses about this period (van Willigen et al. 2014; Martin et al. 2016; Antolín et al. 2020b).

For incomplete grains, the total number of fragments of each taxon was divided by four and then added to the total of complete grain counts for the quantitative analyses. All barley identifications were grouped into one category, *Hordeum distichon/vulgare*, but it includes *H.* ssp. *vulgare*, *H.* ssp. *nudum*, *Hordeum* sp. and *Hordeum* remains (cfs). Grain counts were mostly used because chaff remains were only rarely found. Chaff was only used when there were no charred grains from sites with waterlogged material such as Clos de Roque, except Les Bagnoles.

Frequency per structure at a site level was used to produce bar plots that summarise the trends per phase, which

Fig. 2 Archaeobotanical finds from the wells at Les Bagnoles. **a** *Triticum* cf. *durum/turgidum* (rachis segments, waterlogged); **b** *Hordeum distichum* (naked) (rachis segment, waterlogged); **c** *H. vulgare* var. *nudum* (rachis segment, charred); **d** group of rachis segments of *T.* cf. *durum/turgidum* (waterlogged); **e** *T. monococcum* (spikelet fork, waterlogged); **f** *T. monococcum* (spikelet, charred); **g** *Triticum* sp. new type (spikelet fork, charred); **h** *Papaver somniferum* ssp. *somniferum/setigerum* (seeds, waterlogged); **i** cf. *Pisum sativum* (pod fragments, waterlogged); **j** *Linum usitatissimum* (seed, waterlogged); **k** *L. usitatissimum* (capsule segments, waterlogged). Photos by Raül Soteras

Table 2 Sites included in the analysis, dates, types of features, mesh sizes used, volumes of sediment and charred grain counts

Phase	Site	Date (cal BC)/ pottery typol.	Structures analysed (archaeobotany)	Storage struct. analysed	Mesh (mm)	Vol. (L)	*Hord. vulgare*	*Trit. aestivum/ durum/turgidum*	*Trit. dicoc.*	*Trit. monoc.*	References
MN1	Encombres	4349-3998	5 str. (1069, 1073, 1077, 1081, 1101)	7 deep silo	0.5	63	2	9	-	-	Amiel et al. 1996; Vaquer et al. 2003, p. 349; Martin et al. 2016
MN1	Le Champ du Poste	4339-4068; 4233-3994	8 str. (34, 37, 44, 240, 387, 251, 287, 288)	17 deep silos (incl. 34 and 288)	5; 2; 0.4	110	34	69	16	113	Convertini and Georjon 2018; Figueiral 2018
MN1	ZAC Saint-Antoine II	4330-4050	2 str. (2605, 2219)	4 deep silo (incl. 2605)	4; 2; 0.5	60	6	18	1		Rousselet 2011; Sendra et al. 2011
MN1	Villa Giribaldi	4330-4040	3 str. (3, 6, 7)	-	1	Unk.	44	91	24	7	Binder et al. 2004; Thiébault et al. 2004; Binder and Lepère 2014
MN1	Les Bagnoles	4250-4050	1 well (250)	-	4; 2; 0.35	365	33	53	4	3	Antolin et al. 2020c; van Willigen et al. 2020a
MN2	La Salle	Bizien	1 str. (4)	-	1	Unk.	291	-	-	1	Marinval 2003; Vaquer et al. 2003, p. 348
MN2	Barreau de la Devèze Sud	4071-3953	1 str. (2115)	7 deep silos (incl. 2115)	5; 2; 0.4	10	158	53	-	20	Figueiral 2012; Vergély et al. 2012; van Willigen et al. 2020b, p. 309
MN2	Claparouse	4040–3800	1 str.	1 deep silo	Unknown	?	9	17	27	25	Bouby and Léa 2006; Martin et al. 2016
MN2	Jardins de Vert Parc	Well 1045: 3791-3655	4 str. (1068, 1085, 1093, 1095)	5 deep silos (incl. 1095, 1085 and 1068)	4; 2; 0.5	129	5	13	1	-	Bouby 1999; Vaquer et al. 2003, p. 349; Vignaud 2003
MN2	Les Moulins	3959-3785	12 str. (16, 51, 54, 62, 69, 70, 75, 129, 132, 139, 152, 170	35 deep silos	2	Unk.	1672	20	13	122	Beeching et al. 1986; Beeching and Cordier 1997, 2004; Beeching 2015; Battentier et al. 2015; Martin et al. 2016
MN2	Mas de Vignoles IX	str. 1391: 3360-3098	2 wells	-	2; 0.4	30-60	-	-	-	1	Figueiral and Séjalon 2014; van Willigen et al. 2020b, p. 309
MN2	ZAC Saint-Antoine II	4100-3950 4050-3800	5 str. (2018, 2537, 2288, 2021, 2384)	7 deep silos (incl. 2021 and 2384)	4; 2; 0.5	170	3	15	50	209	Rousselet 2011; Sendra et al. 2011
MN2	Les Bagnoles	4050-3980 3940-3780	2 wells (990 and 994)	5 deep silos	4; 2; 0.35	162.2	46	24		10	Antolin et al. 2020a; van Willigen et al. 2020a
MN2	Clos de Roque	3656-3526	1 well		10; 0.5; 0.2	100		1			Martin 2012, p. 242
MN2	Boulevard périphérique Nord de Lyon	3789-3522	-	3 deep silos	-	-	-	-	-	-	Vital et al. 2007, p. 65

Note that only remains from dated pits have been included, for the total amount of remains at a site level, see Martin et al. (2016)

Table 3 Total results of the identification of cereal and fruit remains of cultivated plants from the three wells at Les Bagnoles

Vol. (L)		379.1	60.6	84.2
Number of samples		39	13	13
Well		250	990	994
Chronological dates (cal BC)		4250-4050	4050-3980	3940-3780
Cereals, charred				
Hordeum distichon/vulgare	Grain	33	36	10
Triticum aestivum/durum/turgidum	Grain	53	13	11
Triticum dicoccum	Grain	4		
Triticum monococcum	Grain	3		10
Triticum monococcum/dicoccum	Grain		1	
Triticum sp.	Grain	62	2	5
Cerealia indet.	Grain	456	5	140
Hordeum distichon/vulgare	Rachis	26	282	32
Triticum cf. *aestivum* type	Rachis	1	6	7
Triticum cf. *durum/turgidum* type	Rachis	34	175	38
Triticum aestivum/durum/turgidum	Rachis	50	96	24
Triticum dicoccum	Glume base	6	24	11
Triticum monococcum	Glume base	2	22	64
Triticum monococcum/dicoccum	Glume base	1	1	
Triticum sp. "new-type"	Glume base		21	2
Triticum sp.	Awn frag.			3
Triticum sp.	Chaff	9	13	13
Cerealia indet.	Ear base	1	5	2
Cerealia indet.	Awn frag.	24		2
Cerealia indet.	Straw node	22	10	
Cerealia indet.	Chaff	21	112	129
Cereals, waterlogged				
Cerealia indet.	Pericarp	277	55	45
Hordeum distichon/vulgare	Rachis	56	2601	10
Triticum cf. *aestivum type*	Rachis		4	16
Triticum cf. *durum/turgidum* type	Rachis	71	3034	16
Triticum aestivum/durum/turgidum	Rachis	55	586	6
Triticum dicoccum	Glume base	4	735	15
Triticum monococcum	Glume base	3	288	77
Triticum monococcum/dicoccum	Glume base		106	17
Triticum sp., "new-type"	Glume base		2	
Triticum sp.	Chaff	3	50	9
Cerealia indet.	Ear base		16	
Cerealia indet.	Straw node	10	2	2
Cerealia indet.	Chaff	65	1,459	148
Pulses, charred				
Lens culinaris	Seed	2		
Pisum sativum	Seed	1		1
Fabaceae (cf. *Pisum sativum*)	Pod fragment		1	
Vicia cf. *faba*	Seed		1	
Pulses, waterlogged				
Pisum sativum	Seed		1	
Fabaceae (cf. *Pisum sativum*)	Pod fragment	4	181	4
Fabaceae (cf. *Pisum sativum*)	Hilum		3	
Fabaceae (cf. *Pisum sativum*)	Calyx		5	1
Oil plants, charred				
Linum usitatissimum	Capsule segment		2	
Oil plants, waterlogged				
Linum usitatissimum	Seed	1	36	4
Linum usitatissimum	Capsule segment	1	231	4
Papaver somniferum ssp. *somniferum/setigerum*	Seed	292	54	15

Springer

represents most accurately the recurrence of the use of a crop taxon within each particular phase at the sites (Popper 1988).

In order to see if these recurrences had a direct expression in the number of grains per crop found per site, we calculated proportions of each crop type for all features with at least 30 identified cereal grains. For the first phase MN1, material from six features and for MN2, five features were available. These results were again drawn as bar plots with the standard deviation shown.

Analysis of storage capacity

Due to the lack of the original ground surface at most open-air sites excavated in our study region, storage features can only be analysed as isolated contexts and not in relation to dwellings or similar features. We cannot be sure if a silo could be related to only one household and that is why we are not interpreting isolated values, but observing the general trend for each of the two chronological phases, as in Prats et al. (2020).

Underground storage features from the analysed sites were classified typologically and their capacity was calculated (for the methodology, see Gilabert 2009; Prats 2017; Prats et al. 2020), to correlate it with any potential changes in the crop assemblage. The resulting volume values are inevitably an underestimate of their real storage capacity (Bogaard et al. 2009).

We initially considered a total of 91 underground features with a clear chronology, with a < 3.5 top diameter/depth index (D–D index) and with a depth of more than 35 cm. Most of the Middle Neolithic pits are bell-shaped (ESM Fig. 3), as observed in Catalonia (Prats 2017), so this will not be further discussed here. From MN1, 28 features from three sites, Encombres, Le Champ du Post and ZAC Saint-Antoine II were analysed with an average depth of 55 cm and average D-D index of 2.5 (Fig. 1). From MN2, 63 structures from seven sites, Barreau de la Devèze Sud, Boulevard périphérique Nord de Lyon, Claparouse, Jardins de Vert Parc, Les Bagnoles, Les Moulins and ZAC Saint-Antoine II, were analysed, with an average depth of 72 cm, average D-D index of 1.5 and with better preservation than the MN1 features.

Results

General results from Les Bagnoles

Overall, 844 remains of charred cereal grains, 1,291 charred and almost 9,500 waterlogged chaff remains were found (Table 3, photos of a selection of remains in Fig. 2). Oil plants and pulses were mostly identified from waterlogged remains (837 waterlogged remains, eight charred). Up to six cereal taxa were identified, barley (identified as *Hordeum distichon/vulgare*, but mostly belonging to six-rowed naked barley), with the presence of the two-rowed type as shown in Fig. 2b, c. Naked wheat included both types of chaff remains, hexaploid *T. aestivum*-type and the tetraploid *durum/turgidum*-type, the latter being overwhelmingly dominant. Glume wheats were found, such as *Triticum dicoccum* (emmer), *T. monococcum* (einkorn) and the new type glume wheat (*Triticum* sp. new type), which are shown in Fig. 2. Free threshing cereals (barley and naked wheat) are in general better represented than glume wheats, in a proportion of 8:1 for grains and 5:1 for chaff remains, both charred and waterlogged. Fragments of the ear base were found in all wells, as well as straw nodes both charred and waterlogged. Waterlogged cereal pericarp and testa fragments, mostly not identifiable to species level, were also recovered. Three species of pulses were found, *Lens culinaris* (lentil), *Pisum sativum* (pea) and *Vicia* cf. *faba* (broad bean), but the number of finds was very low. Only cf. *Pisum sativum* (pea) pod fragments were found in significant numbers. Two oil plants were almost exclusively represented by waterlogged remains of *Linum usitatissimum* (flax) and *Papaver somniferum* ssp. *somniferum/setigerum* (possible opium poppy) (Fig. 2h-j).

Well 250 (ca. 4250–4050 cal BC)

Naked wheat grains are dominant in this well, followed by barley, while glume wheat grains are very rare (Fig. 3a). Among the oil plants and pulses, opium poppy is the best represented, while this is the only well from which lentil has been found at Les Bagnoles.

Well 990 (4050–3980 cal BC)

Hordeum (barley) is clearly dominant in this feature, both in grain and chaff remains, followed by *Triticum* (naked wheat). Charred chaff remains of barley are as well represented as naked wheat, while glume wheats reach ca. 10% of the total remains (Fig. 3b). Uncharred chaff remains show a more explicit dominance of barley, followed by naked wheat and a more important representation of glume wheats (15%). The new type glume wheat was also found in this well. Pea was the dominant pulse in this well, although it also yielded the only find of *Vicia faba* (broad bean) from the site. Both capsule and seed remains of *Linum* (flax) were found in this well, also more than 50 seeds of opium poppy.

Well 994 (3940–3780 cal BC)

The most recent well shows a clearly different crop spectrum, with an equal representation of all cereal groups. In

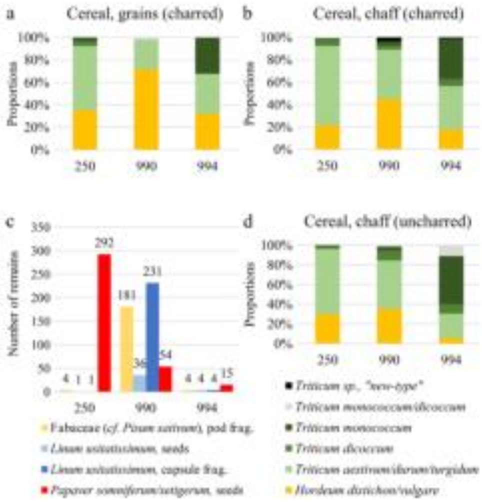

Fig. 3 Proportions of the most important cereal taxa from Les Bagnoles according to **a** charred grains; **b** cereal charred chaff remains; **c** number of remains found per well of the main pulses and oil crops (only waterlogged remains); **d** uncharred (waterlogged) chaff remains

fact, chaff remains of glume wheats are dominant both in the charred and the uncharred record (Fig. 3d). Naked wheat is particularly badly represented among the chaff remains. Oil plants and pulses were recorded in small amounts (Table 3).

Discussion

The crops from the wells at Les Bagnoles in the context of the Early and Middle Neolithic of southern France and adjacent regions

Thousands of uncharred waterlogged chaff remains from naked and glume wheat and also from barley, along with abundant finds of oil plants and pulses, were found from the wells at Les Bagnoles. Neolithic sites with waterlogged preservation are rare in Mediterranean Europe, and dry sites often reveal a limited insight into plant economy due to taphonomic factors. This makes the findings from Les Bagnoles unique and provides a new insight into crop diversity during the Middle Neolithic period in southeastern France.

The infillings of the wells represent accumulations of refuse during the immediate period after the last use of the wells for their original purpose. Besides plant finds, large amounts of animal remains (mostly bones, but also dung of vertebrates and large amounts of invertebrates, mainly insects), pottery, grinding stones, etc. were recovered from these features, suggesting their closeness to the living area (for a discussion of the possible origin of well infillings see Jacomet 2020 and the literature cited there). Therefore, the contents of the wells inform us about domestic economic practices as may do other negative features such as pits and silo pits, which were filled with deposits of secondary refuse (Kreuz 1990; Schiffer 1991; LaMotta and Schiffer 2002; Fuller et al. 2014), with the added benefit of having waterlogged plant remains preserved. Such waterlogged features offer excellent preservation conditions, which allow not only the preservation of a considerable number of charred grains and abundant chaff remains, but particularly also uncharred waterlogged chaff.

Barley is one of the best represented crops at the site. Chaff remains suggest the presence of mostly six-rowed naked barley in all the Les Bagnoles wells, but two-rowed barley was also present. The presence of both types of barley during the Middle Neolithic in the area had not yet been noticed before, mainly due to the scarcity of chaff remains in the archaeobotanical record. Barley seems to have spread in the northwestern Mediterranean area since the Early Neolithic period in the first Impressa culture sites (ca. 5850–5650 cal BC) in southern France (Bouby et al. 2020a). Ear and rachis fragments of two-rowed barley (unclear if hulled or naked) were recorded from La Draga in Banyoles, Spain, belonging to the Cardial culture (ca. 5400–5000 cal BC) (Antolín et al. 2014, 2015). However, only a few barley rachis remains have been recovered from the Middle Neolithic sites of the northwestern Mediterranean, and these were not identified to variety level (Antolín 2016), although they seem to be of the six-rowed type, as suggested in the recent study of the site of Auvelles (Castelló de Farfanya, Catalonia) (Antolín in press).

Naked wheat also spread quickly across the western Mediterranean since the early Neolithic, mostly the tetraploid type (*Triticum durum/turgidum*), found at sites such as La Marmotta (Lago di Bracciano, Italy) (Rottoli 1993) and La Draga (Llac de Banyoles, Spain) (Antolín et al. 2014). Possible rachis fragments of the hexaploid type were reported from La Draga, just like the ones found from Les Bagnoles, mixed with the dominant tetraploid ones. The presence of both types of naked wheat together has long been known from the circum-Alpine Neolithic pile dwellings (Schlumbaum et al. (1998), although the tetraploid type was also strongly dominant there. Thus, we can confirm that tetraploid naked wheat was present in southern France and probably dominant over other naked wheats during the Middle Neolithic, which was not known until now due to the scarcity of chaff remains at previously investigated sites, as reported by other authors (Martin et al. 2016).

The results of Les Bagnoles indicate a significant increase of einkorn in the most recent well, dated to ca. 3950–3750 cal BC (MN2). Earlier results have shown that during the early Neolithic (5th millennium BC) these glume wheats had considerable importance in the area investigated, but then during MN1 they became rare, before they regained importance during MN2 (Bouby et al. 2020a; de Vareilles et al. 2020). This increase coincides with general observations based on grain counts from sites in southern France (Martin et al. 2016; Antolín et al. 2020b), which suggest a revived focus on glume wheats. In order to avoid taphonomic biases, we will test this hypothesis using a contextual approach, by using only negative features such as wells and pits in the following section (as in Jesus et al. 2020).

Until now, the new type of glume wheat had only been found at a Middle Bronze Age site (ca. 1500 BC) in southern France (Toulemonde et al. 2015), while Neolithic finds seemed to be restricted to the Linearbandkeramik (LBK) area. The recent finds of this taxon in northern Italy (Rottoli and Castiglioni 2009) and other Mediterranean sites such as La Draga and Can Sadurní in Catalonia (Antolín et al. 2015; Antolín 2016) show that it was present in the area since the 6th millennium BC, but probably not as a crop on its own. This is presumably also the case at Les Bagnoles, judging from the available evidence.

The results from Les Bagnoles are even more relevant regarding pulses and oil plants. Pulses have already been found from other sites, particularly *Lathyrus cicera/sativus* (pea, grass pea) and *Vicia sativa* (common vetch), but the numerous waterlogged probable pea pod fragments found at Les Bagnoles show that their importance is clearly underestimated in the charred record. In addition to this, one seed of *Vicia faba* (broad bean) was also recovered, which had not been identified to date in this region (Martin et al. 2016). The abundant remains of *Linum* (flax) seeds and capsule segments and *Papaver somniferum* (opium poppy) also suggest that their importance in the economy was greater than originally considered, because they are rarely preserved at dry sites (Jacomet 2013).

Importance of crops at Les Bagnoles compared to other Middle Neolithic wells and pits in southern France

In order to discuss the representativeness of the data on crop changes obtained from the wells at Les Bagnoles in the context of southern France as a whole, we compared first the results from other wells in the region and then from other negative features, as taphonomically comparable deposits.

Sites with waterlogged deposits are extremely rare in southern France. As already mentioned, there are only the wells at Mas de Vignoles (Nîmes) (Figueiral and Séjalon 2014) and Clos de Roque (Saint-Maximin-la-Ste-Baume, Dépt. Var) (Martin 2012). However, little is known about the methodologies used for sampling and processing the waterlogged plant remains from these sites. Only the well of Clos de Roque yielded waterlogged plant remains in high numbers. Unfortunately, the sieved fractions were dried, which probably destroyed all fragile plant remains such as chaff fragments (for a discussion of this topic see Tolar et al. 2010). Both wells also provided a very small amount of charred cereal remains, which renders them irrelevant for the characterization of cereal agriculture in the Neolithic period (Table 4). The scarcity of charred material from Mas de Vignoles led the authors to suggest that food preparation was not taking place near the wells and that the lack of material indicates that these structures were on the periphery of the living area (Figueiral and Séjalon 2014, p 33). Conversely, *Papaver* seeds (presumably uncharred) were found from both wells, confirming the importance of poppy and its consistent underrepresentation at dry sites due to preservation and recovery issues. Pulses were not reported from the wells at Clos de Roque and Mas de Vignoles IX.

The data from Les Bagnoles, with abundant waterlogged remains of chaff and presence of pulses and oil plants, have more in common with the lakeshore sites of different parts of Europe, such as the Jura region in France, in Switzerland and in southern Germany (for example, Maier 2001; Jacomet 2007, 2014). This dissimilarity with other wells in southern France may be due to methodological reasons and it probably suggests that if more wells had been properly excavated and sampled, supraregional comparisons between these areas would be possible.

The charred archaeobotanical record from Les Bagnoles was compared on a regional level with southern France, calculating both the ubiquity (presence) and the proportion of remains of each crop per site. The sites are grouped chronologically into MN1 or MN2, as shown in Table 2.

The calculation of ubiquities at a feature level resulted in the same trend as observed from Les Bagnoles, with a decrease in naked wheat (and emmer), similar importance of barley and a significant increase in einkorn (Fig. 4a). This suggests that the observed trend is representative at the level of the domestic economy, since ubiquity values best reflect the repetition of activities in the past. In order to confirm this, we calculated the average proportions of the same crops at a structure level, only using features with 30 or more crop remains, now including Les Bagnoles to make the dataset more solid (Fig. 4b). The decrease in naked wheat and the increase in einkorn are also clearly visible using this approach, and it therefore confirms the previously observed trend. This is in slight disagreement with the increase of emmer proposed by Martin et al. (2016), which could be due to our different approach and focus on open-air sites.

Table 4 Cultivated plant list from the archaeobotanical analyses of the Neolithic wells studied in southern France (for cereals only grains are shown)

Site	Les Bagnoles			Clos de Roque*	Mas de Vignoles IX**	
Age cal BC	4200-4050	4030-3980	3980-3880	3650-3350	Middle Neolithic (Chasséen)	
Well	250	990	994	ST2096	1157	1051
Stratigraphic unit	Several	Several	Several	16	1719	1724
Volume (l)	379.1	60.6	84.2	100	20-30	20-30
Cereals (grains, *charred*)						
Hordeum vulgare	33	36	10			
Triticum dicoccum	4					
T. monococcum	3		10			1
T. monococcum/dicoccum		1		1		
T. aestivum /durum/turgidum	53	13	11	1		
Pulses (seeds, charred)						
Pisum sativum		1				
Oil plants (seeds, uncharred)						
Papaver somniferum ssp. *somniferum/setigerum*	292	54	15	593	5	
Linum usitatissimum	1	36	4			

* Martin 2012

** Figueiral and Sejalon 2014

Possible reasons for the change in crop choice at the beginning of the 4th millennium BC

The increase in the presence of glume wheats has been discussed already. Martin et al. (2016) propose some possible causes, such as cultural contacts, expansion of farming on to poorer soils, environmental changes or techno-economic changes.

Cultural contacts are indicated by finds which show the exchange of materials such as pottery, raw materials and stone objects. Examples of these are found from throughout the Neolithic period and normally associated with rivers as exchange routes such as the Rhine and also the Mediterranean coastline (Denaire et al. 2011). According to evidence from MN2 burials there are clear signs of exchanges between northern Italy, Catalonia and Switzerland; differences in the funerary practices in southern France also show distinct regional groups within the late Neolithic "classic Chassey" culture such as the Rhodanien Chassey and the Bize group (Vaquer 2014). There is little evidence of house plans in southeastern France, however the few which are available show cultural influences from Switzerland (Cortaillod culture) and from northern Italy (Chassey-Lagozza culture) (Saintot et al. 2009, p. 120; Giligny and Sénépart 2018, pp. 35–42). The presence of Chassey pottery and artefacts in the Sepulcres de Fossa communities in Catalonia demonstrate exchange between these two groups (Mestres and Tarrús 2016), as well the presence of pearls made of variscite (a phosphatic mineral) from Gavà (Spain) in MN2 burials in southeastern France (Vaquer 2014, p. 2). The archaeobotanical record from the Middle Neolithic in Catalonia is dominated by naked barley and naked wheat (Antolín in press; Antolín et al. 2015, 2018), so it is unlikely that cultural contacts with this region favoured the choice of glume wheats over free-threshing cereals. Unfortunately, the archaeobotanical record in northern Italy is poorly known, and we cannot be sure if glume wheats could have arrived from that region (Rottoli and Castiglioni 2009). Current analyses on the lakeshore site of Isolino di Varese suggest that this possibility exists (Antolín, unpublished). Influences from the western Balkans could possibly explain the cultural factors affecting crop choice in northern Italy, considering the state of research for this period (Reed 2016), but much more research is needed on northern Italy to show that this was the case. In such a hypothetical scenario, the contacts between northern Italy and southern France could also have favoured the increased presence of glume wheats in the latter region, but this is currently a matter of pure speculation. In fact, glume wheats were always present to some degree in the region, so external influences might not be the only reason for an increase in these crops. This could also be due to changes in preferences and uses of the crop by-products, for instance. As indicated by Bouby et al. (2020b), einkorn was still an important crop in southern France during the Late Neolithic (3500–2200 BC), with an apparent lack of correlation with climatic events, which would suggest that the choice could have been just a matter of a greater interest in this crop. Ethnographic studies show that einkorn is used nowadays by people with less income (Peña-Chocarro et al. 2009, p. 109), despite its lower productivity and higher workload requirements, such as for dehusking, but this could have been perceived in a different way in the past. The

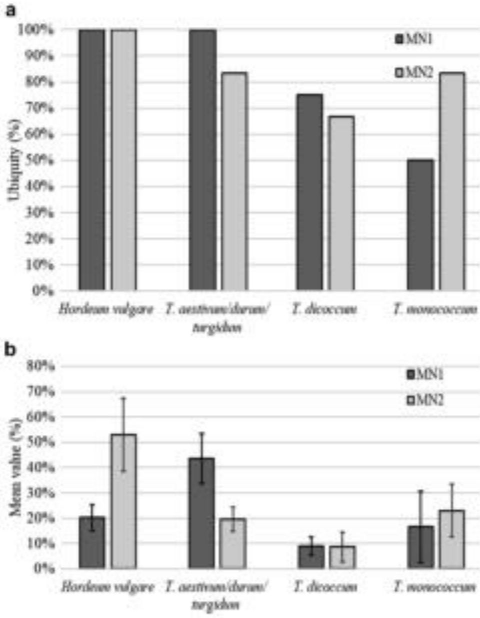

Fig. 4 Comparison of ubiquities and proportions at a context level between pits/silos from open-air sites in southern France grouped into MN1 and MN2 phases. **a** ubiquity of each crop at a feature level (silo/pit) per site, wells excluded (MN1, 5 sites; MN2, 6 sites, further details in Table 4); **b** average value and standard deviation obtained from the proportions calculated for each crop at a feature level, including the wells of Les Bagnoles. (MN1, 3 sites and 6 structures; MN2, 5 sites and 7 structures)

villages where einkorn is still grown nowadays are intimately associated with traditional uses of the crop by-products such as the use of einkorn straw for thatching, and for making hats and other things (Peña-Chocarro et al. 2009, p. 109; Hajnalová and Dreslerová 2010, p. 171). This might suggest that during MN2 there could have been a change of preference to a richer grain in terms of taste and nutrients, which is more resistant to fungi and to harsh weather but also had possible uses of its straw for other activities. This preference could have been sustained in some areas of southern France until the Late Neolithic period (Bouby et al. 2020b).

Climatic influence could also have determined the type of wheat which was grown. Glume wheats have several advantages compared to free-threshing wheat. It is well known that their storage in spikelet form protects them from insect attack both in the field and in storage (Jones et al. (1986). Glume wheats are known for surviving harsh conditions and poor soils, yet still providing good yields (Laghetti et al. 2009, p. 4), while under colder weather conditions einkorn is the most durable (Laghetti et al. 2009, p. 6). Emmer is also known to resist fungal diseases (Laghetti et al. 2009, p. 4). A recent palaeoclimatic model suggests that there were lower mean annual temperatures and particularly lower annual rainfall after 4000 BC in the area around Les Bagnoles (Contreras et al. 2018, Fig. 2). While durum wheat would have tolerated drier climatic conditions, a colder climate in combination with lower rainfall could have been a reason for a reduction in productivity of naked wheat (Pala et al. (1996).

In order to test a possible influence of climate on annual crop productivity, we decided to use underground storage capacity as an indicator. Given that glume wheats are stored as spikelets (see above), an increase in storage capacity would be expected for these in MN2, if productivity and storage practices stayed constant. As mentioned above, 28 features from three MN1 sites and 63 structures from seven MN2 sites were taken into consideration (ESM Table 1).

The comparison between the volumetric means (MN1, 866 L; MN2, 797 L) and the medians (MN1, 855 L; MN2, 662 L) between MN1 and MN2 unexpectedly reveals a small volume decrease in MN2 (Fig. 5). Actually, neither mean value can be considered significantly different according to the T test. As explained in the introduction, this contradicts our hypothesis that growing more glume wheats would lead to larger mean storage capacity values. We exclude a taphonomic bias because, as shown in the results, the MN2 silo pits are better preserved. It is also an unexpected trend compared with previous diachronic evaluations in nearby regions such as Catalonia (Prats et al. 2020). This result may be due to various reasons: 1, an overall lower productivity during MN2; 2, a more diverse storage system during MN2, including above-ground structures or large jars, which could only be further investigated archaeologically; 3, a continuity of storage pit shape and capacity irrespective of productivity; or 4, a biased result influenced by our choice of sites. Although the state of research is still at an early stage, we interpret the lack of significant increase in storage values in MN2, coupled with the decrease of naked wheat in the record, as signs of lower productivity of naked wheat grown. It could be due to less favourable climatic conditions, as suggested above, that farmers tried to compensate for by growing more einkorn, already present in previous phases but in small amounts, thus increasing its ubiquity and absolute numbers in the MN2 record.

For the moment, it is not clear if one or all of these hypotheses may play a role in explaining the decrease of naked wheat and increase of einkorn in MN2. Future investigations should look into further aspects such as crop pests or crop or artefact exchange as well as other indicators of cultural influences (such as new house plans, funerary practices or regional pottery styles) between Switzerland, southeastern France, northern Italy, the western Balkans and Catalonia in order to give a better indication of cultural contacts among them.

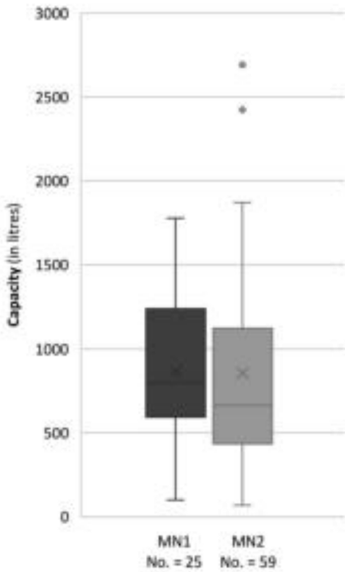

Fig. 5 Box plots summarizing the minimum and maximum volumes in L of the preserved parts of the silos, as well as the medians and means (×) for MN1 (3 sites) and MN2 phases (7 sites)

Conclusion

This paper discusses the archaeobotanical results from three Middle Neolithic wells at Les Bagnoles in southeastern France and compares them to other similar structures at sites of the two phases of the Middle Neolithic period. The results from Les Bagnoles provide an unusually large amount of data that allow new detailed insights into agriculture in Middle Neolithic France. The large quantity of plant remains found at this site, in comparison to other investigated wells, shows how essential it is to apply the appropriate sampling and sample processing methodology to such waterlogged sediments. Uncharred cereal chaff remains are among the first types of finds to be damaged by inappropriate sieving and handling of the sieving residues. At the same time, charred material is also better preserved in such waterlogged contexts and it was retrieved in significantly greater amounts from Les Bagnoles compared to other contemporary sites. A continuation and improvement in systematic sampling and sediment processing techniques are therefore necessary to achieve the desired quality and quantity of data on Neolithic farming practices in the region.

The regional comparison of the available archaeobotanical data shows some further gaps in research, such as absence of full context-level publications and clear dating of archaeological features and/or archaeobotanical material. The review in this paper is solidly based on a selected choice of reliably dated features and thus it obtained novel results. Our results partly corroborate existing chronological overviews in that there is a slight decrease in the presence of naked wheat and increase of glume wheats. The difference is that in our study, einkorn is more predominant in refuse deposits from open-air sites dated after 4000 cal BC. These results indicate that the increase in interest towards this crop happened before the Late Neolithic, as suspected until recently. The comparison of the archaeobotanical results with the underground storage capacity values revealed unexpected patterns that suggest increased instability in crop productivity which probably affected naked wheat crops, coupled with the increased presence of glume wheats, which from then onwards became more important in the record. This integrated approach opens new ways of dealing with factors affecting crop choice in prehistory. This comparison shows that by looking at the same data but examining it according to the type of context, such as silos, new perspectives appear, as well as new questions. Further insights may be gained in the future by integrating other proxies such as stable isotope analysis of grains and evidence for crop pests in the region, which are currently in progress within our AgriChange project.

Acknowledgements The authors would like to thank Laurent Bouby, Lucie Martin, Isabel Figueiral and Samuel van Willigen for sharing site reports and their own personal raw data and Ruth Sahli and Raül Soteras for sieving the samples. The comments of three anonymous reviewers and those of James Greig (copy editor) also contributed to the improvement of the paper. The Schweizerischer Nationalfonds zur Förderung der wissenschaftlichen Forschung (Swiss National Science Foundation) has funded this research as part of a SNSF professorship for F. Antolín, Grant Number PP00P1_170515.

Funding Open access funding provided by University of Basel.

References

Alonso N, Antolín F, López D et al (2013) The effect of dehusking on cereals: experimentation for archaeobotanical comparison. In: Anderson PC, Cheval C, Durand A (eds) Regards croisés sur les outils liés au travail des végétaux: actes des rencontres 23-25 octobre 2012: XXXIII rencontres Internationales d'Archéologie et d'Histoire d'Antibes. An interdisciplinary focus on plant-working tools. Editions APDCA, Antibes, pp 155-168

Amiel C, Carrère I, Mahieu É (1996) Premières données sur l'habitat chasséen d'Encombres, Quarante. Document final d'opération de diagnostic, SRA Languedoc-Roussillon, AFAN ..., Montpellier/Aix-en-Provence/Nîmes

Antolín F (2016) Local, intensive and diverse? Early farmers and plant economy in the North-East of the Iberian Peninsula (5500–2300 cal BC). Barkhuis, Eelde

Antolín F (in press) Estudi paleocarpològic (llavors i fruits) del jaciment d'Auvelles i l'agricultura del Neolític mitjà a la plana occidental catalana. In: Mangado X, Sánchez-de-la-Torre M (eds) L'assentament arqueològic de les Auvelles (Castelló de Farfanya, La Noguera) en el context de la mineria del sílex a la Prehistòria. Monografies del SERP, Universitat de Barcelona

Antolín F, Schäfer M (2020) Insect pests of pulse crops and their management in Neolithic Europe. Environ Archaeol. https://doi.org/10.1080/14614103.2020.1713602

Antolín F, Buxó R, Jacomet S et al (2014) An integrated perspective on farming in the early Neolithic lakeshore site of La Draga (Banyoles, Spain). Environ Archaeol 19:241–255. https://doi.org/10.1179/1749631414Y.0000000027

Antolín F, Delefosse C, Errera M et al (2020a) Les structures attribuables au Néolithique moyen de type La Roberte (fin du Ve millénaire-début de l'Ive millénaire avant notre ère). In: van Willigen S, Bailly M, Röder B, et al. (eds) Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité). Presses Universitaires de Provence, Aix-en-Provence, pp 229–280

Antolín F, Häberle S, Jesus A et al (2018) The AgriChange project: an integrated on-site approach to agricultural and land-use change during the Neolithic in Western Europe. Past Glob Chang Mag 26:26–27. https://doi.org/10.22498/pages.26.1.26

Antolín F, Jacomet S, Buxó R (2015) The hard knock life. Archaeobotanical data on farming practices during the Neolithic (5400–2300 cal BC) in the NE of the Iberian Peninsula. J Archaeol Sci 61:90–104. https://doi.org/10.1016/j.jas.2015.05.007

Antolín F, Jesus A, Follmann F, Jacomet S (2020b) Économie et alimentation. In: van Willigen S, Bailly M, Röder B, et al. (eds) Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse)—le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité). Presses Universitaires de Provence, Aix-en-Provence, pp 316–329

Antolín F, Schmitt A, Bader M et al (2020c) Les structures attribuables au Néolithique moyen de type Chassey (dernier tiers du Ve millénaire avant notre ère). In: van Willigen S, Bailly M, Röder B, et al. (eds) Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse)—le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité). Presses Universitaires de Provence, Aix-en-Provence, pp 117–228

Battentier J, Thiébault S, Binder D et al (2015) L'abri pendimoun (Castellar, Alpes-Maritimes): Nouvelles données sur l'évolution du couvert forestier et l'exploitation du milieu au néolithique (5 800–2 000 ans cal. BCE). Quaternaire 26:279–292

Beeching A (2002) La fin du Chasséen et le Néolithique final dans le bassin du Rhône moyen. In: Ferrari A, Visentini P (eds) Il declino del mondo neolitico. Ricerche in Italia centro-settentrionale fra aspetti peninsulari, occidentali e nord-alpini (Pordenone, 2001). Quaderni del Museo Archeologico del Friuli Occidentale 4. Museo delle Scienze, Pordenone, pp 67–83

Beeching A (2015) Saint-Paul-Trois-Châteaux (Drôme). Site funéraire du Néolithique moyen chasséen. Etat préliminaire de la publication. In: Beeching A, Brochier JL (eds) Les Grands sites de terrasses chasséens dans le contexte des recherches rhodaniennes. ACR, Rapports de 2005 et 2006, CAPRA, Valence

Beeching A, Brochier J-L (2011) De l'environnement au territoire néolithiques dans le bassin rhodanien. In: Kourtessi-Philippakis G, Treuil R (eds) Archéologie du territoire: de l'Egée au Sahara. Publications de la Sorbonne, Paris, pp 137–153

Beeching A, Cordier F (1997) Saint-Paul-Trois-Chateaux, Les Moulins. Site sepulcral chasséen et silos medievaux. Fouille de sauvetage 1984–1985. Centre d'Archéologie Préhistorique de Valence, Valence

Beeching A, Cordier F (2004) Saint-Paul-Trois-Châteaux: Les Moulins—Carrefour de l'Europe. In: Bilan scientifique. Région Rhône-Alpes 2001, Ministère de la Culture, Lyon, pp 68–69

Beeching A, Berger JF, Brochier J-L et al (2000) Chasséens: agriculteurs ou éleveurs, sédentaires ou nomades? Quels types de milieux, d'économies et de sociétés? In: Leduc M, Valdeyron N, Vaquer J (eds) Sociétés et Espaces, Rencontres Méridionales de Préhistoire Récente, 3ème session, Toulouse, 1998. Archives d'Écologie Préhistorique, Toulouse, pp 59–79

Beeching A, Brochier JL, Rimbault S, Vital J (2010) Les sites à fosses circulaires du néolithique et de l'âge du bronze ancien en moyenne vallée du Rhône: approches typologiques et fonctionnelles, implications économiques et sociales. In: Beeching A, Thirault E, Vital J (eds) Economie et société à la fin de la préhistoire. Actualité de la recherche. Actes des 7e rencontres méridionales de préhistoire récente. Maison de l'Orient et de la Méditerranée Jean Pouilloux, Lyon, pp 147–169

Beeching A, Cordier F, Thiercelin F (1986) Découverte et fouille partielle du village chasséen de Saint-Paul-Trois-Châteaux "Les Moulins" (Drôme). In: Arenera: Actes des rencontres "Néolithique de Rhône-Alpes". Univ. Lumière Lyon II, Centre d'Archéol. Préhist. de Valence, Valence, pp 27–31

Beeching A, Nicod P-Y, Thiercelin F, Voruz J-L (1997) Le Saint-Uze, un style céramique non-chasséen du cinquième millénaire dans le bassin rhodanien. In: Constantin C, Mordant D, Simonin D (eds) La Culture de Cerny: nouvelle économie, nouvelle société au Néolithique. Association pour la promotion de la recherche archéologique en Ile-de-France. APRAIF, Nemours, pp 575-592

Berger JF, Shennan S, Woodbridge J et al (2019) Holocene land cover and population dynamics in Southern France. Holocene 29:776–798. https://doi.org/10.1177/0959683619826698

Binder D, Brochier EJ, Duday H et al (1993) L'abri Pendimoun à Castellar (Alpes-Maritimes). Nouvelles données sur le complexe culturel de la céramique imprimée méditerranéenne dans son contexte stratigraphique. Gall Préhistoire 35:177–251. https://doi.org/10.3406/galip.1993.2087

Binder D, Cade C, Desse-Berset N et al (2004) Un chantier archéologique à la loupe: Villa Giribaldi. In: Nice: [catalogue d'exposition 23 octobre 2004–4 janvier 2005]. Nice-Musées, Nice

Binder D, Lepère C (2014) From impresso-cardial to SMP and chassey in provence. In: Brea MB, Maggi R, Manfredini A (eds) Atti del convegno: Il pieno sviluppo del Neolitico in Italia: Museo Archeologico del Finale—Finale Ligure Borgo, 8–10 giugno 2009. Istituto Internazionale di Studi Liguri, Bordighera, pp 21–29

Bogaard A, Charles M, Twiss KCC et al (2009) Private pantries and celebrated surplus: storing and sharing food at Neolithic Çatalhöyük, Central Anatolia. Antiquity 83:649–668. https://doi.org/10.1017/s0003598x00098896

Bouby L (1999) Rapport d'étude carpologique. In: Vignaud A (ed) Les jardins de Vert Parc, Castelnau-le-Lez, 34. Un habitat

Néolithique moyen de culture chasséenne, Document Final de Synthèse, Ministère de la Culture, SRA Languedoc-Roussillon, Association pour les fouilles archéologiques nationales (AFAN), pp 77–80

Bouby L (2009) Les restes carpologiques des couches 60 à 47. In: Voruz J-L, Bonnardin S, Chaix L et al (eds) La grotte du Gardon (Ain), vol 1, le site et la séquence néolithique des couches 60 à 47. (Archives d'Écologie Préhistorique) Ecole des Hautes Etudes en Sciences Sociales, Toulouse, pp 227–230

Bouby L, Léa V (2006) Exploitation de la vesce commune (*Vicia sativa* L.) au Néolithique moyen dans le Sud de la France. Données carpologiques du site de Claparouse (Lagnes, Vaucluse). CR Palevol 5:973–980. https://doi.org/10.1016/j.crpv.2006.07.007

Bouby L, Dietsch-Sellami M-F, Martin L et al (2018) Ressources végétales et économie de subsistance au Néolithique en France (6000–2000 av. J.-C.). In: Guilaine J, Garcia D (eds) La Protohistoire de la France. Hermann, Paris, pp 141–152

Bouby L, Marinval P, Durand F et al (2020a) Early Neolithic (ca. 5850–4500 cal BC) agricultural diffusion in the Western Mediterranean: an update of archaeobotanical data in SW France. PLoS One 15:1–26. https://doi.org/10.1371/journal.pone.0230731

Bouby L, Marinval P, Rovira N (2020b) Late Neolithic plant subsistence and farming activities on the southern margins of the Massif Central (France). Holocene 30:599–617. https://doi.org/10.1177/0959683619895576

Bronk Ramsey C (2017) OxCal Program, Version 43. Oxford Radiocarbon Accelerator Unit, University of Oxford, Oxford

Buxó R (2006) Les restes des semences et fruits archéologiques de la grotte de Montou. Études Roussillonnaises 22:33–42

Cappers R, Heinrich F, Kaaijk S et al (2013) Barley revisited: production of barley bread in Umm Mawagir (Kharga Oasis, Egypt). In: Accetta K, Fellinger R, Gonçalves PL et al (eds) Current Research in Egyptology. Proceedings of the Fourteenth Annual Symposium, University of Cambridge 2013. Oxbow, Oxford, pp 49–63

Contreras DA, Hiriart E, Bondeau A et al (2018) Regional paleoclimates and local consequences: Integrating GIS analysis of diachronic settlement patterns and process based agroecosystem modeling of potential agricultural productivity in Provence (France). PLoS One 13:1–27. https://doi.org/10.1371/journal.pone.0207622

Convertini F, Georjon C (2018) Le Champ du Poste (Carcassonne, Aude). Une succession d'occupations du début du Néolithique moyen à l'âge du Bronze ancien. Archives d'Ecologie Préhistorique, Toulouse

De Vareilles A, Bouby L, Jesus A et al (2020) One sea but many routes to sail. The early maritime dispersal of Neolithic crops from the Aegean to the western Mediterranean. J Archaeol Sci Rep 29:102140. https://doi.org/10.1016/j.jasrep.2019.102140

Delhon C, Thiébault S, Berger JF (2009) Environment and landscape management during the Middle Neolithic in Southern France: Evidence for agro-sylvo-pastoral systems in the Middle Rhone Valley. Quat Int 200:50–65. https://doi.org/10.1016/j.quaint.2008.05.008

Denaire A, van Willigen S (2020) Les structures et leur attribution culturelle. In: van Willigen S, Bailly M, Röder B, et al. (eds) Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse)—le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité). Presses Universitaires de Provence, Aix-en-Provence, pp 101–116

Denaire A, Doppler T, Nicod P-Y, van Willigen S (2011) Espaces culturels, frontières et interactions au 5ème millénaire entre la plaine du Rhin supérieur et les rivages de la Méditerranée. Annu d'Archéologie Suisse 94:21–59

Figueiral I (2018) Les restes végétaux carbonisés. In: Convertini F, Georjon C (eds) Le Champ du Poste (Carcassonne, Aude) Une succession d'occupations du début du Néolithique moyen à l'âge du Bronze ancien. Archives d'Ecologie Préhistorique, Toulouse, pp 239–242

Figueiral I (2012) 1(5), pp. 4. Les vestiges végétaux carbonisés. In: Vergély H, Haurillon R, Sanchez G (eds) Les occupations humaines du Barreau de la Devèze Sud, vol 1. HAL CCSD, Lyon, pp 402–406

Figueiral I, Séjalon P (2014) Archaeological wells in southern France: Late Neolithic to Roman plant remains from Mas de Vignoles IX (Gard) and their implications for the study of settlement, economy and environment. Environ Archaeol 19:23–38

Fuller DQ, Stevens C, McClatchie M (2014) Routine activities, tertiary refuse and labor organization: social inferences from everyday archaeobotany. In: Savard M, Lancelotti C, Madella M (eds) Ancient plants and people, contemporary trends in archaeology. University of Arizona Press, Tucson, pp 174–217

Gernigon K (2014) Le Chasséen entre temps et espace: 20 ans de périodisations des assemblages céramiques et le retour de l'identité chasséenne. In: Sénépart I, Leandri F, Cauliez J, et al. (eds) Chronologie de la Préhistoire récente dans le Sud de la France Actualité de la recherche, Actes des 10e Rencontres méridionales de Préhistoire récente Porticcio (20) - 18 au 20 octobre 2012. Archives d'Ecologie Préhistorique, Toulouse, pp 37–61

Gilabert C (2009) Les structures en creux dans le Néolithique final provençal: synthèse et approche méthodologique. In: Beeching A, Sénépart I (ed) De la maison au village - L'habitat néolithique dans le Sud de la France et le Nord-Ouest méditerranéen - Actes de la table ronde des 23 et 24 mai 2003, Marseille/Musée d'Histoire de la Ville de Marseille. (Mémoire Société Préhistorique Française 48) Société Préhistorique Française, Paris, pp 285-300

Giligny F, Sénépart I (2018) Construire et habiter au Néolithique. In: Guilaine J, Garcia D (eds) La Protohistoire de la France. Hermann, Paris, pp 27–51

Hajnalová M, Dreslerová D (2010) Ethnobotany of einkorn and emmer in Romania and Slovakia: towards interpretation of archaeological evidence. Pamatky Archeol 101:169–202

Heinz C, Ruas M-P, Vaquer J (1992) La grotte de l'Abeurador (Félines-Minervois, Hérault): paléoécologie d'après l'anthracologie et la carpologie. Bull Soc Bot Fr Actual Bot 139:465–482. https://doi.org/10.1080/01811789.1992.10827121

Herbig VC, Maier U, Stäuble H, Elburg R (2013) "Neolithische Füllhörner" Archäobotanische Untersuchungen in fünf linienbandkeramischen Brunnen in Westsachsen. Offa 69(70):265–293

Hillman GC, Mason S, de Moulins D, Nesbitt M (1996) Identification of archaeological remains of wheat: the 1992 London workshop. Circaea 12:195–209

Jacomet S (2006) Identification of cereal remains from archaeological sites. IPAS Basel University, Basel

Jacomet S (2007) Neolithic plant economies in the northern Alpine Foreland from 5500–3500 cal. BC. In: Colledge S, Conolly J (eds) The origins and spread of domestic plants in southwest Asia and Europe. Left Coast Press, Walnut Creek, pp 221–258

Jacomet S (2013) Archaeobotany: analyses of plant remains from waterlogged archaeological sites. In: Menott F, O'Sullivan A (eds) The Oxford handbook of wetland archaeology. Oxford University Press, Oxford, pp 497–514

Jacomet S (2014) crop diversity in Southwestern central Europe from the Neolithic onwards. In: Chevalier A, Marinova E, Peña-Chocarro L (eds) Plants and people choices and diversity through time. Oxbow Books, Oxford, pp 82–139

Jacomet S (2020) Environnement végétal naturel et paysage. In: van Willigen S, Bailly M, Röder B, et al. (eds) Les Bagnoles à

L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité). Presses Universitaires de Provence, Aix-en-Provence, pp 60–77

Jesus A, Tereso JP, Gaspar R (2020) Interpretative trajectories towards the understanding of negative features using Terraço das Laranjeiras Bronze Age site as a case study. J Archaeol Sci Rep 30:102222. https://doi.org/10.1016/j.jasrep.2020.102222

Jones G (1990) The application of present-day cereal processing studies to charred archaeobotanical remains. Circaea 6:91–96

Jones G, Wardle K, Halstead P, Wardle D (1986) Crop storage at Assiros. At a site in northern Greece charred fragments of grain from crop new light on how the majestic Bronze Age Mycenaean palaces arose. Sci Am 254:96–103

Kreuz A (1990) Searching for 'single-activity refuse' in Linearbandkeramik settlements. An archaeobotanical approach. In: Robinson DE (ed) Experimentation and reconstruction in environmental archaeolology. Oxbow Books, Oxford, pp 63–74

Kreuz A, Schäfer E (2002) A new archaeobotanical database program. Veget Hist Archaeobot 11:177–180. https://doi.org/10.1007/s003340200019

Laghetti G, Fiorentino G, Hammer K, Pignone D (2009) On the trail of the last autochthonous Italian einkorn (*Triticum monococcum* L.) and emmer (*Triticum dicoccon* Schrank) populations: a mission impossible? Genet Resour Crop Evol 56:1,163–1,170. https://doi.org/10.1007/s10722-009-9439-x

LaMotta VM, Schiffer MB (2002) Formation processes of house floor assemblages. In: Allison PM (ed) The archaeology of household activities. Routledge, London, pp 19–29

Magny M, Haas JN (2004) A major widespread climatic change around 5300 cal. yr BP at the time of the Alpine Iceman. J Quat Sci 19:423–430

Maier U (2001) Untersuchungen in der neolithischen Ufersiedlung Hornstaad-Hörnle IA am Bodensee. In: Maier U, Vogt R (eds) Siedlungsarchäologie im Alpenvorland VI: Botanische und pedologische Untersuchungen zur Ufersiedlung Hornstaad-Hörnle IA. (Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 74) Theiss, Stuttgart

Marinval P (1988a) L'alimentation végétale en France: du mésolithique jusqu'à l'âge du fer. Editions du Centre nationale de la recherche scientifique, Paris

Marinval P (1988b) Cueillette, agriculture et alimentation végétale de l'epipaléolithique jusqu'au 2e âge du fer en France méridionale: apports palethnographiques de la carpologie. École de Hautes Études en Sciences Sociales, Paris

Marinval P (2003) L'ensemble carpologique du site bizien de la Salle (Carcassonne, Aude). Bull Soc Prehist Fr 100:353–355

Martin L (2012) Analyse carpologique du puits. Néolithique récent ST2096. In: Remicourt M, Andrieu-Ponel V, Audibert C et al (eds) Les occupations pré et protohistoriques du Clos de Roque, à Saint-Maximin-la-Sainte Baume. Rapport Final d'Opération 1. Paléotime, Villard-de-Lans, pp 242–246

Martin L (2014) Premiers paysans des Alpes. Presses Universitaires de Rennes, Rennes, Alimentation végétale et agriculture au Néolithique

Martin L, Bouby L, Marinval P et al (2016) L'exploitation des ressources végétales durant le Chasséen: un bilan des données carpologiques en France entre 4400 et 3500 avant notre ère. In: Perrin T, Chambon P, Gibaja JF, Goude G (eds) Le Chasséen, des Chasséens… Retour sur une culture nationale et ses parallèles: Sepulcres de fossa, Cortaillod, Lagozza Colloque international de Paris, 18–20 novembre 2014. Archives d'Écologie Préhistorique, Toulouse, pp 259–272

Martin L, Jacomet S, Thiebault S (2008) Plant economy during the Neolithic in a mountain context: the case of "le Chenet des Pierres" in the French Alps (Bozel-Savoie, France). Veget Hist Archaeobot 17:113–122. https://doi.org/10.1007/s00334-008-0191-5

Martínez-Grau H, Antolín F, van Willigen S (2020) Néolithique moyen type La Roberte et Néolithique moyen type Chassey sur le site des Bagnoles: relations spatiales et chronologiques. In: van Willigen S, Bailly M, Röder B, et al. (eds) Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse)—le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité). Presses Universitaires de Provence, Aix-en-Provence, pp 270–278

Mestres J, Tarrús J (2016) Las estructuras de hábitat en Catalunya durante el Neolítico medio: entre el Chassey y los Sepulcres de Fossa. In: Perrin T, Chambon P, Gibaja JF, Goude G (eds) Le Chasséen, des Chasséens… Retour sur une culture nationale et ses parallèles: Sepulcres de fossa, Cortaillod, Lagozza Colloque international de Paris, 18–20 novembre 2014. Archives d'Écologie Préhistorique, Toulouse, pp 289–302

Pala M, Stockle CO, Harris HC (1996) Simulation of Durum wheat (*Triticum turgidum* ssp. durum) growth under different water and nitrogen regimes in a Mediterranean environment using CropSyst. Agric Syst 51:147–163. https://doi.org/10.1016/0308-521X(95)00043-5

Peña-Chocarro L, Zapata L, González Urquijo JE, Ibáñez JJ (2009) Einkorn (Triticum monococcum L.) cultivation in mountain communities of the western Rif (Morocco): an ethnoarchaeological project. In: Fairbairn AS, Weiss E (eds) From foragers to farmers: papers in honour of Gordon C. Hillman. Oxbow, Oxford, pp 103–111

Phillips P (1982) The Middle Neolithic in Southern France: Chasséen farming and culture process. (British Archaeological Reports International Series S142) BAR, Oxford

Popper V (1988) Selecting quantitative measurements in paleoethnobotany. In: Hastorf C, Popper V (eds) Current paleoethnobotany: analytical methods and cultural interpretations of archaeological plant remains. University of Chicago Press, Chicago, pp 53–71

Prats G (2017) L'emmagatzematge en sitja entre el neolític i l'època ibèrica (del 5500 ANE al I ANE). Aproximació socioeconòmica a les comunitats del nord-est de la Península Ibèrica, Unpublished doctoral thesis, Universitat de Lleida

Prats G, Antolín F, Alonso N (2020) A socioeconomic analysis of the changes in underground storage practices in the Northwestern Mediterranean Arc: from the earliest farmers to the first urban centres. Antiquity 94:653–668

Reed K (2016) Archaeobotany in Croatia: an overview. Vamz 49:7–28

Reimer PJ, Bard E, Bayliss A et al (2013) IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55:1,869–1,887

Rottoli M (1993) Analisi paletnobotaniche: prime risultanze, "La Marmotta", Anguillara Sabazia (RM), Scavi 1989, Appendice 1, Un abitato perilacustre di età neolitica. Bull Paletnol Ital Roma, Nuova Ser II 84:305–315

Rottoli M, Castiglioni E (2009) Prehistory of plant growing and collecting in northern Italy, based on seed remains from the early Neolithic to the Chalcolithic (c. 5600–2100 cal B.C.). Veget Hist Archaeobot 18:91–103. https://doi.org/10.1007/s00334-007-0139-1

Rousselet O (2011) Analyse carpologique. In: Sendra B, Gourlin B, Cockin G (eds) ZAC Saint-Antoine 2. Saint-Aunès (Hérault), Languedoc-Roussillon. Rapport final d'opération. Fouilles archéologiques préventives, Oxford Archéologie Méditerranée, Service Régional de l' Archéologie de Languedoc-Roussillon, pp 264–272

Saintot S, Le Barrier C, Cabanis M (2009) L'habitat chasséen de Champ Madame et Artière-Ronzière à Beaumont (Puyde-Dôme). Structuration, architecture et fonction du bâtiment 3. In: Beeching A, Senépart I (eds) De la maison au village. L'habitat néolithique dans le Sud de la France et le Nord-Ouest méditerranéen, actes de la table ronde (Marseille, 23–24 mai 2003). (Mémoires de la Société préhistorique française 48) Société préhistorique française, Paris, pp 99–121

Sargiano J-P, van Willigen S, D'Anna A et al (2010) Les Bagnoles à l'Isle-sur-la-Sorgue (Vaucluse). Aspects nouveaux dans le Néolithique moyen du midi de la France. Gallia Préhistoire 52:193–239

Savard M (2000) Etude de l'assemblage carpologique de la Baume de Fontbrégoua (Var) du Paléolithique final au Chasséen récent. Mémoire de DEA: Environnement et archéologie: Paris 1

Schiffer MB (1991) Formation processes of the archaeological record, 2nd edn. University of New Mexico Press, Albuquerque

Schlumbaum A, Jacomet S, Neuhaus JM (1998) Coexistence of tetraploid and hexaploid naked wheat in a Neolithic lake dwelling of Central Europe: evidence from morphology and ancient DNA. J Archaeol Sci 25:1,111–1,118. https://doi.org/10.1006/jasc.1998.0338

Sendra B, Gourlin B, Cockin G (2011) ZAC Saint-Antoine 2. Saint-Aunès (Hérault), Languedoc-Roussillon. Rapport final d'opération. Fouilles archéologiques préventives Oxford Archéologie Méditerranée, Service Régional de l' Archéologie de Languedoc-Roussillon

Sénépart I, Leandri F, Cauliez J et al (2014) Chronologie de la Préhistoire récente dans le Sud de la France. Acquis 1992–2012. Actualité de la recherché. Actes des 10e Rencontres Méridionales de Préhistoire Récente, Porticcio, 18 au 20 octobre 2012. Archives d'Ecologie Préhistorique, Toulouse

Sharples NM (1991) Maiden Castle: excavations and field survey 1985–6. English Heritage, London

Sigaut F (1988) A method for identifying grain storage techniques and its application for European agricultural history. In: Lerche G, Fenton A, Steensberg A (eds) Tools and tillage. National Museum of Denmark, Copenhagen, pp 3–32

Steiner BL, Antolín F, Jacomet S (2015) Testing of the consistency of the sieving (wash-over) process of waterlogged sediments by multiple operators. J Archaeol Sci Rep 2:310–320. https://doi.org/10.1016/j.jasrep.2015.02.012

Tegel W, Elburg R, Hakelberg D et al (2012) Early Neolithic water wells reveal the world's oldest wood architecture. PLoS One 7:e51374. https://doi.org/10.1371/journal.pone.0051374

Thiébault S, Terral J-F, Marinval P (2004) Gestion et exploitation d'un territoire au Néolithique: le cas de Giribaldi (Nice, Alpes-Maritimes). L'apport des macrorestes végétaux. In: Bodu P, Constantin C (eds) Approches fonctionnelles en préhistoire. Actes du XXVe congrès SPF, Nanterre, nov. 2000. Société Préhistorique Française, Nanterre, pp 325–333

Thirault É, Remicourt M (2014) Les puits à eau néolithiques dans le Sud de la France: une question à creuser . In Sénépart I, Billard C, Bostyn F et al (eds) Méthodologie des recherches de terrain sur la Préhistoire récente en France. Nouveaux acquis, nouveaux outils, 1987–2012. Archives d'Ecologie Préhistorique, Toulouse, pp 231–250

Tolar T, Jacomet S, Velušček A, Čufar K (2010) Recovery techniques for waterlogged archaeological sediments: a comparison of different treatment methods for samples from Neolithic lake shore settlements. Veget Hist Archaeobot 19:53–67. https://doi.org/10.1007/s00334-009-0221-y

Toulemonde F, Durand F, Berrio L et al (2015) Records of "new" glume wheat in France: a review. Veget Hist Archaeobot 24:197–206. https://doi.org/10.1007/s00334-014-0479-6

Van der Veen M, Fieller N (1982) Sampling seeds. J Archaeol Sci 9:287–298. https://doi.org/10.1016/0305-4403(82)90024-3

Van Willigen S, André G, Antolín F et al (2020) Déroulement des opérations et moyens mis en œuvre. In: van Willigen S, Bailly M, Röder B, et al. (eds) Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse)—le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité). Presses Universitaires de Provence, Aix-en-Provence, pp 87–100

Van Willigen S, Antolín F, Brochier J et al (2020) Les apports du site pour la connaissance du Néolithique moyen. In: van Willigen S, Bailly M, Röder B, et al. (eds) Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse)—le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité). Presses Universitaires de Provence, Aix-en-Provence, pp 281–352

Van Willigen S, Brochier JÉ, Renault S, Sargiano J-P (2014) Chronologie relative et chronologie absolue du Néolithique moyen dans le sud-est de la France: l'apport de l'analyse des données et de la modélisation chronologique bayésienne. In: Sénépart I, Leandri F, Cauliez J, Perrin T, Thirault É (eds) Chronologie de la Préhistoire récente dans le Sud de la France: Actualité de la recherche. (Actes des 10e Rencontres méridionales Préhistoire récente Porticcio 20), 18 au 20 octobre 2012. Toulouse, Archives d'Ecologie Préhistorique, pp 63–74

Vandorpe P, Jacomet S (2007) Comparing different pre-treatment methods for strongly compacted organic sediments prior to wet-sieving: a case study on Roman waterlogged deposits. Environ Archaeol 12:207–214. https://doi.org/10.1179/174963107x226462

Vaquer J (2014) Les pratiques funéraires au Néolithique moyen dans le Midi de la France. Riv Sci Preist 64:5–24

Vaquer J, Jedikian G, Carrère I, Marinval P (2003) La Salle, Carcassonne (Aude). Un habitat de plein air du groupe de Bize. Bull Soc Préhist Fr 100:323–351

Vergély H, Haurillon R, Sanchez G (2012) Les occupations humaines du Barreau de la Devèze Sud: autoroute A75, section Béziers—Pézenas, Hérault, rapport final d'opération. Fouille archéologique, Inrap Meditérranée Béziers

Vignaud A (2003) Les jardins de Vert Parc (Castelnau-le-Lez, Hérault): un habitat néolithique moyen de culture chasséenne. In: Gascó J, Gutherz X, Labriffe P-A (eds) Temps et espaces culturels: du 6e au 2e millénaire en France du Sud: Actualité de la recherche. (Monographie d'Archéologie Méditerranéenne 15) Association pour le Développement de l'Archéologie en Languedoc-Roussillon, Lattes, pp 397-400

Vital J, Bouby L, Jallet F, Rey P-J (2007) Un autre regard sur le gisement du boulevard périphérique nord de Lyon (Rhône) au Néolithique et à l'âge du Bronze, secteurs 94.1 et 94.8. Gallia Préhistoire 49:1–126

Zohary D, Hopf M, Weiss E (2012) Domestication of plants in the Old World: the origin and spread of domesticated plants in Southwest Asia, Europe, and the Mediterranean Basin. Oxford University Press, Oxford

Chapter 6 The importance of opium poppy today

6.1 Introduction

Opium poppy, *Papaver somniferum* subsp. *somniferum* L. (Figure 6.1) is a species with various uses and is world-famous for its medicinal, alimentary and decorative purposes (Tetenyi, 1997). The country with the largest production of opium poppy is Afghanistan, with 6.000 tons of opium and 250.000 hectares of cultivated poppy (UNODC, 2020, fig. 1). This production is then seized by its neighbour country Iran, the majority as opium, morphine and heroin (UNODC, 2020, fig. 4).

In Europe (apart from the pharmaceutic production), opium poppy production is around 1086 tons (FAO). Seeds are mainly used for food in many regional dishes in eastern Europe (Czech Republic, Poland, Hungary, Slovakia, Romania). The seeds can be used in savoury and sweet dishes being, the most famous the poppy strudel baked at Christmas time and Easter.

Papaver probably originates from the Latin *papariorum* or "papa" as baby food, while in ancient Greek "Mḗkōn" means poppy (2017a). There is also a word in Sanskrit, papavira ou papavara, which denotes the "pernicious juice", latex (Grauso et al., 2021). In Europe, there are two clear roots for the names of opium poppy: on one side coming from the Latin "papa": *Papaver*, papoila, pavot, poppy and from the eastern side resembling more to the greek word "Mḗkōn": Mohn (german) and mak (russian).

6.2 Taxonomy

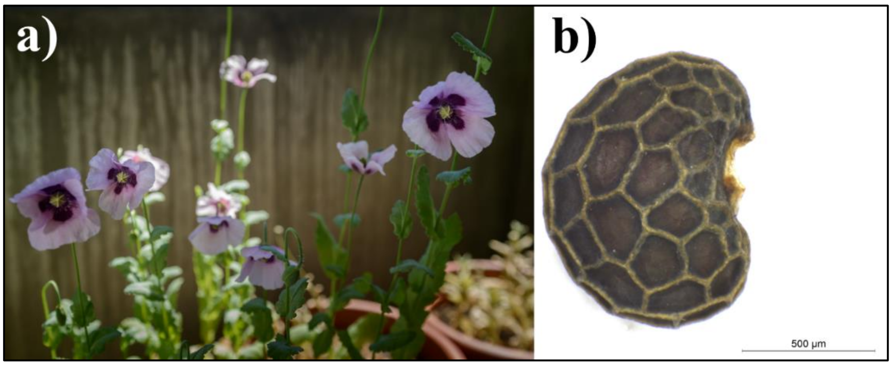

Figure 6.1 Plant and seed of opium poppy. a) Flowers of opium poppy from experimental cultivation at IPNA in 2018.b) seeds of opium poppy from the IPNA collection. Photos by Raül Soterras.

The opium poppy species was first coined by Linnaeus in 1753 as *Papaver somniferum* L. and accepted today as *P. somniferum* L. subsp. *somniferum* (Kadereit, 1988). Despite this name change, the progenitor of the opium poppy is still being discussed today. One of the candidates is *Papaver somniferum* L. subsp. *setigerum* (DC.) Arcang (Bakels, 1982; Kreuz, 2012; Salavert, 2010; Zohary et al., 2012). To keep the names in a more straightforward matter in this work, they will be abbreviated from now on as *P. somniferum* and *P. setigerum.*

P. somniferum is an annual herb, 30-150 cm high, self-pollinated and most actual cultivars are diploid. It belongs to the Genus *Papaver* from the Papaveraceae family, order Ranunculales. The family includes 41 genera and 660 species (Tison & Foucault, 2014). This family is famous for its many ornamental and pharmaceutical plants. Some species of *Papaver* are cultivated and used such as *Papaver rhoeas*, *Papaver bracteatum* and *Papaver orientale*. *Papaver somniferum* is, however, the only domesticated species.

Table 6.1 *Papaver* species present in the study-area

Taxa	Size (Bojnanský & Fargašová, 2007)	Study-area	Distribution reference
Papaver cambricum L.		FR; ES	(Kadereit et al., 2011)
Papaver apulum Ten.		IT	EuroMed
Papaver argemone L.	0.5-0.6 x0.9-1.1	FR; ES; CH; IT	EuroMed
Papaver dubium L.	0.5-0.6 x 0.7-0.9	FR; ES; CH; IT	EuroMed
Papaver hybridum L.	0.5-0.7 x0.8-1	FR; ES; CH; IT	EuroMed
Papaver dubium subsp. *lecoqii*		FR; ES; CH; IT	EuroMed
Papaver occidentale (Markgr.) H. E. Hess & Landolt		FR; CH	EuroMed
Papaver pinnatifidum Moris		FR;ES	EuroMed
Papaver rhoeas L.	0.5-0.7 x 0.8-1	FR; ES; CH; IT	EuroMed
Papaver alpinum aggr.	0.9-1.1 x 0.5-0.6	FR; CH; IT	EuroMed
Papaver lapeyrousianum Gutermann		FR; IT	EuroMed
Papaver croceum Ledeb.	0.5-0.6 x 0.8-1	FR; IT; CH	EuroMed
Papaver aurantiacum Loisel.		FR; IT; CH	InfoFlora
Papaver sendtneri Hayek		CH	InfoFlora
Papaver somniferum subsp. *setigerum* (DC.) Arcang.	0.6-0.7 x c. 0.9	ES; FR; IT	EuroMed
Papaver somniferum subsp. *somniferum* L.	0.9-1.1 x 1.3-1.5	ES; FR; IT	EuroMed

The *Papaver* genus includes over 80 different species (Tison & Foucault, 2014, p. 876), which can be annual, biennial and perennial plants distributed in central and south-western Asia, central and southern Europe and northern Africa (Kadereit, 1988). All species of *Papaver* grow in open and unevenly disturbed habitats. Perennials and biennials taxa grow in the mountains above 1000 m of altitude; annuals are mostly lowland taxa (Kadereit, 1997). The seeds are all reniform to a comma-shaped/kidney shape in outline, globoid and round. The seed size varies from 0.5 to 1.5 mm (see Table 6.1). The seed's surface is concentrically areolate/reticulate with several areoles, some with outer edges and ridges. In this thesis, we call them "cells".

6.3 Phylogeny of the genus *Papaver*

Papaver taxonomy is still debated. Kadereit (1988), Zohary et al.(2012), and Carolan et al. (2006) all argued that *P. somniferum* has two subspecies: *setigerum* and *somniferum*, the latter being the domesticated one. Whether *P. setigerum* and *P. somniferum* represent two distinct species or should be considered as two subspecies is still debated. At the molecular level, Hosokawa et al.(2004) argued that both species were identical, but for Dittbrenner et al. (2008), the differences are strong enough to consider them as two different species.

Opium poppy (*P. somniferum*) contains more than 40 different alkaloids. The main alkaloids are morphine, codeine, thebaine, papaverine and noscapine (Dittbrenner et al., 2009). According to some studies (Dittbrenner et al., 2009; Garnock-Jones & Scholes, 1990), the main alkaloid content of *P. setigerum* is almost the same as *P. somniferum*, only less quantity of morphine is reported. Dittbrenner et al. (2009, p. 106) conclude that the way to distinguish *P. setigerum* from *P. somniferum* was by the hairiness of the buds and the high content of papaverine compound. Using only certain alkaloids to distinguish different species can be equivocal. Since alterations to the alkaloids' quality and quantity can vary depending on where and when opium poppy is grown (Dittbrenner et al., 2009; Yazıcı & Yılmaz, 2017). Interestingly, a study from Turkey shows that plants sown during summer have more codeine and morphine than those sown in winter (Yazıcı & Yılmaz, 2017).

6.4 Distributions of *Papaver* species past and present

The *Papaver* species mentioned in this thesis are mainly localized in the Mediterranean areas or in central Europe (Figure 6.2). Nowadays, *P. somniferum* is everywhere (see EuroMed), and *P. hybridum* has been introduced in different countries (see KewScience); though, no use is known for this species.

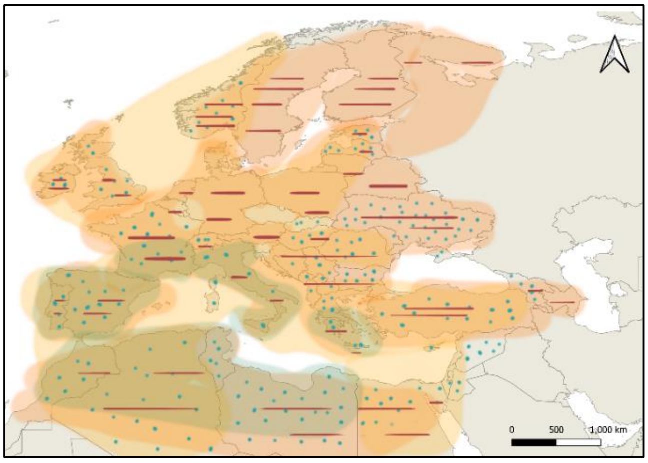

Figure 6.2 Map with the distribution of the main *Papaver* species. Green: *Papaver setigerum*; Light pink: *P. rhoeas*; yellow *P. argemone*; red lines: *P.dubium*; blue dots: *P.hybridum* source: EUROMED

There are several native *Papaver* species in the study region, as shown in Table 6.1 and on the map (Figure 6.2), showing the most typical taxa present at the European level. In our study, the *P. somniferum* group correspond to three subspecies that could potentially be present in the archaeological seeds identified as *P. somniferum/setigerum*. These are *P. somniferum* seeds related to domestic species, *P. setigerum* seeds for not domestic and *P. nigrum*, a domesticated subspecies of *P. somniferum* (Hammer, 1981; Hrishi, 1960; J. Renfrew, 1973). Other common species found in the archaeological record are *P. album*, *P. hybridum*, *P. rhoeas,* and *P. argemone*. For this reason, our analyses only used these species (Figure 6.3).

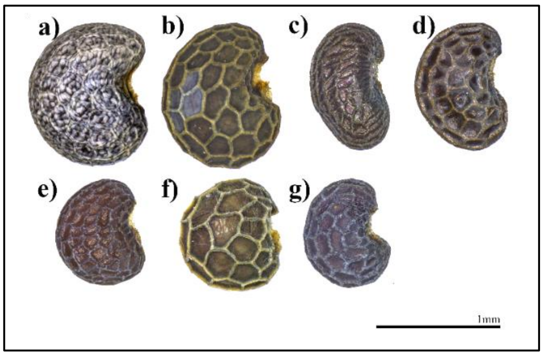

Figure 6.3 Photos of the seeds from different species found in the study area. a) *P. nigrum*; b) *P. somniferum*; c) *P. argemone*; d) *P. hybridum*; e) *P. rhoeas*; f) *P. setigerum*; g) *P. dubium*. Photos by Raül Soterras.

6.5 Geographic area and habitat

P. setigerum is an annual plant, 60 cm high, and, as a field weed, it occurs in disturbed grounds (Bojnanský & Fargašová, 2007, p. 167). This species is native to the western Mediterranean (Bojnanský & Fargašová, 2007; Zohary et al., 2012). The species' native area englobes Algeria, Baleares, Canary Island, Corse, France, Italy, Libya, Madeira, Morocco, Portugal, Sardinia, Sicilia, Spain, and Tunisia (KewScience, 2017b). At the same time, *P. setigerum* is both diploid and tetraploid and inter-fertile with the *Papaver somniferum* cultivars (Hammer & Fritsch, 1977); taxonomy is still debated, as mentioned before.

The area of the present opium poppy covers different parts of Europe, see EuroMed. It grows in damp soil, in warm temperate climates. The narcotic principles are not produced in the plant when grown in colder temperate zones. Sowing time is just after the last snow or into the springtime. The production and maturation of seeds require long and warm weather, and rain might affect the seeds' quality (Yazıcı & Yılmaz, 2017).

6.6 Uses

Four species of *Papaver* are known to be used for food, ornamentation and medicine. These are field poppy (*Papaver rhoeas*), oriental poppy *(Papaver orientale)*, Persian poppy (*Papaver bracteatum* L.) and opium poppy (*Papaver somniferum*).

As its common name indicates, field poppy (*Papaver rhoeas*) is a field weed. The flowers can be eaten and turned into syrup, which is used today as a red dye or food flavouring, especially in wine (Pfaf). They can also be used as medicine to treat earache, toothache and neuralgia. An infusion of the petals is traditionally taken for coughs, insomnia and poor digestion (Kew). The presence of rhoeadine and benzylisoquinoline acts as a sedative and does not induce addiction (Grauso et al., 2021; Oh et al., 2018). The seed has a nutty flavour and does not contain alkaloids; it can also produce an edible oil. Leaves (raw or cooked) can be eaten before the flower buds are formed. Oriental poppy *(Papaver orientale)* is used for ornamental purposes, while Persian Poppy (*Papaver bracteatum* L.) is used as a medicinal plant, a natural source of opiate - thebaine (Hadipour et al., 2020). From thebaine, oxycodone is produced, this is semi-synthetic drug with potent pain-relieving effects (Riley et al., 2008).

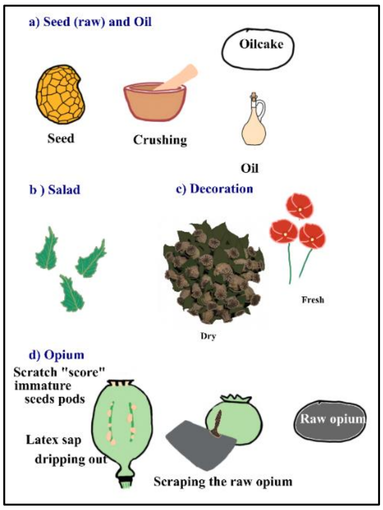

Figure 6.4 Scheme of the uses of opium poppy

The leaves (Figure 6.4: b) of the opium poppy (*Papaver somniferum*) are eaten in salads in Southeast Asia (Tetenyi, 1997, p. 415). Poppy oil (Figure 6.4: a), made from seeds, is also used in cooking; however, its shelf life is not long as it becomes rancid quickly (Tetenyi, 1997). The by-products of poppy oil, such as oilcake (Figure 6.4a), can also be given to domestic animals (Tetenyi, 1997). However, the poppy straws cause distress to animals and are not used as fodder (Tetenyi, 1997). Fresh flowers or dry capsules can be used as decoration (Figure 6.4c). Latex (Figure 6.4d) is a thick juice that comes from the immature seed pods (capsule), and opium is dried latex. The most known method of extracting opium is scoring the capsules with a pointing tool (e.g. nashtar), making small incisive lines that make the opium sap drip out (Krikorian & Ledbetter, 1975, p. 40). The sap (latex) is left to dry on the capsule. When the sap is dry and becomes a darker paste, it is then scraped from the capsules (Krikorian & Ledbetter, 1975, p. 44).

Opium poppy seeds can be white, blue, yellow, brown, and grey and have a distinct taste described as nut aroma (Tetenyi, 1997). The seed is highly nutritious, with most of its fat content, followed by protein. It also has an abundance of vitamin E, F, pantothenic acid, biotin, and minerals such as calcium, iron, magnesium, and potassium. They can also have alkaloids if contaminated by insects or by external contamination during harvesting (OJEU, 2014). The EU has some recommendations that have been published in the Official Journal of the European Union concerning the growing of seeds, storage and pre-treatment (OJEU, 2014). The main recommendation is that when the seeds are contaminated and have alkaloids, the seeds themselves are pre-treated before consumption. This pre-treatment is known from traditional Czech Republic, Hungary, Russia, Bulgaria, and Slovenia recipes. The poppy seeds are typically ground, cooked in milk and then mixed with the batter to be baked.

6.7 Domestication and previous studies

The main domestication traits in opium poppy are capsule indehiscence and increased capsule and seed size (Zohary et al., 2012). However, since the sizes can overlap, the seed's size has not proven a good criterion for distinguishing different species (Fritsch, 1979). Cultivated varieties accepted are var. *hortensis* (Zohary et al., 2012) and var. *nigrum* (Hammer, 1981; Hrishi, 1960; J. Renfrew, 1973).

The best part of the plant for the morphological distinction between domestic and wild poppies would be the capsule. The characteristics of domesticated opium poppy are that the capsules become larger and the pores beneath the stigmatic lobes do not open when the seeds are matured (Zohary et al., 2012). However, capsules are rarely present at archaeological sites. Therefore, in this thesis, seeds are used instead of capsules.

Archaeobotanical research can bring insights into the poppy domestication process. Since several seeds are found in the study area, as discussed in the previous chapter, a method to study these tiny seeds was developed. A detailed protocol can be found at the end of Appendix E and synthesized in the article found at the end of this chapter (Jesus, Bonhomme, et al., 2021).

Previous studies focused on the size of the seed not only as a criterion for identifying the domestic species in the Swiss sites but also for comparing the archaeological seeds to modern species (Bosi et al., 2006; Fritsch, 1979; Hammer, 1981; Knorzer, 1971, pp. 34–39; Merlin, 1984, p. 57; Villaret-von Rochow, 1967, p. 50). The modern species used and described by these scholars were *Papaver sominiferum* var. *setigerum,* var *nigrum* DC, var *album* DC, var *rotundilobum*, *P. argemone*, *P. dubium* and *P. rhoeas*. While papers of Hammer (1981) and Fritsch (1979) focus on modern seeds of *Papaver somniferum*, Bosi et al. (2006) compare modern seeds with archaeological seeds from a medieval site based on their morphologic aspect (appearance of the surface, the shape of the cells and colour) and biometric factors (length, width of the seed and ratio between the two measures, edge thickness of the areolae, maximum diameter (= Ø max) of the five largest areolae in succession on the same face).

Besides size, the seed coat pattern referred here to as cell was also used as a criterion in previous studies; Fritsch (1979) and Bosi et al. (2006) measured the largest cell dimension. Villaret-von Rochow (1967) checked the range and means of the number of cells between recent *P. somniferum* and *P. setigerum* and the archaeological seeds from the Neolithic site of Burgäschisee-Sud, on the border of the cantons of Berne and Solothurn in Switzerland.

In Fritsch (1979) paper, the main conclusions are that *P. somniferum* and *P. setigerum* are hard to distinguish due to their large variability in length, width, and seed coat structure. In the Burgaschisee-Sud site (Switzerland) case, Villaret-von Rochow concluded that the *P. nigrum* was not similar to the archaeological seeds and showed correspondence to *P. somniferum* and the closest relation to *P. somniferum* convar. *rotundilobum* (Villaret-von Rochow, 1967, p. 50).

In order to get optimal results, we focus on two criteria that previous studies used (Bosi et al., 2006; Fritsch, 1979; Villaret-von Rochow, 1967), namely size measurements (width and length) and the number of cells, to which we added a new descriptor – shape. The new criterion shape was retrieved using geometric morphometric methods (GMM). Geometric morphometric analysis is a quantitative method of measuring the form (size and shape) and shape (only shape) (Gunz, 2020, p. 199). Geometric morphometrics (GM) has become part of the biological research because it combines statistical rigour and intuitive interpretation (Gunz, 2020). This method has been used in archaeobotanical research for the study of large macroremains such as grapes (Pagnoux et al., 2015; Terral et al., 2010), date palm stones (Terral et al., 2012), olive stones (Terral et al., 2004) and grains (Bonhomme et al., 2017; Ros et al., 2014; Roushannafas et al., 2022; Wallace et al., 2019). This approach will be, for the first time, applied to tiny seeds such as poppy seeds.

Before starting the shape analysis, the protocol and photo technique are defined (Appendix E: Protocol for application of GMM to archaeobotanical material). The error analysis is performed to check for potential errors in the protocols and if the technique is reproducible. Then, measuring a sequence of two-dimensional (x and y) landmark coordinates. The landmarks had been chosen and can be identified on every specimen in the sample set. Five landmarks were positioned in each photo. The results of the error messurments were noted at the operator level but these were small enough to be able to be used and reproduced (Jesus, Bonhomme, et al., 2021).

The shape of the modern and archaeological seeds was described with outline analyses using elliptic Fourier transforms (EFT) (Kuhl & Giardina, 1982). This protocol was developed in Research paper 2. The (x; y) coordinates of the outline were obtained with the Momocs 1.3.0 (Bonhomme et al., 2014) package in an R 4.0.0 environment (R Core Team, 2020). Landmark n°2 was used as the initial point for each outline that corresponds to 360 points equally spaced points. The outlines were normalised for their position, size and orientation using full generalised Procrustes alignment of the landmarks (Rohlf & Slice, 1990). The elliptic Fourier transform method decomposes the outlines into a harmonic series of trigonometric functions - called harmonics - associated with coefficients (Bonhomme et al., 2014), further used as quantitative shape variables.

For more details on this approach, check Research paper 2 at the end of this chapter. Mainly the approach was applied first to the different modern species according to each descriptor. Then, we combine all the criteria (size, number of cells and shape) to discriminate the different species. Finally, this method was applied to the archaeological seed as the method proved to be successful on modern seeds (Research paper 3).

Previous studies did not use digital photos, which are more practical, even though not error-free. Measuring with a binocular can lead to similar positioning errors, while digital photos could bring other problems such as errors in processing mounted pictures, cleaning and landmarking. The main advantage is the possibility of double-checking the results and seeing the seeds without doing it physically (in case the seed is elsewhere, was lent, disappeared, or destroyed for dating). The biggest advantage of this protocol is that it allows the repeatability of the results by other scholars and the use of the data for future comparisons. All seeds are measured in the same way using the same software and can be used by other researchers (Appendix F: Metadata of the morphometric study of poppy seeds).

6.8 Collecting modern species

Since the method was applied only to waterlogged material, carbonising or attempting experimental charring tests were unnecessary. Creating a high-quality modern seed collection of *Papaver* species was essential to be able to compare to archaeological seeds. Nevertheless, the poppy seeds were collected from four different sources: 1) seeds already existing in the institute (IPNA), 2) seeds donated from collaborators of the project (Graineterie - seed collection of the National Museum of Natural History (MNHN) in Paris, France), 3) collected from old archives from National Museum of Natural History (MNHN) in Paris, France and the Jardin Botanique de Genève, Switzerland and lastly 4) from six *Papaver somniferum* given by Pro Specie Rara for growing as an experiment in the balcony of the institute (IPNA). The importance of having an extensive collection of poppy seeds is that there is a lack of knowledge of the variability within opium poppy seeds. The need for this is to ensure that differences between them are meaningful and not just an artefact of environmental or geological variables. Even though only seeds from Graineterie and the institute (IPNA) were used for this thesis's geometric modern morphometrics (GMM), it was not possible to study all the seeds due to time constraints. Nevertheless, the seeds were kept, and a brief description was done; consequently, they can be used for future projects.

The sample collection from Herbaria was performed with care. In order to extract the seeds from within closed capsules, the plant was moved slightly upside down and softly beat the capsules making the seeds come out. In rare cases, *bisturi* was used to remove a piece of the capsule and take some seeds. From the National Museum of Natural History (MNHN) in Paris, 37 plants were sampled and from Jardin Botanique de Genève, 24 plants. In total, the assessment of these seeds resulted in 18 specimens with seeds that could be used for GMM, Table G1 in Appendix G.

The experiment of growing poppy seeds on the balcony lasted two years. The first year held more plants than the second one. Six varieties of *P. somniferum* given by the Pro Specie Rara (a non-profit charitable organization dedicated to preserving the genetic diversity of plants and animals in Switzerland) were grown in small pots on the balcony. This experiment was to see if seeds size would change when grown in particular conditions, such as in a pot in the North of Switzerland. Sadly, the plants were infected by black aphids and spider mites in both years. The seeds themselves were not healthy as well. For more details and photos, see Appendix G: Collecting poppy seeds. This experiment was to be able to do a more detailed analysis of the specimens and landrace level. It could test the possibility to distinguish seeds from the same variety from the same capsule, same year and then to other capsules from that year. This would give a better overview of the variability of the seeds in a small experiment.

6.9 Research paper 2

Detailed results of modern species' shape, size and number of cells analyses are given in Paper 2: **A morphometric approach to track opium poppy domestication** on the next page. This is the first time the distinction of these different *Papaver* species is systematically assessed for all these descriptors.

Jesus, A., Bonhomme, V., Evin, A., Ivorra, S., Soteras, R., Salavert, A., Antolín, F., & Bouby, L. (2021). A morphometric approach to track opium poppy domestication. *Scientific Reports*, *11*(1), 9778. https://doi.org/10.1038/s41598-021-88964-4

www.nature.com/scientificreports

scientific reports

Check for updates

OPEN

A morphometric approach to track opium poppy domestication

Ana Jesus[1], Vincent Bonhomme[2], Allowen Evin[2], Sarah Ivorra[2], Raül Soteras[1], Aurélie Salavert[3], Ferran Antolín[1,4]✉ & Laurent Bouby[2]

Opium poppy (*Papaver somniferum* L. subsp. *somniferum*) was likely domesticated in the Western Mediterranean, where its putative wild ancestor is indigenous, and then spread to central and northern Europe. While opium poppy seeds are regularly identified in archaeobotanical studies, the absence of morphological criteria to distinguish the seeds of wild and domestic forms prevents the documentation of their respective historical and geographical occurrences and of the process of opium domestication as a whole. To fill this gap and better understand the status of this crop in the Neolithic, we combined seed outline analyses, namely elliptic Fourier transforms, with other morphometric descriptors to describe and identify *Papaver setigerum*, *Papaver somniferum* and other *Papaver* taxa. The combination of all measured parameters gives the most precise predictions for the identification of all seven taxa. We finally provide a case study on a Neolithic assemblage from a pile-dwelling site in Switzerland (Zurich-Parkhaus Opéra, ca. 3170 BC). Our results indicate the presence of mixed populations of domestic and wild seeds belonging to the *P. somniferum* group, suggesting that the plant was already in the process of domestication at the end of 4th millennium BC. Altogether, these results pave the way to understand the geography and history of the poppy domestication and its spread into Europe.

Opium poppy (*Papaver somniferum* L.), as the principal source of opium and opiate drugs, today, as in the past, is a most controversial species. This plant has multiple uses including medicine (e.g. morphine), decoration (as an ornamental plant) and food. Poppy seeds can be used for making porridge, eaten raw or pressed for edible oil[1]. Unlike the founder crops (different cereals, pulses and flax) that are known in Europe, arriving from the Near-East during the Neolithic period (ca. 6500–3500 BC), opium poppy is currently supposed to have been domesticated outside of the Fertile Crescent. Its domestication probably took place in the Western Mediterranean area from where the putative progenitor is native and still growing wild today, *Papaver somniferum* subsp. *setigerum* (DC.) Arcang.[2–6] (from now on *P. setigerum*). *Papaver somniferum/setigerum* seeds are reported in the archaeological record starting from the Neolithic period (6th-millennium cal. BC)[5,7,8]. Regrettably, these are not identified to subspecies/status level (i.e. at the wild/domesticated level) because no clear criterion exists for these seeds to be distinguished. This paper aims to fill this methodological gap to further gain knowledge for the archaeological and the botanical sides of *Papaver* domestication history. The goals of the paper are to distinguish the wild from domestic species in modern *Papaver* through the application of traditional and geometric morphometrics on seeds. Then we use this methodology to establish the status of this plant during the Neolithic period using archaeological seeds from a case study in central Europe, Zurich-Parkhaus Opéra (ca. 3170 BC). This is the first time this approach is used to study the domestication process of opium poppy.

The genus *Papaver* encompasses more than 80 different species[9] of annual, biennial and perennial plants distributed in central and south-western Asia, central and southern Europe and northern Africa[10]. All species of *Papaver* grow in open and unevenly disturbed habitats. Perennials and biennials are mountain taxa growing above 1000 m while annuals are mostly lowland taxa[11]. *Papaver* species encountered in western and southern Europe and identified in the archaeological record are: *P. album*; *P. hybridum*; *P. rhoeas*; *P. argemone;* as well as different subspecies and one variety of the *P. somniferum* group (here referred at the species level for the sake of simplicity): *P. somniferum*, *P. setigerum* and *P. nigrum*.

Papaver taxonomy is still debated, Kadereit[10], Zohary et al.[6] and Carolan et al.[12] all argued that *P. somniferum* has two subspecies: *setigerum* and *somniferum*, the latter being the domesticated descendant. Whether *P. setigerum* and *P. somniferum* represent two distinct species or whether they should be considered as two subspecies is still debated. Using sequences of the plastid gene rpl16 and the rpl16-rpl14 Hosokawa et al.[13] argued that both

[1]Integrative Prehistory and Archaeological Science (IPAS), Universität Basel, Basel, Switzerland. [2]ISEM, University of Montpellier, CNRS-IRD-EPHE, Montpellier, France. [3]Archéozoologie, Archéobotanique: Sociétés, Pratiques et Environnements (AASPE), Muséum National d'Histoire Naturelle, CNRS, Paris, France. [4]Department of Natural Sciences, German Archaeological Institute (DAI), Berlin, Germany. ✉email: ferran.antolin@unibas.ch

Scientific Reports | (2021) 11:9778 | https://doi.org/10.1038/s41598-021-88964-4 natureportfolio 1

Taxa	ANOVA F	P-value	%ME
Position test			
P. somniferum	1.3208	0.093	85.339
P. setigerum	2.3065	0.039	79.283
P. nigrum	3.2988	0.013	68.504
Cleaning test			
P. somniferum	4.4525	0.004	46.493
P. setigerum	17.502	0.001	15.382
P. nigrum	7.079	0.001	33.043
Landmark test			
P. somniferum	37.649	0.001	7.566
P. setigerum	13.648	0.001	19.171
P. nigrum	27.335	0.001	10.226

Table 1. Results of the reproducibility tests (seed positioning, photography cleaning and landmarking) performed through Anova: F: Fisher statistics, *P*-value and measuring error (%) when comparing the three taxa of *P. somniferum*.

species were identical. Likewise, a phylogenetic study of *Papaver* based on DNA sequences was unable to distinguish these two taxa[12]. The opium poppy (*P. somniferum*) is an annual herb, 30–150 cm high, self-pollinated and most of the actual cultivars are diploid. *Papaver setigerum* is an annual plant, 60 cm high, a field weed occurring in disturbed grounds[14] and native to the western Mediterranean[6,14] in Algeria, France, Italy, Morocco, Portugal, Spain, Tunisia[15]. *P. setigerum* is both diploid and tetraploid and inter-fertile with the *P. somniferum* cultivars[16].

The history and mechanisms of opium poppy domestication remain unclear despite the abundance of archaeological seeds in sites dated to the Neolithic period, particularly in the Alpine Foreland[5]. Archaeobotanical remains are usually broadly identified as *P. somniferum*, yet their domesticated status is unclear[7]. The domestication syndrome of opium poppy encompasses the increase in the size of the capsule and seeds, as well as capsule indehiscence[6]. Previous studies attempted to distinguish wild from domestic opium poppy seeds based on the size, comparing archaeological seeds to modern species[17–22]. However, the size of the seed alone has not proven to be a good discriminating criterium[20] since it overlaps between the two species.

This paper addresses two questions: (i) can we distinguish between modern seeds of the wild (*Papaver setigerum*), domestic (*P. somniferum*) and other *Papaver* species? If so, (ii) can we distinguish *Papaver* species in archaeological assemblages previously identified as *P. setigerum/somniferum*?

The modern plant material consisted of 270 seeds belonging to seven *Papaver* taxa (30 seeds per taxon) obtained from the seed collection of the Integrative Prähistorische und Naturwissenschaftliche Archäologie (IPNA/IPAS) at the University of Basel, Switzerland (Supplementary Material Table 1). Two additional sets of 30 seeds of *P. somniferum* and *P. setigerum* were obtained from the Graineterie (seed collection) of the National Museum of Natural History (MNHN) in Paris, France. We first established new identification criteria between *Papaver* species, and chiefly between *P. setigerum* and *P. somniferum*. We applied traditional and geometric morphometrics on seeds, considering the number of cells, size measurements and shape using outline analysis. Outline analysis has been successfully used to identify archaeobotanical remains of an array of species such as grape pips[23], olive stones[24] cereals[25–27], dates[28] and cherry stones[29]. The technical challenge for *Papaver* seed lies in the millimetric size of the seeds and their globoid shape. Prior to any morphometric analysis, repeatability tests were performed to establish the effects of taking the photos, cleaning and landmarking in the observed seed morphometric variation.

This protocol was then applied to 33 uncharred poppy seeds preserved in waterlogging conditions from a Neolithic pile-dwelling site in the Alpine Foreland (Zurich-Parkhaus Opéra, dendro-dated to ca. 3170 BC[30]). This site is an ideal starting point since the Swiss Plateau is outside of the natural area of spread of *P. setigerum*, thus suggesting a human introduction. *P. somniferum* seeds are known in Switzerland since ca. 5000–4800 BC in the Valais region[31], and seed and capsule fragments were recovered in large quantities in pile-dwelling sites starting from 4300 BC, indicating widespread cultivation[32]. Zurich-Parkhaus Opéra is, therefore, a perfect case study to test our methodology, since opium poppy had been cultivated in the area for ca. 1000 years and might therefore show morphometrical signs of domestication. Furthermore, the waterlogging conditions maintained the original seed shape and size, unlike what is known to occur to charred remains[33].

Results

Measurement error. The error measurements was quantified by acquiring data 3 times on 5 seeds independently for the three species (Table 1), which allow to test for the different steps of the protocol: positioning, image cleaning and landmarking. These three steps yield contrasting results. Positioning error is high (between 68 and 85%) (Table 1). This originates from the difficulty to orientate the seed consistently under the stereomicroscope, due to the small size and globoid shape of poppy seeds. On the other hand, cleaning and landmarking errors are much lower. Despite the existence of a certain positioning error, this does not prevent taxonomic identification (see below) and the protocol can therefore be used for the purpose of this study.

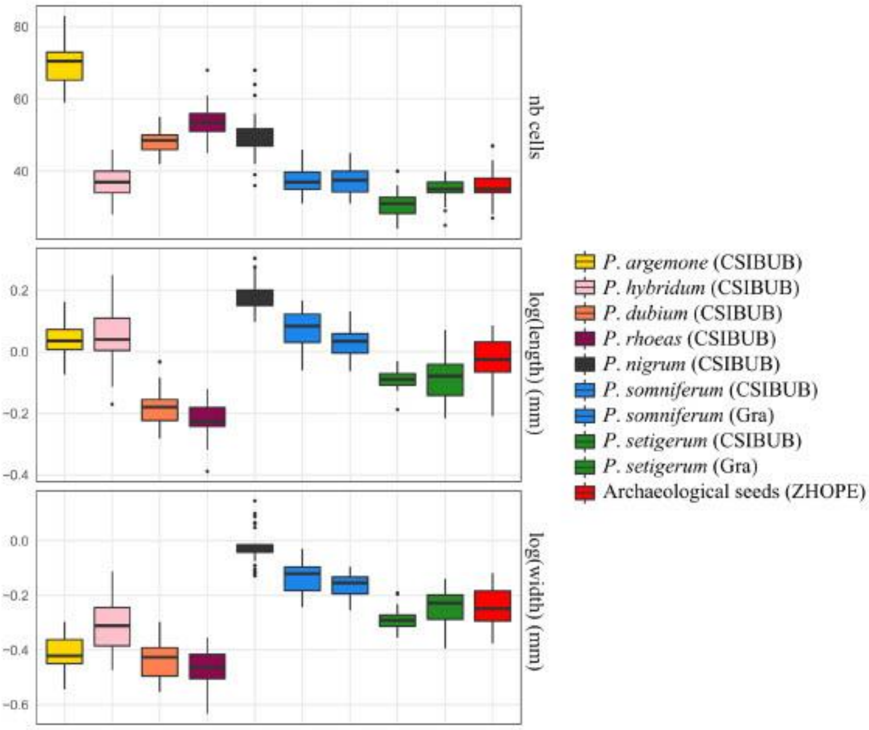

Figure 1. Boxplot of measurements (number of cells, length, width,) made on the modern seeds. Length and width are (natural) logged. Archaeological seeds are presented in red.

Phenotypic variation among species. Length and width show considerable variation with significant differences between the various *Papaver* species (Fig. 1), as reported by the results of the Kruskal–Wallis tests (length: $\chi^2=231.78$, df=7, $P<10^{-16}$; width: $\chi^2=243.76$, df=7, $P<10^{-16}$). The two domestic species (*P. somniferum* and *P. nigrum*) have bigger seeds than the wild species, especially in width (Wilcoxon rank tests, all P values $<10^{-11}$). The seeds of *P. somniferum* and *P. setigerum* are different in size (Wilcoxon rank tests, all *P* values $<10^{-8}$). For both species, the two investigated samples are close, yet some dimensions appear different (Wilcoxon rank tests, *P. setigerum*, width $P=0.003$; *P. somniferum* length $P=0.005$). The number of cells also present differences between species (Fig. 1, Kruskal–Wallis tests number cells: $\chi^2=233.21$, df=7, $P<10^{-16}$) and between samples of *P. setigerum*. *P. argemone* is clearly the species with more cells. *P. nigrum* is also different from the other species of the *P. somniferum* group. *P somniferum* and *P. setigerum* and consequently the archaeological seeds are very close regarding this criterion.

The first two PCs (Fig. 2) gathered 84% of the total shape variation. Shape changes along PC1 (46%) are related to roundness while changes along PC2 (38%) correspond to an asymmetry component between the two parts of the seed. Asymmetry mostly represents intraspecific variability. It is higher for the species with the most rounded seeds (*P. setigerum* and *P. somniferum*).

The permutational MANOVA (df=6, F=32.126, adj. $r^2=0.42$, $P=0.001$) showed differences in shape between taxa. The species with the most elongated seeds (*P. argemone* and *P. hybridum*) are clearly distinguished from the other species with proportionally rounder seeds. Shape overlapping is particularly important between *P. setigerum*, *P. somniferum*, *P. nigrum* both on PC1 and PC2.

The hierarchical clustering performed on the euclidean distance matrix computed on the coefficients averaged per taxa confirmed the shape proximity between *P. setigerum* and *P. somniferum*, as well as between *P. rhoeas* and *P. dubium* and, in the other branch, *P. hybridum* and *P. argemone*. (Fig. 3). The slight differences in shape between the species of the *P. somniferum* group occur in part surrounding the hilum (Fig. 4 and Fig. 1 in Supplementary material).

Identification of modern seeds. The linear discriminant analyses (LDA) on modern material allowed a good identification at the species level. The percentage of accuracy identification using the cells and size ranged between 67 and 73% for two taxa (*P. dubium* and *P. rhoeas*) but for the other five taxa it was above 80% (Fig. 5).

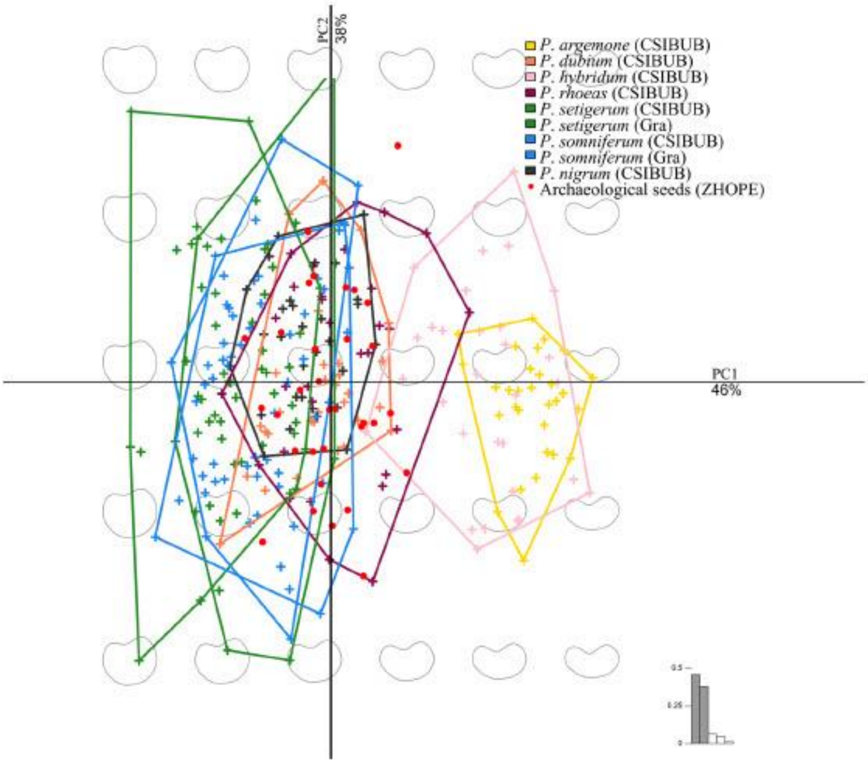

Figure 2. Principal component analysis performed on shape coefficients. The first two components are shown here gather 84% of the total shape variability. Archaeological seeds (red dots) are added as supplementary individuals, i.e. reprojected, on this biplot.

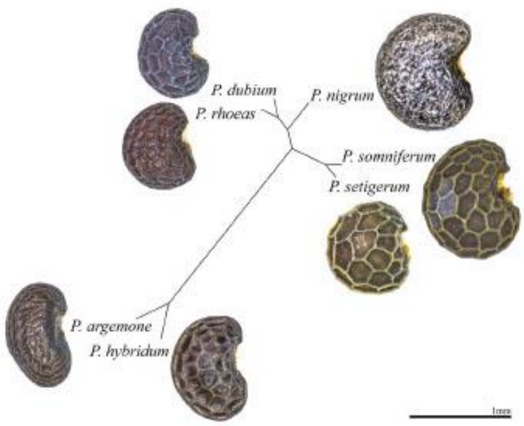

Figure 3. The unrooted tree obtained with hierarchical clustering on the Euclidean distance matrix between Fourier coefficients averaged per taxa.

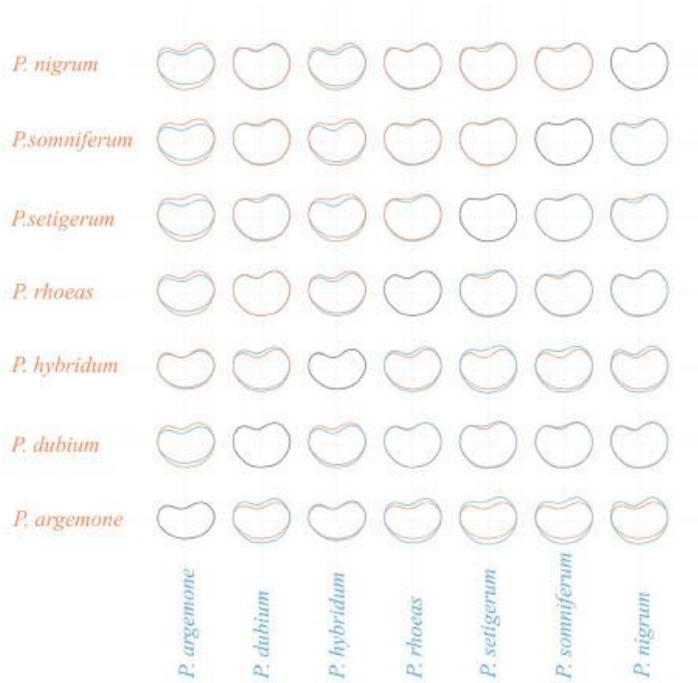

Figure 4. Mean shapes pairwise comparisons for all *Papaver* taxa studied here. Orange colour corresponds to the taxon of the rows and the blue colour to the taxon of the columns.

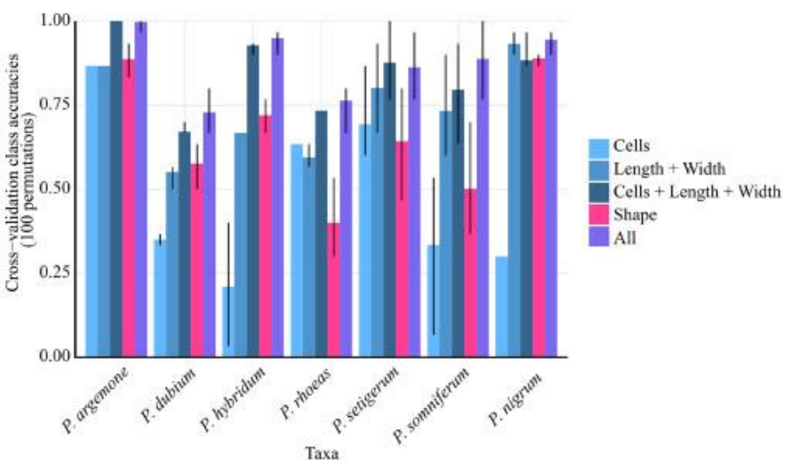

Figure 5. Benchmarking of linear discriminant analyses on all species and using different proxies. Accuracy per classes and their variability were obtained using 100 permutations on classes-balanced dataset with the error bars.

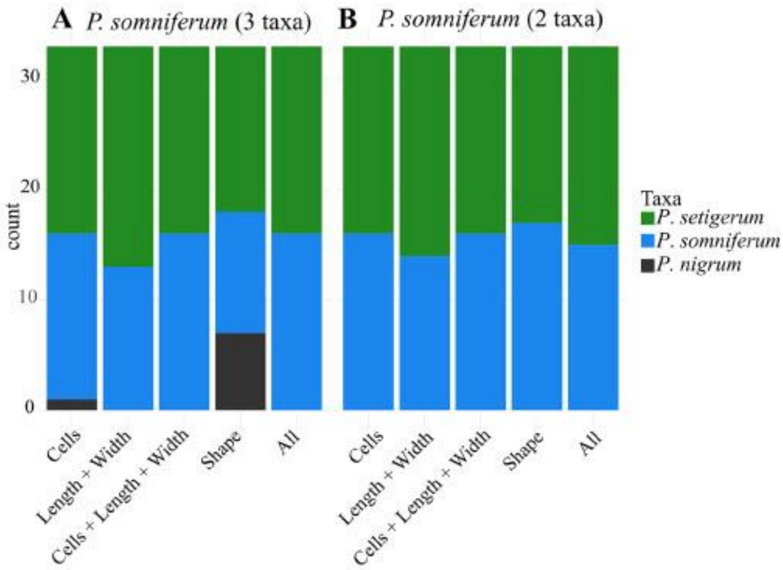

Figure 6. Assignation of the 33 archaeological seeds: Benchmarking of linear discriminant analyses on (A) three taxa (*P. setigerum*, *P. somniferum* and *P. nigrum*) and (B) two taxa (*P. setigerum*, *P. somniferum*) using different variables or set of variables.

Although the performance of individual variables (length, width, shape and cell number) provided relatively good discrimination, the best percentages were obtained when all traditional and shape parameters were combined (Fig. 5: 73–100%).

The results were similar if we considered only the species from the *P. somniferum* group with two taxa and three taxa (Figs. 2 and 3 in supplementary material). Combining all variables, more than 87% of the seeds were correctly identified to their specific taxon (Supplementary data Fig. 2).

Assignation of archaeological seeds. Length and width showed considerable variation between modern seeds of *Papaver* and archaeological seeds (Fig. 1). The width of the archaeological seeds of Zurich-Parkhaus Opéra is closer to modern *P. setigerum* seeds while the length is intermediate between *P. setigerum* and *P. somniferum* modern seeds (Fig. 1). The LDAs using various sets of descriptors were used to infer species on the archaeological material. The archaeological seeds from Zurich-Parkhaus Opéra were identified as *P. setigerum* and *P. somniferum* (see Fig. 6A). Some seeds were identified as *P. nigrum* only when using one of the descriptors: number of cells (3%) and shape (21%). When all criteria are combined, no seed is allocated to *P. nigrum*. In every case, and more especially when all criteria are combined, about half of the seeds are attributed to *P. setigerum* and a half to *P. somniferum*.

Discussion

Here we show that the combined application of morphometric descriptors, number of cells and shape analysis outline elliptic Fourier transforms (EFT) allows the discrimination of seven modern species of *Papaver* genus.

In spite of a high positioning error, due to the small size of this material, morphometrics can be done. The various species and sub-species are well discriminated, which validates the methodology used (Table 1). Indeed, the most interesting result was that by using this method, with all descriptors, the LDA gave optimal results when distinguishing between *P. setigerum* and *P. somniferum* as well as when compared to other *Papaver* related modern seed species. The second finding of this study was that allow for the first time the application of this method to archaeological seeds.

Phenotypic variation among modern seeds. The first question that this study sought to answer was if it is possible to discriminate between the different taxa. The LDA results (Fig. 5) show that it is possible to distinguish the taxa with high accuracy results by using all the descriptors or the combination of the number of cells and size.

According to our results, adding the cell number to the size descriptors gives a better prediction for *P. dubium*, *P. rhoeas* and *P. somniferum* (Fig. 5). These are also the taxa where the shape yielded the lowest additional accuracy. A possible explanation for this confusion might be that their shape is identically reniform (as seen in Fig. 4). Instead, shape is a powerful descriptor in the case of *P. nigrum*, *P. argemone* and *P. hybridum* seeds, which are more elongated, with the accuracy being over 93% (Fig. 4).

The results of the unrooted distance network (Fig. 3) showed morphometrics proximities that mirror the results of previous phylogenetic studies[12]. On the one hand, Carolan et al.[12] identified *P. setigerum* and *P. somniferum* as sister group with a common ancestor[12]. On the other hand, *P. hybridum* and *P. argemone* also have a common ancestor, which again is congruent with our results based on seed shape (Fig. 3).

Our results show that cell number alone gives lower accuracy (23–33% see Fig. 5). Surprisingly, it is a critical discriminant variable in the identification of *P. setigerum* (with the lowest number of cells) and *P. argemone* (with the largest number of cells). The importance of cell number, as well as cell size, were also the previous observed[18,20,21], however, according to our results the total number of cells from one of the seed face gives better discrimination results than solely count the cells by rows or measuring the cells[18,20,21].

P. somniferum seeds. The results show that it is possible not only to distinguish *P. somniferum* from the other taxa but also between *P. somniferum* subspecies (Figs. 2 and 3 in supplementary material). Previous studies on the *Papaver* genus encountered problems distinguishing mainly *P. somiferum* apart from *P. setigerum*[20]. Based mainly on size, other authors[16,20] stated that the high variability within the species *P. somniferum* makes it impossible to distinguish between the different subspecies. Future research may include a higher number of varieties and accessions to better assess the intra(sub)specific variability in terms of cell number, size and shape, including in terms of environmental conditions[34].

Assignation of archaeological seeds. The classification of archaeological seeds from the late Neolithic site of Zurich-Parkhaus Opéra (Switzerland) based on the model trained on modern seeds allow for the first time to apply this method to these small seeds (Fig. 6). In this case, it is essential to combine all descriptors and not only the shape. The results of the taxonomic attribution of the archaeological seeds found in Zurich-Parkhaus Opéra suggest a mixed population of domestic and wild-type seeds. Nevertheless, one should consider the caveats of using modern material to classify archaeological specimens and of the preservation of archaeological remains. Swelling of the seeds in waterlogged preservation[1,18] may also play a role in the model's prediction. In order to develop an understanding of the possible effects of taphonomic factors in the future, two tasks should be implemented. One would be to increase the number of samples, and the other one should be to perform experiments to replicate the state of the archaeological seeds. Nevertheless, the archaeological material results suggest that well-preserved waterlogged seeds of *Papaver* species can be used for this type of analysis.

In our results, 18 seeds were attributed to *P. setigerum* and 15 seeds to *P. somniferum*. This may be interpreted in two ways: the population at Zurich-Parkhaus Opéra is a mixture of wild and domestic forms belonging to a population in an intermediate stage of domestication, or we have a fully domestic form with some wild individuals still surviving as weeds in the fields. This opens several scenarios to explain the process of domestication of poppy. There is evidence of the use and potential cultivation of opium poppy in the Western Mediterranean since ca. 5600 BC, according to the finds at the lake village of La Marmotta, Italy (ca.5620–5480 Cal BCE)[8,35] and in several other sites, for instance, at the pile-dwelling site of La Draga, Spain, ca. 5200 BC[3,8]. The authors of both archaeobotanical studies actually suggest that opium poppy was cultivated, based on the number of finds and their ubiquity[3,35]. Nevertheless, it is possible that the plant was still morphologically wild since these sites fall within the native area of *P. setigerum* and isolation of the cultivated population would have been more difficult. Thus, it is unclear if opium poppy spread northwards as morphologically wild, not fully domesticated, or as a domesticated plant. It is actually possible that opium poppy arrived at the Alpine foreland as a domesticated form along with some wild *P. setigerum* forms as weeds.

The domestication process could have been accelerated with the beginning of cultivation of opium poppy outside of the area of the natural distribution of the wild subspecies such as in the Alpine Foreland around 4300 BC[32]. After ca. 1100–1200 years of cultivation of opium poppy in this region, the Zurich-Parkhaus Opéra seeds seem to indicate that the plant is still in the process of being domesticated. This may be interpreted as an indication of a protracted domestication process[36], as observed with other plants domesticated in the Neolithic period. In order to test this hypothesis, similar analyses should be performed on opium poppy seeds from archaeological sites located in the Western Mediterranean region.

Another critical factor is that some of the seemingly early finds of opium poppy seeds outside of *P. setigerum* natural zone are not dated. Early deposits found in Israel[37] but also in central Europe[38,39] lack radiocarbon dates on the seeds or on direct contexts where the seeds were found. New efforts on dating these seeds and their contexts should be made before interpreting the route of cultivation/domestication[5,8]. Future studies on poppy seeds should integrate the morphometric as well as the direct dating approaches[36]. Likewise, it is foreseen to attempt to obtain aDNA from the archaeological seeds and so confirm, if possible, their status as domestic or cultivated.

Conclusions

The present paper provides the first results of geometric morphometrics for *Papaver* taxa. The combination of descriptors such as the number of cells, size and shape of different modern species of *Papaver* allows to classify the seeds with good accuracy despite the methodological challenge due to the small size and globoid shape of poppy seeds. The classification model from the modern species used to assign archaeological seeds recovered at the late Neolithic site of Zurich-Parkhaus Opéra was also successful as it did attribute them to either *P. setigerum* and *P. somniferum*. The seeds were actually distributed within these two subspecies in equal parts, which might suggest that the plant has not yet acquired the morphometric characteristics of modern domestic seed. Further studies should be done in order to test the classification model. Future research should consider the study of

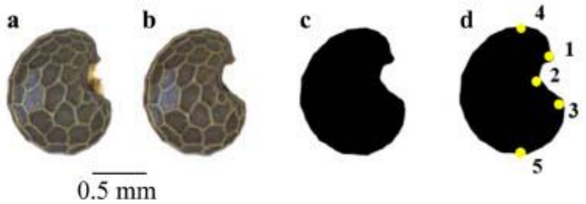

Figure 7. Data acquisition and post-processing (a) Lateral view position; (b) Background removal and cleaning; (c) Mask; (d) Landmarked-mask.

opium poppy seeds from historical periods to confirm their assignation to the domesticated subspecies, as well as the study of earlier Neolithic finds in the Western Mediterranean in order to trace the pace of the domestication process.

Methods

Archeological material. One archaeological case included in the AgriChange Project[40] was used in this paper: Zurich-Parkhaus Opéra (ZHOPE) located in Zurich, Switzerland is a Neolithic lake-dwelling site. A total of 33 whole and well-preserved uncharred waterlogged seeds (with visible cells) identified as *P. somniferum*[41] were used. All seeds were obtained from the sample 12015.1B in layer 13 dated by dendrochronology between 3176 and 3153 BC (middle Horgen Culture[42]). Zurich-Parkhaus Opéra was excavated during the construction of subterranean parking in 2010 and 2011. Located in the northern shore of the Lake Zurich, eight settlement phases were identified and dendro-dated to 3234–2727 BC. In this late Neolithic site, archaeological deposits related to pile-dwelling houses are preserved in a waterlogged state where thousands of plant remains are present in charred and uncharred states, especially in layer 13, large quantities of opium poppy seeds were found concentrated mostly within building limits[41].

These analyses were non-destructive and therefore no special permissions were required. Permission for the use of the archaeological seeds of Parkhaus Opéra for this study was granted by the scientific director of the project, Dr. Niels Bleicher (Office for Urbanism Zurich). Permission for the use of modern seed reference material was granted by the Graineterie of the National Museum of Natural History (MNHN) and no permission was necessary for the use of our own seed collection of the Integrative Prähistorische und Naturwissenschaftliche Archäologie (IPNA/IPAS).

Data collection. All *Papaver* seeds were photographed from a lateral view, with the hilum to the right. In this angle, it shows the cells, including those close to the hilum (Fig. 7A). The broader part of the seed at the bottom. The background of the seeds was a white surface to ease further background removal. The photos were made using Leica Z16 APO Binocular Stereo Microscope with a digital camera Leica DFC 420 and Leica Application Suite software (LAS 4.0, Leica), creating one mounted photo from several single photos that are stacked together to give depth of field to the seed and enable the counting of the number of seed cells. The background of the photo was removed manually using Photoshop 6 (Adobe) as well as the yellow soft tissue on the hilum part, in both archaeological and modern individuals (Fig. 7B). Then a mask (a black shape over a white background) was created using Photoshop (Fig. 7C). In order to normalise the outlines before elliptic Fourier transforms (EFT), coordinates of five landmarks were recorded using ImageJ[43]. The position of the landmarks was chosen in order to be the most reproducible as possible: two landmarks were positioned at the top and bottom extremes of the seeds and three around the hilum part (Fig. 7D). The landmark points covered most critical biological traits, from seed length (ldk: 4–5) to the hilum arch (ldk:1–3).

Outline analysis. Seed shape was analysed using outline analysis based on elliptic Fourier transforms (EFT) using Momocs 1.3.0[44] in a R 4.0.0 environment[45]. The elliptic Fourier transforms is a progressive decomposition of the outline (x; y) coordinates into a series of trigonometric functions called harmonics, associated with coefficients, used as quantitative shape variables. Here, outlines were normalised for their position, size and orientation using full generalised Procrustes alignment[46]. Landmark n°2 was used as the initial point for each outline. Then EFT was calculated from 360 points equally spaced along the curvilinear abscissa, and two landmarks (4 and 5) were extracted on each image. Based on harmonic power, five harmonics were retained and gathered 95% of the total harmonic power; more details on EFT can be found in Bonhomme et al.[44].

Measurement error. The poppy seeds are small and round and thus difficult to position in a specific orientation under the stereomicroscope. To minimise the error and aid with its reproducibility, some precautions were taken: the use of the same protocol, the same equipment, a single operator (RS) took the photos, a single operator (AJ) did all the cleaning and landmarking. As a preliminary step, all measurements were tested for the overall reproducibility. We used analyses of variance (ANOVA) following Claude[34]. The percentage of measurement error (%ME) is defined as "the ratio of the within measurement component of variance on the sum of the within- and among-measurement component"[34]. A set of five photos from three different taxa from the *P. somniferum* group (*P. setigerum*, *P. somniferum* and *P. nigrum*) were used in three different tests. The position test compares five photos of the same 15 seeds of the three different taxa by one single operator (RS). The cleaning and landmarking tests compared the repetition of the same action of digitalising cleaning and landmarks on the same photos (same 15 photos, same three species, three times).

Phenotypic variation among species. The size (length and width of the bounding box) of the seed was recorded using the rectangular tool in ImageJ. The number of cells was counted for every seed using the multi-point tool in Image J. Length and width of the seeds were log-transformed[47,48]. Distributions of seed lengths, widths and cell number values were illustrated using boxplots. For each univariate variable (length measurements, cells number), overall differences were tested using Kruskal–Wallis non-parametric rank tests for multi-group comparison and Wilcoxon's tests between each pairs of species.

To explore the overall shape variability, we used a principal component analysis (PCA) on the full matrix of Fourier coefficients and added the archaeological seeds as supplementary individuals. The first two principal components (see Results) were used as synthetic shape variables.

Then we used the coefficients on the first five harmonics in a permutational MANOVA using the package vegan[49], to test for differences between taxa. A hierarchical clustering using UPGMA on the euclidean distance matrix between coefficients averaged per taxa is presented as an unrooted tree obtained with the package ape[50].

To benchmark the performance of the different descriptors (width, length, number of cells, shape) at identifying species, we used linear discriminant analyses (LDA) provided by the package MASS[51]. Different combinations were used: first to all modern species, then only to *P. somniferum* group (*P. setigerum*, *P. somniferum* and *P. nigrum*) and finally only to *P. setigerum* and *P. somniferum*. To cope with unbalanced group sizes between sets due to the repeated *P. setigerum* and *P. somniferum*), we used random sampling of the over-represented classes so that they all sum up to 30. The process was repeated for 1000 permutations[52,53]. To compare the model performances with those obtained with chance alone, we also randomised labels and provide the maximum class accuracies (expected to follow a multinomial distribution), obtained among the permutations. The accuracies presented are the percentages of specimens correctly classified by using leave-one-out cross-validation. To visualise mean species shapes, we averaged Fourier coefficients and reconstructed seed outlines for each taxon.

Archaeological identification. Each archaeological seed was classified using the "predictive" linear discriminant analyses trained on the modern material. For each seed, the dominant classification obtained along the 100 permutations was considered as the predicted class. The archaeological seeds were classified within three taxa of *P. somniferum: P. nigrum P. setigerum* and *P. somniferum* first, and after only classified within *P. setigerum* or *P. somniferum*. All descriptors (length, width, shape and number of cells) were used.

Received: 25 January 2021; Accepted: 20 April 2021
Published online: 07 May 2021

References

1. Merlin, M. D. *On the Trail of the Ancient Opium Poppy* (Fairleigh Dickinson University Press, 1984).
2. De Candolle, A. *Origine des plantes cultivées* (Laffitte Reprints, 1884).
3. Antolín, F. *Local, intensive and diverse? Early farmers and plant economy in the North-East of the Iberian Peninsula (5500–2300 cal BC). Local, intensive and diverse?* (Barkhuis, 2016). https://doi.org/10.2307/j.ctt20p56hs.
4. Salavert, A. Agricultural dispersals in mediterranean and temperate Europe. In *Oxford Research Encyclopedia of Environmental Science* (Oxford University Press, 2017). https://doi.org/10.1093/acrefore/9780199389414.013.307.
5. Salavert, A., Martin, L., Antolín, F. & Zazzo, A. The opium poppy in Europe: exploring its origin and dispersal during the Neolithic. *Antiquity* 92, E1 (2018).
6. Zohary, D., Hopf, M. & Weiss, E. *Domestication of Plants in the Old World: The origin and spread of domesticated plants in Southwest Asia, Europe, and the Mediterranean Basin. Domestication of Plants in the Old World: The Origin and Spread of Domesticated Plants in Southwest Asia, Europe, and the Mediterranean Basin* (Oxford University Press, 2012). https://doi.org/10.1093/acprof:osobl/9780199549061.001.0001.
7. Salavert, A. Le pavot (Papaver somniferum) à la fin du 6e millénaire av. J.-C. en Europe occidentale. *Anthropobotanica* 1, 3–16 (2010).
8. Salavert, A. *et al.* Direct dating reveals the early history of opium poppy in western Europe. *Sci. Rep.* 10, 20263 (2020).
9. Tison, J.-M. & Foucault, B. de. *Flora Gallica Flore de France. Société Botanique de France* (Biotope Éditions, 2014).
10. Kadereit, J. Sectional affinities and geographical distribution in the genus Papaver L. (Papaveraceae). *Beiträge zur Biol der Pflanz* 63, 139–156 (1988).
11. Kadereit, J. The genus Papaver L. in the mediterranean area. *Lagascalia* 19, 83–92 (1997).
12. Carolan, J. C., Hook, I. L. I., Chase, M. W., Kadereit, J. & Hodkinson, T. R. Phylogenetics of Papaver and related genera based on DNA sequences from ITS nuclear ribosomal DNA and plastid trnL intron and trnL-F intergenic spacers. *Ann. Bot.* 98, 141–155 (2006).
13. Hosokawa, K., Shibata, T., Nakamura, I. & Hishida, A. Discrimination among species of Papaver based on the plastid rpl16 gene and the rpl16-rpl14 spacer sequence. *Forensic Sci. Int.* 139, 195–199 (2004).
14. Bojnanský, V. & Fargašová, A. *Atlas of Seeds and Fruits of Central and East-European Flora: The Carpathian Mountains Region* (Springer, 2007).
15. Papaver somniferum subsp. setigerum (DC.) Arcang. | Plants of the World Online | Kew Science.
16. Hammer, K. & Fritsch, R. Zur Frage nach der Ursprungsart des Kulturmohns Papaver somniferum L. *Kulturpflanze* 25, 113–124 (1977).
17. Merlin, M. D. Chap3 - The Natural Origins of the Opium Poppy. In *On the Trail of the Ancient Opium Poppy* 45–87 (Associated University Presses, 1984).

18. Villaret-von Rochow, M. Frucht- und Samenreste aus der neolithischen Station Seeberg, Burgäschisee-Süd. in *Seeberg Burgäschisee Süd, Teil 4: Chronologie und Umwelt* vol. 2 21–63 (Verlag Stämpfli & Cie, 1967).
19. Knorzer, K.-H. Prahistorische Mohnsamen in Rheinland. *Bonner Jahrbücher des Rheinischen Landesmuseums in Bonn und des Vereins von Altertumsfreuden im Rheinlande* 171, 34–39 (1971).
20. Fritsch, R. Zur Samenmorphologie des Kulturmohns (Papaver somniferum L.). *Kulturpflanze* 27, 217–227 (1979).
21. Bosi, G. *et al.* Applicazioni morfobiometriche in campo archeo- carpologico: primi dati su Papaver somniferum nell' Alto Medioevo di Ferrara. *Atti della Societa dei Naturalisti e Matematici di Modena* 137, 373–387 (2006).
22. Hrishi, N. J. Cytogenetical studies on Papaver somniferum L. and Papaver setigerum DC. and their hybrid. *Genetica* 11, 1–130 (1960).
23. Terral, J. F. *et al.* Evolution and history of grapevine (Vitis vinifera) under domestication: new morphometric perspectives to understand seed domestication syndrome and reveal origins of ancient European cultivars. *Ann. Bot.* 105, 443–455 (2010).
24. Terral, J. F. *et al.* Historical biogeography of olive domestication (Olea europaea L.) as revealed by geometrical morphometry applied to biological and archaeological material. *J. Biogeogr.* 31, 63–77 (2004).
25. Bonhomme, V. *et al.* Identification of inter- and intra-species variation in cereal grains through geometric morphometric analysis, and its resilience under experimental charring. *J. Archaeol. Sci.* 86, 60–67 (2017).
26. Ros, J., Evin, A., Bouby, L. & Ruas, M.-P. Geometric morphometric analysis of grain shape and the identification of two-rowed barley (Hordeum vulgare subsp. distichum L.) in southern France. *J. Archaeol. Sci.* 41, 568–575 (2014).
27. Wallace, M. *et al.* Searching for the origins of bere barley: a geometric morphometric approach to cereal landrace recognition in archaeology. *J. Archaeol. Method Theory* 26, 1125–1142 (2019).
28. Terral, J.-F. *et al.* Insights into the historical biogeography of the date palm (Phoenix dactylifera L.) using geometric morphometry of modern and ancient seeds. *J. Biogeogr.* 39, 929–941 (2012).
29. Burger, P., Terral, J. F., Ruas, M. P., Ivorra, S. & Picq, S. Assessing past agrobiodiversity of Prunus avium L. (Rosaceae): a morphometric approach focussed on the stones from the archaeological site Hôtel-Dieu (16th century, Tours, France). *Veget. Hist. Archaeobot.* 20, 447–458 (2011).
30. Antolin, F., Brombacher, C., Kühn, M., Steiner, B. L. & Jacomet, S. Archäobotanik (Makroreste): Ergebnisse der Untersuchungen der Flächenproben im Hinblick auf Taphonomie, Ackerbau, Sammelwirtschaft und Umwelt. In *Zürich-Parkhaus Opéra. Eine neolithische Feuchtbodensiedlung. Band 3: Naturwissenschaftliche Untersuchungen* (eds. Bleicher, N. & Harb, C.) 50–92 (2017).
31. Martin, L. Plant economy and territory exploitation in the Alps during the Neolithic (5000–4200 cal bc): first results of archaeobotanical studies in the Valais (Switzerland). *Veget. Hist. Archaeobot.* 24, 63–73 (2015).
32. Jacomet, S., Brombacher, C. & Dick, M. *Archäobotanik am Zürichsee. Ackerbau, Sammelwirtschaft und Umwelt von neolithischen und bronzezeitlichen Seeufersiedlungen im Raum Zürich. Ergebnisse von Untersuchungen pflanzlicher Makroreste der Jahre 1979–1988. Zürcher Denkmalpflege, Monographien* vol. 7 (Orell Füssli Verlag, 1989).
33. Märkle, T. & Rösch, M. Experiments on the effects of carbonization on some cultivated plant seeds. *Veget. Hist. Archaeobot.* 17, 257–263 (2008).
34. Claude, J. *Morphometrics with R* (Springer Science & Business Media, 2008).
35. Rottoli, M. Analisi paletnobotaniche: prime risultanze, "La Marmotta", Anguillara Sabazia (RM), Scavi 1989, Appendice 1, Un abitato perilacustre di età neolitica. *Bull di Paletnologia Italiana* 84, 305–315 (1993).
36. Fuller, D. Q., Asouti, E. & Purugganan, M. D. Cultivation as slow evolutionary entanglement: comparative data on rate and sequence of domestication. *Veget. Hist. Archaeobot.* 21, 131–145 (2012).
37. Kislev, M. E., Hartmann, A. & Galili, E. Archaeobotanical and archaeoentomological evidence from a well at Atlit-Yam indicates colder, more humid climate on the Israeli coast during the PPNC period. *J. Archaeol. Sci.* 31, 1301–1310 (2004).
38. Herbig, V. C., Maier, U. & Stäuble, H. „ Neolithische Füllhörner " Archäobotanische Untersuchungen in fünf linienbandkeramischen Brunnen in Westsachsen. *Offa* 69(70), 265–293 (2013).
39. Herbig, C. & Stäuble, H. Gedanken zur Herkunft der frühneolithischen Schlafmohnfunde (Papaver somniferum L.) In Mitteleuropa. In *Trees, Grasses and Crops. People and Plants in Sub-Saharan Africa and Beyond* (eds. Eichhorn, B. & Höhn, A.) vol. 37 173–186 (Frankfurter Archäologische Schriften, 2019).
40. Antolín, F. *et al.* The AgriChange project: an integrated on-site approach to agricultural and land-use change during the Neolithic in Western Europe. *Past Glob Chang Mag* 26, 26–27 (2018).
41. Antolín, F. *et al.* A new look at late Neolithic plant economy from the site of Zürich-Parkhaus Opéra (Switzerland): methods, activity areas and diet. In *Settling waterscapes in Europe. The archaeology of Neolithic & Bronze Age pile-dwellings.* (eds. Hafner, A., Dolbunova, E., Mazurkevich, A., Pranckenaite, E. & Hinz, M.) 157–172 (Open Series in Prehistoric Archaeology 1, 2020).
42. Bleicher, N., Harb, C. & Anselmetti, F. Zürich-Parkhaus Opéra. Eine neolithische Feuchtbodenfundstelle. Band 1. Befunde, Schichten und Dendroarchäologie. (2015).
43. Schneider, C. A., Rasband, W. S. & Eliceiri, K. W. NIH Image to ImageJ: 25 years of image analysis. *Nat. Methods* 9, 671–675 (2012).
44. Bonhomme, V., Picq, S., Gaucherel, C. & Claude, J. Momocs: outline analysis using R. *J. Stat. Softw.* 56, (2014).
45. Team, R. C. R: A language and environment for statistical computing. Version 4.0. 2 (Taking Off Again). *R Found Stat Comput Vienna, Austria* (2020).
46. Rohlf, F. J. & Slice, D. Extensions of the procrustes method for the optimal superimposition of landmarks. *Syst. Zool.* 39, 40 (1990).
47. Bonhomme, V. *et al.* Eco-evo-devo implications and archaeobiological perspectives of trait covariance in fruits of wild and domesticated grapevines. *PLoS ONE* 15, e0239863 (2020).
48. Bouby, L. *et al.* Bioarchaeological insights into the process of domestication of grapevine (Vitis vinifera L.) during Roman Times in Southern France. *PLoS ONE* 8, e63195 (2013).
49. Oksanen, J. *et al.* vegan: Community Ecology Package. R package version 2.5-5 (2019).
50. Paradis, E. & Schliep, K. ape 5.0: an environment for modern phylogenetics and evolutionary analyses in R. *Bioinformatics* 35, 526–528 (2019).
51. Venables, W. N. & Ripley, B. D. *Modern Applied Statistics with S-PLUS.* (Springer Science & Business Media, 2013).
52. Evin, A. *et al.* Unravelling the complexity of domestication: a case study using morphometrics and ancient DNA analyses of archaeological pigs from Romania. *Philos. Trans. R. Soc. B Biol. Sci.* 370, 20130616 (2015).
53. Evin, A. *et al.* The long and winding road: Identifying pig domestication through molar size and shape. *J. Archaeol. Sci.* 40, 735–743 (2013).

Acknowledgements

This research was funded by The Swiss National Science Foundation as part of a SNF Professorship (AgriChange Project, PI: F. Antolín), grant number: PP00P1_170515. The archaeobotanical analyses of Zurich-Parkhaus Opéra were funded by the Office for Urbanism of the City of Zürich. We thank Florian Jabbour (MNHN, Paris) for his botanical overview of the evolutionary origin and evolution of the *P. somniferum* L., Yves Pauthier from the Graineterie of the MNHN for giving us seeds of *P. somniferum* and *P. setigerum*. Also we thank the Fyssen project 'Origine et premières diffusions du pavot somnifère en Europe au Néolithique', and Lucie Martin for her comments. We thank the reviewers for their positive comments on our manuscript.

Author contributions

F.A. and L.B designed the research and share senior authorship of the paper; R.S. took all photographs; A.J. generated the data; A.J., VB and R.S. prepared the figures; A.J., R.S., S.I., A.E. performed error measurement tests and analysis; V.B. wrote the R script for the analysis and AE did the R script for the Error analysis; A.J., V.B., A.E., L.B., S.I. validated and analysed the data, F.A. provided the funding; F.A and A.S. supplied the samples. All authors contributed to the final manuscript.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-021-88964-4.

Correspondence and requests for materials should be addressed to F.A.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Chapter 7 The Archaeological story of opium poppy seeds

7.1 Introduction

Papaver setigerum/somniferum appears in archaeological sites mainly as seeds, while evidence of capsules or food preparations with poppy are rarely found. A recent overview of the earliest dates on *Papaver setigerum/somniferum* seeds with direct dating argues that poppy diffusion started in western Europe from ca. 5600 to 4000 BCE (Salavert et al., 2020). It also suggests that the western Alps had a different spread dynamic due to delay in Neolithic diffusion to mountainous areas, and it is attested ca. 5000-4800 BCE. In this chapter, first, a historical and iconographical overview was done. This section is followed by a summary of the archaeological findings of wild and possibly domestic poppy in North Europe, the West Mediterranean, and southwestern Asia. Later, a short overview is done of the findings of poppy seeds and capsules in the Agrichange area. At the end of the chapter, there is research paper 3. This paper focuses on the archaeological seeds of *Papaver setigerum/somniferum.* The aim is to determine which seeds are morphologically similar to the wild or the domestic type. This determination is built on the modern geometric morphometric model published in research paper 2.

7.2 Oldest findings of poppy

The oldest reported finding of wild poppy seeds (*Papaver setigerum*) comes from Cantabria, associated to deposits from the Upper Palaeolithic (López Sáez & Guerra-Doce, 2006), at El Juyo. Other old records are found in two Pre-Pottery Neolithic sites in Körtik Tepe, 10400-9250 BC (Rössner et al., 2018) and Attlit Yam, dating 6050–5550 BC (Kislev et al., 2004). However, the seeds were not directly radiocarbon dated, and they could be younger intrusions.

After all the examples of the possible uses of opium poppy described in Chapter 6, the allegedly oldest evidence of use for its psychoactive properties comes from chemical analysis (presence of morphine) on the bone and phytolith remains (parenchyma) from the poppy capsules in dental calculus (Juan-Tresserras & Villalba, 1999). This evidence was found in samples retrieved from the individual number 10 from Mine 28 of the Gava Mine site. This individual had two trepanations and seemed to have survived both. The authors suggested that the opium poppy was used as a sedative.

Other plant parts, such as capsules, are rarely found in archaeological sites. The oldest and most exceptional discovery was at Murciélagos cave (Andalusia, Spain), where four capsules were found under desiccated preservations conditions (Merlin, 2003, p. 298). However, complete capsules are not commonly found, even in waterlogged preservation (not properly published but in La Marmotta exist some preserved charred). In contrast, the discs/upper part of the capsules survive better and appear sporadically in waterlogged sites, such as Hornstaad Hörnle IA, Parkhaus Opera and Concise (Antolín, Brombacher, et al., 2017; Harb & Bleicher, 2016; Karg & Märkle, 2002; Maier, 2001, p. 72). The lack of these remains could be related to the bad preservation of the capsules when exposed to water - noticed by Bigna Steiner in her garden, where poppy capsules seemed more degraded than, for example, the flax capsules that were longer exposed (Figure 7.1).

Figure 7.1 Degradation of poppy capsules (Photo by Bigna Steiner)

The possible earliest evidence of opium poppy cultivation comes from La Marmota, Italy, ca. 5620-5480 cal. BCE (Salavert et al., 2020), where many capsule fragments and seeds were found (Rottoli & Castiglioni, 2009). This large number of poppy remains might indicate a particular usage and will be discussed in the last part of this chapter.

7.3 Historical documents

There is a presumption that the opium poppy is one of the plants used and written about in the ancient world (Sumerians, Babylonians, Assyrians). However, these translations are still debated (Krikorian, 1975). Several papers are written on the Sumerian ideogram of "hul gil", which is translated as the plant of joy (Brownstein, 1993) and assumed to be opium poppy. Recent papers in medicine and pharmacy refer to opium poppy being used in Mesopotamia medicine (Petrovska, 2012; Teall, 2014). However, the primary sources of these statements are solely based on old translations of Sumerian and Assyrian texts, which can be dubious. Further discussion on the translations and the use of inadequate translations can be seen in Merlin (1984, pp. 152–157). Parallel to this, opium poppy seeds were not yet found in this area.

The first clear written records of the uses of opium poppy are from Greece. The Greek word for poppy is *mḗkōn*. It usually appears associated with medicinal uses. In Greek mythology, there are different references to the opium poppy. The effect of poppy latex is attributed to the god Hypnos (Tetenyi, 1997, p. 400).

Several Greek and Roman authors refer to poppy, and its different varieties and uses. The systematic revision is not intended for this thesis. In ancient manuscripts, Hippocrates (460-377 or 355 B.C.) mentions the uses of poppy to aid sleeping, Aristotle (384-322 B.C.) considered poppy as a hypnotic drug and Theophrastus (371-287 BC) categorizes three species of poppy and also refers to the collection of the juice from the capsule. Boiling leaves and capsules of poppies as a tea helps with sleeping; this tea was described as *mekonion* in Dioskourides (first century AD) (Kritikos & Papadaki, 1967a). More details regarding the mentions of poppy use by classic authors such as Hippocrates (460-377 BC), Aristotle (384-322 BC), Theophrastus (371-287 BC), and Pliny the Elder (23/24-79) can be read in Kritikos & Papadaki (Kritikos & Papadaki, 1967a) Scarborough (1995) and in the United Nations website UNODC (Kritikos & Papadaki, 1967b).

According to Chinese written sources, the opium poppy was transported along the silk road from central Asia to China (Canton-Alvarez, 2019). Even though Tetenyi (1997) mentions that opium poppy was transported to South China during roman times, written references of poppy cultivation in China only appear during the 7th century (Canton-Alvarez, 2019; Veselovskaia, 1976, p. 9). The opium poppy was used as medicine by Buddhists and referred to by different poets during the Tang dynasty (618-907) and was only included in official medical books during the Song dynasty (960-1279) (Canton-Alvarez, 2019; Tetenyi, 1997).

In Persia, Abū Bakr Muhammad Zakariyyā Rāzī (854-925) wrote different books on medicine, where some recipes or prescriptions used opium as a pain reliever (Scarborough, 1995, p. 8; Tibi, 2006).

7.4 Art and iconography

In the Mesopotamia, depictions and iconography are other subjects of discussion, as the depictions might resemble pomegranates or poppy capsules (Merlin, 1984). Depictions of Sumerian rules appear holding a flower looking like a poppy capsule (Hnila, 2002) or could be a pomegranate or a lotus flower. In eastern Mediterranean, objects have been suggested to represent poppy capsules. An example of this object is the Cypriot Base-ring juglet with the poppy shape in Egypt, dating 1549/1550 to 1292 BC (Hnila, 2002). Another interesting object is the golden pins with the shape of a poppy capsule (Hnila, 2002). The golden pins can be seen on the website of the MET museum. Moulds of these pins were bought by the Istanbul museum and do not have any determinate chronology, but are attributed to the Hittite civilization, 1700 BCE (Blanchard, 2019, p. 75; Hnila, 2002, fig. 3).

Evidence of opium poppy use is known in the eastern Mediterranean region during the Late Bronze age (Merlin, 1984, p. 249). These findings are the juglets, pinheads in the shape of opium capsules, clay statues with poppies, amulets, necklaces, opium pipes (Merlin, 1984, pp. 249–268) and Minoan goddesses adorned with poppy capsules (Kritikos & Papadaki, 1967a). However, no such findings are present in North Europe or West Mediterranean.

In North Europe and West Mediterranean, there are abundant finds of *Papaver* seeds and no iconographic representations (Bakels, 1982; Banchieri & Rottoli, 2009; Jacomet, 2006b, 2009; Salavert, 2010, 2011). In comparison, in the eastern Mediterranean region, there has been a symbolic use of opium poppy at least since the Minoan civilization of Bronze Age Crete (2000-1500 BCE), typically associated with rulers or gods by its representation in objects. No seeds are preserved from Mesopotamian times (Askitopoulou et al., 2002; Behn, 1986; Merlin, 1984).

7.5 Evidence of oil

Lipid analysis identified oil residues from flax or/and poppy, possibly hazelnut and some brassicaceae on bone and antler tools from a Late Neolithic settlement, Zurich-Parkhaus Opéra ca. 3170 BC, in Switzerland (Spangenberg et al., 2014). The authors suggested that oil was used on bone tools to prolong their life usage. However, more studies on this subject should be done as other researchers (Jesus & Antolín, 2021; Saul et al., 2013) noted that the large evidence of *P. setigerum/somniferum* seeds indicates that they were used for culinary purposes.

Organic residues were analysed in the Late Bronze Age Cyprus juglets, 1650-1350 BC (Merrillees, 1992). Merrillees (1962) argued that the Base Ring juglet was modelled in the shape of an inverted poppy capsule to indicate that the content of the vase was opium poppy oil (Chovanec et al., 2015). The most abundant alkaloid in opium poppy is morphine which degrades quickly, but noscapine and papaverine and their derivatives proved to be relatively stable (Chovanec et al., 2012, p. 28). Using these markers as a guideline of the different compounds in modern samples and comparing them to the archaeological samples, Chovanec et al. (2015) failed to identify any association between the Base Ring juglets residue and opium. The organic residue found within the juglets contained oil of unknown origin infused with aromatic plants such as mint and others (Chovanec et al., 2012, 2015). The only positive identification of opium alkaloids comes from unstratified Base Ring juglets obtained from Egypt (Koschel, 1996; Smith et al., 2018). In the study of Chovanec et al. (2012, p. 12), they synthesized all the possible evidence of narcotic use of opium poppy in the archaeobotanical record, including several sites in the Near East. Some sites had some *Papaver* seeds in this region but were not identified to the species level. The authors also referred to pipes allegedly used for opium. However, they declare that the evidence is insufficient. Most claims of narcotic use come from interpreting botanical representations on artefacts and structures (Chovanec et al., 2012, p. 13).

7.6 Archaeological seeds in the study area

The overview of archaeobotanical data from the study area done in Chapter 4 indicates that *Papaver setigerum/somniferum* was present in all regions during the Neolithic period (5700-2300 cal. BC). There are 81 records with poppy seeds, eight from the Early Neolithic period, 39 from the Middle Neolithic period and 34 from the Late Neolithic period (Figure 7.2, Figure 7.4 and Figure 7.7). However, as explained in Chapter 3, some information was missing from the archaeological publications. In some reports, the number of poppy seeds was not explicit, and in others, no information about the volume of the sample or the type of processing. Therefore, in some cases, seed concentrations are not possible to calculate.

7.6.1 Early Neolithic (EN) Phase 1 – 5700-4500 cal. BC

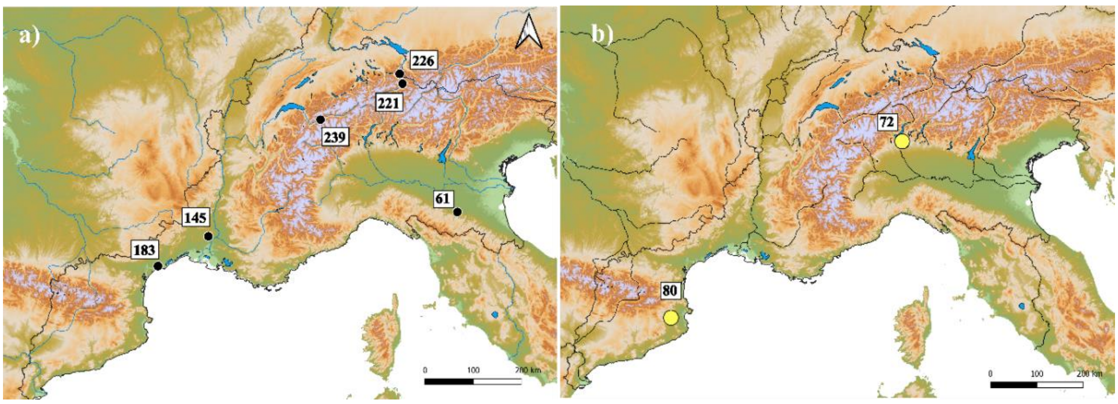

Figure 7.2 Records with poppy seeds from the study area dating from 5700 to 4500 cal. BC. a) sites with charred poppy seeds from dry sites, b) sites with uncharred poppy seeds from wet sites.

As mentioned before, *P. setigerum* is possibly the wild progenitor of *P. somniferum,* and its native area is in the western Mediterranean (Zohary et al., 2012). Poppy seeds appear first near the native area of *P. setigerum* in the Mediterranean Basin. The first site where large quantities of poppy seeds and capsules are found is in the La Marmota site (Rottoli & Castiglioni, 2009), dated to ca. 5620-5480 cal. BC (Salavert et al., 2020). These researchers (Salavert et al., 2020) noted a 300-year gap between this site and the other sites with poppy, La Draga and Taï sites dated around 5200-5000 cal. BC. The recurrent appearance of poppy seeds (*P. setigerum/ somniferum*) in the LBK sites dating 5200-5000 cal. BC in France, Belgium, and Germany attest to this seed's importance and integration within the farmers' communities (Bogaard et al., 2016; Kreuz, 2012; Kreuz et al., 2005; Salavert, 2010; Salavert et al., 2020; Van de Velde, 2007).

In the La Draga pile dwelling (Figure 7.2b), more than 5000 uncharred and charred seeds (Antolín, 2016) were found in the same record in waterlogged preservation. This corresponds to 4.8 uncharred seeds and 0.04 charred seeds per litre (Figure 7.3). The seeds were found in its oldest occupation phase, 5300-5150 cal. BC (Andreaki et al., 2020). In NE Iberia, different types of preservation of poppy remains are common.

In the Andalusia region, poppy capsules were found dried at Cueva de Los Murcielagos, Granada, according to Gorgora and Martinez (1808 in Peña-Chocarro et al., 2018, p. 378). The poppy heads were inside an esparto grass basket as a grave good near individuals buried inside the cave. The unique type of preservation, dry due to the cave environment, made it possible to be preserved since the sixth and fifth-millennium cal. BC. However, this finding is not direct radiocarbon dated, and its assumed chronology is based on the type of painted basketry (Cacho Quesada et al., 1996). From the sixth-millennium, other sites held seeds, in Cordoba, at another cave, Los Murciélagos, 500 seeds were found charred and desiccated (Peña-Chocarro et al., 2018), few seeds were as well found at Los Castillejos (Rovira, 2007) and from an inner Iberian site La Lámpara one seed was found (Stika, 2005).

In SE France (Figure 7.2a), one charred seed was found at Peiro Signado, an *impressa* site suggesting that these communities were already familiar with this plant (Bouby, Marinval, Durand, et al., 2020), and thirteen seeds were found at Tai cave ca. 5200 cal. BC, where researchers claim this plant was cultivated as the seeds were in a specific pit within a closed context (Bouby et al., 2019).

In Northern Italy (Figure 7.2a), there are two sites with poppy seeds; the first one, Spilamberto dry site, ca. 5000 cal. BC held only one seed (Gobbo, 2010). The second site (Figure 7.2b), Isolino di Varese, is a pile-dwelling, dating to c.5000-4600 cal. BC with several poppy seeds (Antolín et al., 2022; Banchieri & Rottoli, 2009; Steiner et al., n.d.). This site is currently being studied and soon to be published; therefore, this thesis does not present the most updated information on the Agrichange project.

As explained in Chapter 4, Eastern Switzerland and the Alsace (France) are influenced by the continental spread of domesticated plants by the LBK groups, and the south of Switzerland Valais was influenced by Mediterranean groups (Curdy, 2007; Jacomet, 2014) and especially from Northern Italy (Gallay, 2008).

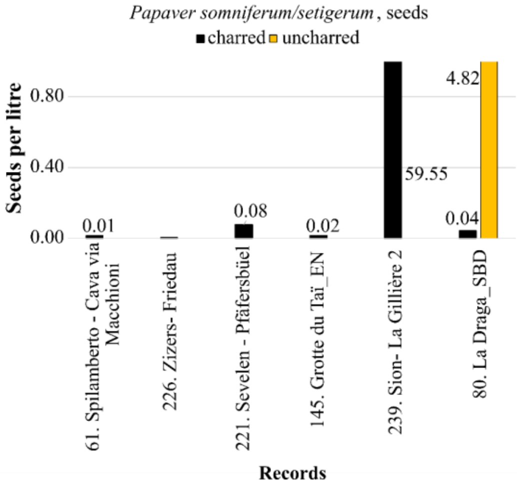

Figure 7.3 Concentration values (seeds per litre sediment) of charred poppy seeds (black colour) and uncharred seeds from waterlogged preservation (yellow colour), per record, dating the Early Neolithic period. The numbers in La Gillière 2 and La Draga columns are the values exceeding the scale.

From eastern Switzerland (Figure 7.2a), one seed of poppy was found at Zizers, in the Alpine Rhine Valley (around 4800 BC), and two seeds were found at Sevelen Pfäfersbüel, Roessen culture (Rigert, Ebneter, et al., 2005). While from the South of Switzerland, Sion-La Gillière 2, over 7000 seeds were found (Martin, 2015). In a site nearby, the Sion-Tourbillon site (Switzerland), the ceramics show similarities with the Isolino group from Northern Italy (Müller 1995 in Martin, 2015). Mediterranean species at both sites suggest a Mediterranean connection (Martin, 2015). These parts of Switzerland could be connected via exchanges with communities living in the French regions using the Rhone river, Lake Geneva, and other routes that might have existed connecting to the North of Italy or the SE France.

For phase 1, eight records with poppy seeds are present in the study area (Figure 7.2 a and b), and concentrations are found in Sion-Gillière 2 (dryland site in Switzerland) and La Draga (wetland site in NE Spain). In contrast, the other records hold few remains (Figure 7.3) due to possible taphonomic bias (Märkle & Rösch, 2008). The Sion-Gillière 2 site is exceptional, with more than 7000 seeds found in a hearth.

7.6.2 Middle Neolithic (MN) Phase 2 – 4500-3300 cal. BC

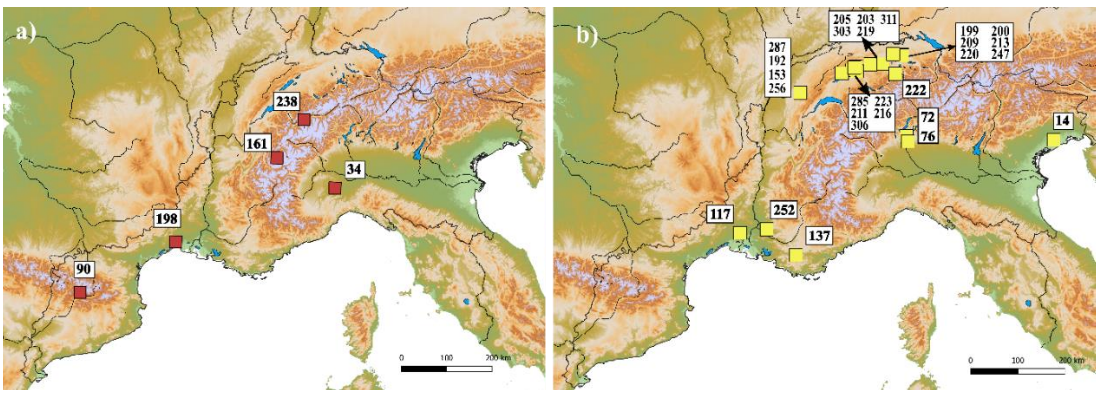

Figure 7.4 Sites with poppy seeds from the study area dating from 4500-3300 cal. BC. a) sites with charred poppy seeds from dry sites, b) uncharred poppy seeds from wetland sites and three dry sites with wells.

Poppy seeds are identified in more sites than in the previous phase (Figure 7.4) for more details on the different types of sites and crops present, see Chapter 4. Poppy seeds are found north of the NE Iberia, in the Pyrenees at Camp del Colomer, an open-air site with ten seeds (4500-4200 cal. BC) and Cueva del Toro (Buxó, 1997). No wetland site was found in this region. Another site mentioned before was Gava mines with indirect evidence of poppy. The chemical analysis at Gava mines indicates the presence of morphine on the human bone and allegedly provided the oldest evidence of the use of opium poppy indirectly dated around 3870-3365 cal. BC (Juan-Tresserras & Villalba, 1999).

In SE France, a habitat in the interior valleys of the Northern French Alps, Le Chenet des Pierres (Martin et al., 2008) held 421 poppy seeds (two seeds per litre, Figure 7.5), and from the Chassey site Zac Saint-Antoine only one charred seed was found (Sendra et al., 2011). The site Le Chenet des Pierres (Martin et al., 2008) had clear evidence of influence from Northern Italy and Rhone Valley in SE France, where pottery styles of "VBQ" (Square Mouthed Vases) and Saint Uze were among the findings at the site (Martin, 2010, p. 98). Uncharred poppy seeds (Figure 7.4b and Figure 7.5b) are found at Clairvaux's pile dwellings (Neveu & Zech-Matterne, 2016; Schaal & Pétrequin, 2016) and at open air dry sites with wells, Les Bagnoles, Mas Vignoles IX and Clos de Roque (Figueiral & Séjalon, 2014; Jesus, Prats, et al., 2021; Martin, 2012). The concentration values of poppy seeds on the wells are small, less than six seeds per litre (Figure 7.5b).

In Northern Italy, uncharred seeds are found at the pile dwelling of Lagozza di Besnate, Palu Livenza and charred seeds at Castello d'Annone. However, only the presence of the seeds is published; therefore, no precise number can be assessed (Motella de Carlo, 2014; Rottoli & Castiglioni, 2009).

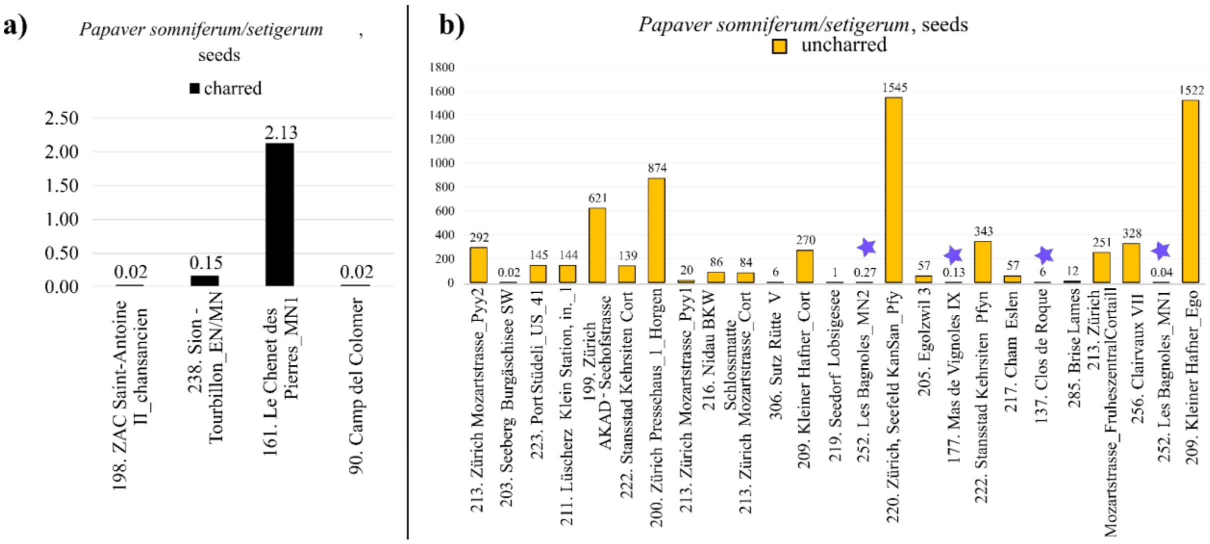

Figure 7.5 Concentration values (seeds per litre sediment) of charred poppy seeds (a) black colour) and uncharred seeds from waterlogged preservation (b) yellow colour), per record dating the Middle Neolithic period. Purple stars indicate seeds found within wells.

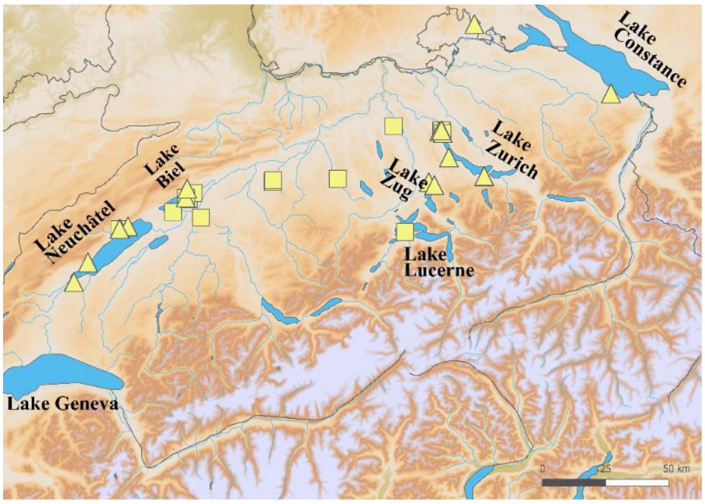

Figure 7.6 Map of Switzerland with wetland sites that held poppy seeds from the Middle (yellow squares) and Late Neolithic (yellow triangles) with the names of the most important lakes.

In South Switzerland, at Valais, charred poppy seeds appear in less quantity; only six seeds have been found at the Tourbillon site (Martin, 2015). Sites with poppy seeds appear for the first time in the Swiss Plateau, mainly at the edges of Lakes such as Neuchâtel, Biel, Lucerne, Zug and Zurich, related to pile-dwellings (Figure 7.6). It was also found, in smaller lakes that are not visible on the map, Figure 7.6, such as Lobsigensee and Burgäschisee. Large quantities of poppy seeds were found in these sites, with over 10000 at Stansstad-Kehrsiten, Lake Lucerne, Zurich-Mozartstrasse, Zurich-AKAD and Zurich-KANSAN sites in Lake Zurich and at Gachnang-Niederwil site in Egel lake (for detail bibliographic check Appendix A: List of all sites with archaeobotanical data). High densities of 100 per litre seeds were observed in several pile-dwellings (Jacomet & Steiner, n.d.), which can also be seen in the bar chart in Figure 7.5b) No storage was found; however, Zurich-AKAD seeds might have been within vases (Jacomet et al., 1989, p. 116).

In a pile-dwelling in South Germany, in the Lake Constance, near Switzerland, burnt seeds and the upper part of the capsules (disc and stigmatic rays) of poppy are accumulated in one burnt layer (Layer AH2) at Hornstaad Hörnle IA (Maier, 2001, p. 72). These findings might indicate that the plants or the capsules were stored inside the houses. Indirect evidence of using poppy seeds as food is also known from this site from human faeces (Maier, 2001, p. 144).
Very few charred remains were found in the Middle Neolithic in the Mediterranean area. No seeds were retrieved from caves. The spatial distribution from the findings of these tiny seeds also includes inland sides, inner alpine valleys and high altitudes (Figure 7.4).

7.6.3 Late Neolithic (LN) Phase 3 – 3300-2300 cal. BC

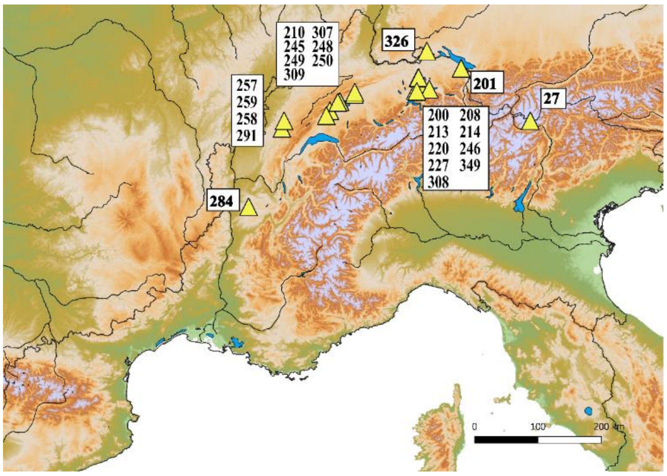

Figure 7.7 Sites with poppy seeds from the study area dating from 3300-2300 cal. BC only sites with uncharred poppy seeds from wet sites.

During the Late Neolithic period, poppy seeds were only present in wet sites and one undefined site, the frozen mummy site of Ötzi (Figure 7.7). In SE France, there are some pile-dwellings with large quantities of poppy seeds at lake Clairvaux and Chalain (Baudais et al., 1997; Lundström-Baudais, 2010; Schaal, 2000; Schoch, 1989).

In the Swiss Plateau, thousands of seeds appear mainly at the edges of Lakes such as Neuchâtel, Biel, Zug, Zurich and Constance, related to pile-dwellings (Figure 7.6 and Figure 7.7). For these sites, large quantities of poppy were found, with over 10000 at Zug-Riedmatt, in Lake Zug, at Zurich-Mozartstrasse, Zurich-Kansan, Zurich-Horgen-Scheller and Zurich-ParkHaus Opera sites in Lake Zurich, at Arbon Bleiche 3 site in Constance lake and Lattringen at Biel lake (for detail bibliographic check Appendix A: List of all sites with archaeobotanical data). High densities of 1000 seeds per litre were observed in the archaeobotanical results from the pile-dwellings (Antolín, Brombacher, et al., 2017, p. 84) and can be seen in Figure 7.8. Jacomet (2006b, p. 80) noted that poppy seeds were found in larger quantities in Horgen sites than in previous Pfyn sites and later Corded Ware settlements. Even though the Late Neolithic was not divided into local periodization in this study, it is still possible to see at the record level in Figure 7.8 that sites with Horgen names have larger values than “Schunr” names (Corded Ware culture = german Schnurkeramik).

Fragments of poppy capsules are found at Zurich-Parkhaus Opera layer 13 (around 3150 cal. BC) and Concise-sous-Colachoz site (Canton of Vaud, western Switzerland), suggesting that poppy was processed within the settlement (Antolín, Brombacher, et al., 2017; Bleicher & Harb, 2015; Harb & Bleicher, 2016; Karg & Märkle, 2002). At Zurich-Parkhaus Opera, it was suggested that poppy oil was used for tool maintenance as some bone tools had oil residues (Spangenberg et al., 2014). Indirect evidence comes from Saint Blaise-Bains des Dames 4, where Mermod (2000, 2007) suggested that poppy seeds were processed for oil based on their highly fragmented state.

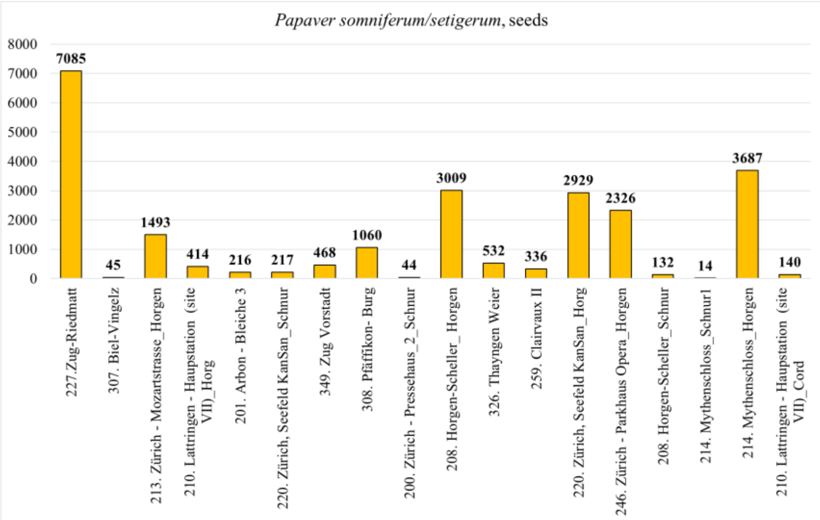

Figure 7.8 Concentration values (seeds per litre sediment) of uncharred poppy seeds from waterlogged preservation, per record, dating from the Late Neolithic period (3300-2300 cal. BC).

Close to the study area, in Southwest Germany, at Buchau-Torwiesen II pile-dwelling, there are clear clusters of poppy seeds with large accumulations inside houses 1, 3, 10 and 11 and concentrations in buildings 5, 10 and 12 (Maier & Harwath, 2011, p. 355). The authors also refer to the accumulations near house 3, near the street, where there is evidence of poppy processing. Within the houses around the hearths, charred opium poppy is found, indicating that it was used for cooking.

For Phase 3, poppy seeds only occurred in wetland sites and in terms of regions, they did not appear in NE Iberia (Figure 7.7). As described above, accumulations of seeds and evidence of processing for food or oil are suggested in several pile-dwellings. There is clear evidence of human consumption of poppy seeds in this phase, and the seeds were probably stored within the houses. However, these findings are only apparent in pile-dwellings and cannot be assessed in other regions where only dryland sites are present. It could be only a matter of taphonomic preservation (Märkle & Rösch, 2008), or poppy had lost its importance in other regions.

7.7 The role of poppy seeds in the Neolithic period

The importance of poppy seeds can be assessed by looking at the type of sites throughout all databases and phases (Figure 7.2, Figure 7.4 and Figure 7.7). Poppy seeds were found in all types of sites in the first phase, while for the second and third phases, there was no evidence from cave sites, and by the third phase, there were no seeds from the dry sites. The number of dry sites was always superior to the open wet sites (Figure 4.1 and Table 4.2), including in the last phase with more than 90 dryland and 40 wetland records. In this chapter, specific poppy contexts were described to evaluate in which context these tiny seeds were found. There is no evidence until now that poppy seeds had any ritual or funeral connotation, even though in the study area, funerary sites with archaeobotanical studies are rare (Anastasiu & Langenegger, 2010; Castiglioni & Tecchiati, 2005).

Nonetheless, as mentioned, it could be a taphonomic issue related to its large composition being oil and being easily destroyed by fire (Märkle & Rösch, 2008). Therefore, the presence of tiny poppy seeds might be related to the seeds not being in close contact with fire or where burned in large quantities, and only a few survive. Another reason for the absence of this tiny seed is that it requires adequate sampling and processing with a small mesh size.

Throughout the Neolithic period in the study area, evidence of poppy seeds suggests it has been used for food, and its oil might have also been used for tool maintenance. No evidence of medicinal or ritual use of opium poppy has been found. In the study area's few burials and burnt offerings with archaeobotanical remains, hazelnut was the predominant plant. It was present at Aux Courbes Rayes burial site (Anastasiu & Langenegger, 2010). In later periods of the Bronze and Iron age (Außerlechner, 2021), in Eastern Alps, hazelnut, emmer and barley were some of the main plants used for burnt offering rituals (Außerlechner, 2021; Heiss, 2014), and flax seeds appear at a Chalcolithic site, but poppy seeds were only found as a burnt offering during the Iron age. Nevertheless, oil plants, such as opium poppy, have less chance of carbonization (Märkle & Rösch, 2008) and a much lesser chance of surviving intentional burnt offerings (Heiss, 2014, p. 352).

In summary, plants played a central role in people's day-to-day lives. During the Neolithic period, new types of plants started being cultivated in the study area; consequently, prehistoric communities started a new relationship with their environment. In high-density numbers during the Late Neolithic period, poppy seeds are present in almost all pile-dwellings, mainly from Switzerland (Figure 7.8). The role of the *P. setigerum/somniferum* seeds found in these periods was associated with food and oil. Although the use of the poppy as a burnt offering was present only later in Iron Age in the Alpine region (Außerlechner, 2021; Heiss, 2014), it could be that this association with mortuary and ritual practices started early, but no evidence can be found as the seeds would be quickly destroyed due to its fragile seed structure and high temperatures (Märkle & Rösch, 2008). No clear evidence of its use as medicine was found.

The poppy plant might have had different importance depending on where it was available and the cultural environment it was found and used. Examples of poppy capsules' representations in iconography are not known from NW Mediterranean or Central Europe but from the eastern Mediterranean. In Eastern Mediterranean, several iconography objects suggest poppy was used as a symbolic representation usually associated with rulers or goods at least since the Minoan civilisation of Bronze Age Crete (2000-1500 BCE), as discussed in this chapter, section 7.4.

7.8 Research paper 3

In Paper 3, the modern LDA model created in the previous paper (Jesus, Bonhomme, et al., 2021) was applied to archaeological poppy seeds from 10 wetland sites dating between 5300 and 800 cal. BC. The protocol and statistical analyses were grounded in the first paper, and now the focus is on archaeological seeds and their morphological change through space and time.

Version: will be submitted to PLOS One journal

Note: Please use the final published version to cite this publication.

First spread, then domestication? Morphometrics of archaeological seeds suggests a pathway of domestication of *Papaver somniferum* L. in the Western Mediterranean

Ana Jesus[1], Vincent Bonhomme[2], Allowen Evin[2], Raül Soteras[1,3], Stefanie Jacomet[1], Laurent Bouby[2 *], Ferran Antolín[1,3 *]

[1]Universität Basel, Integrative Prehistory and Archaeological Science (IPAS), Basel, Switzerland
anaclaudiasousajesus6@gmail.com , ferran.antolin@unibas.ch
[2]ISEM, University of Montpellier-CNRS-IRD-EPHE, Montpellier, France
laurent.bouby@umontpellier.fr, bonhomme.vincent@gmail.com , allowen.evin@umontpellier.fr,
[3]Division of Natural Sciences, German Archaeological Institute, Berlin, Germany,
ferran.antolin@dainst.de, www.raulsoteras.com
*These authors share senior authorship of the paper

Abstract

Domesticated opium poppy *Papaver somniferum* L. subsp. *somniferum* probably originated in the Western Mediterranean and spread to other European regions. Seeds of opium poppy have been identified in this area since the Early Neolithic period. However, until recently, the absence of morphological identification criteria has prevented the discrimination between wild and domestic morphotypes. New morphometric approaches to distinguish modern subspecies have been proven to be applicable to waterlogged archaeological remains, opening the possibility of understanding the process of domestication of the plant in both time and space.

This paper applies seed outline analyses, namely elliptic Fourier transforms, combined with size and number of seed cells to archaeological waterlogged *Papaver* seeds throughout the Neolithic period and the Late Bronze Age in the NW Mediterranean and the Northern Alpine Foreland. This study aims to classify the archaeological seeds as domestic or wild morphotypes and observe morphometric changes in connection to geographical and chronological patterns that can explain the spread and domestication process(es) of this important crop. A total of 295 archaeological seeds coming from 10 waterlogged sites dating between 5300 and 1070 cal. BC were analysed.

The results indicate the presence of seeds similar to the wild morphotype in the Mediterranean sites and larger seeds similar to the domestic morphotype in the regions surrounding the Alps. The number of cells mainly increased during the Late Neolithic (3300 to 2300 cal. BC) and, finally, in the Late Bronze Age (ca. 1050 – 800 cal. BC), larger, domesticated seeds are clearly predominant. The shape of seeds only changes in the Late Bronze Age. Altogether our results suggest that opium poppy seeds show no sign of domestication in the early periods of the Neolithic, despite the fact that the plant was very probably already cultivated at that time in the western Mediterranean region.

Introduction

Plant domestication in Southwest Asia and Europe has been approached by archaeobotanists through a variety of techniques, including seed size [1,2], the proportion of botanical macroremains presenting domestication traits [3,4] and, more recently, seed shape analysis [5,6]. This has led to different narratives on the pathways of domestication of different old crops [7] but the datasets still remain scarce due to preservation issues and often inconclusive due to the insufficient diagnostic traits. In addition, the domestication process is complex and researchers are only starting to grasp it. Among the limitations of these studies one could highlight the sole possibility of analysis of charred material, which is always a biased representation of past plant populations (especially of oil crops) and hence limits the availability of representative material [8]. A second limitation is the long time-span that exists between the establishment of a broad-spectrum economy amongst the last hunter-gatherers (and the beginning of a long co-evolutionary process with plants and animals that would end in some domestication events) and the development of agriculture (a necessary step in plant domestication). The domestication process in this sense was clearly human-driven but not deliberate from the beginning and hence difficult to trace [9]. Secondary domestication centres (where new plants species were domesticated once the societies became agricultural) [10] may offer the possibility of documenting domestication processes over shorter periods of time, since they do not run in parallel to the development of agricultural practices, which are already known to the society. Our case study is opium poppy (*Papaver somniferum* subsp. *somniferum* L., further abbreviated as *P. somniferum*), a plant that could have been domesticated in Western Europe after the arrival of the first farming populations [11,12]. The seeds of opium poppy are very well documented in, among other sites, lakeshore settlements with excellent preservation conditions (waterlogged) that allow working with uncharred subfossil seeds whose size and shape remain much closer to the original than the carbonized seeds.

Currently, the largest producer of opium poppy is Afghanistan, with 6.000 tons of opium and 250.00 hectares cultivated [13]. The Czech Republic, France and Russia are also important producers [13]. The opium poppy is nowadays mainly used for its medicinal, alimentary and decorative purposes [14]. In the past, opium poppy might have been collected for its seeds, which are rich in fibre, healthy fats and several micronutrients such as manganese, copper and iron [15,16]. Despite its current and past economic importance, opium poppy domestication has been challenging to approach archaeologically. Most researchers convey that the domestication occurred or was initiated during the Neolithic period in Western Europe [12,17–19], making it the only plant known to have been domesticated in Europe during the Neolithic.

Domestication refers to genetic, morphological and physiological changes in plants and animals [20]. Pre-domestication cultivation refers to the continuous management of wild progenitors (planting, harvesting and storing) and soil preparation by land clearance and tillage; these practices reflect as well on the evolution of larger seeds and reduction of the dispersal aids [20]. The main domestication traits of poppy are the increase in the size of the capsules and seeds and the indehiscence of the capsule [11]. A rare finding of complete capsules of opium poppy is known from pictures of material (currently lost) from Murciélagos cave in Spain [21–23], presumably dating to the Late Neolithic period. Whole capsules are almost never preserved in archaeological sites (e.g. lid-parts were found uncharred in the Late Neolithic sites such as Zurich-Parkhaus Opera [24] and in charred state in a burnt layer (AH2) of Hornstaad Hörle IA site [25]). Therefore, only two options are available to study the domestication and spread of this species: seed size and geographic spread. The latter refers to the spread of the plant (evidenced by seed finds) beyond its native area and therefore a sign that it might have been cultivated. The domestication centre of origin of *P. somniferum* has been assumed to be in the Western Mediterranean area where the putative wild progenitor, *Papaver somniferum subsp. setigerum* (DC.) Corb. (from now on *P. setigerum)*, would have naturally grown without human intervention [11,17,18,26].

In the archaeological record, the seeds are the most common remains of this plant, preserved charred in dryland or mostly uncharred in waterlogged environments. Unfortunately, they are usually found in very small amounts in dryland sites because of the bad survival chances of the oil rich seeds when exposed to heat, and their extreme fragility when preserved in a charred state. In addition to this, the seeds are tiny (<1mm length) and require adequate sampling and very gentle sieving (the so-called "wash-over" method sensu Kenward et al. [27]) with a small-sized mesh. Large seed numbers are almost exclusively known from wetland sites, where uncharred (waterlogged) seeds (and rarely capsule fragments, mostly lid parts see above) are usually preserved in higher numbers (for numbers of finds, see e.g. [28]). Therefore, it is uncertain to which extent taphonomy has played an important role in the reconstruction of opium poppy history (i.e. it could have been present in other regions and gone unnoticed).

The archaeological *P. somniferum* might correspond to three current subspecies. These are *P. setigerum*, the putative wild ancestor, and two domestic subspecies, *Papaver somniferum* subsp. *somniferum* and *Papaver somniferum* var. *nigrum* [11,29]. The *Papaver somniferum*/*setigerum* seeds reported in the archaeological record are, so far, not identified to subspecies/status level (i.e. at the wild/domesticated level) due to the lack of discriminating criteria [30,31], since all three taxa are very close in both size and shape. *P. setigerum* is native to the Western Mediterranean area, and for this reason, it is assumed that the plant must have been first collected and cultivated in this area [11,26]. It is assumed that the wild progenitor of opium poppy would have had the same biochemical characteristics but with a lower proportion of the morphine alkaloid [32]. Therefore, Neolithic communities might have started to gather or cultivate the plant for its nutritional value, including the production of oil [33], and one could speculate that only later (yet possibly during the Neolithic), the plant could have developed higher alkaloid quantities under domestication. In Central Switzerland, at Zurich-Parkhaus Opéra, layer 13 (around 3150 cal. BC) bone tools had oil residues coming from flax and poppy, hazelnut and Brassicaceae, and it was suggested that the oil served as tool surface treatment to prolong their lifespan [34].

Archaeological evidence shows that seeds of *P. setigerum* could have been gathered from the wild already during the Palaeolithic time, as suggested in El Juyo, in Cantabria, with seeds attributed (without direct dating) to the Upper Palaeolithic [35]. Other questionable early records are reported in two Pre-Pottery Neolithic sites in Körtik Tepe, with deposits dated to 10400-9250 BC [36] - but these seem to be the only finds of this crop in Turkey up to the Medieval period [37]. There are also some waterlogged finds in a PPN-well outside the Israeli coast at Atlit Yam, probably dating to 6050-5550 BC [38]. However, the seeds were not directly radiocarbon-dated and could be younger intrusions as shown in e.g. [39] for Mesolithic layers in Europe. Most of the early evidence of poppy is actually found in Western Europe during the Early Neolithic. La Marmota (central Italy) is the earliest site that holds charred poppy capsules and seeds directly dated to ca. 5620-5480 cal. BC [12,40]. One charred poppy seed was found in the similarly old deposits of Peiro Signado, 5960–5720 cal. BC, in Southern France [41], but it was not directly dated. In La Draga, a pile dwelling in the northeast of the Iberian Peninsula, more than 5000 waterlogged and charred seeds were found within layer VII [42], its oldest occupation phase is dated to, 5300-5150 cal. BC [43]. In the Taï cave in Southern France, 13 charred seeds of poppy were found in one pit, dated to 5270-4990 cal. BC, confirmed by direct dating of the poppy seeds [12,44]; they were found in close proximity to cereal grains suggesting an anthropogenic origin and, therefore, it is probable, that the seeds come from plants which were cultivated [44]. Other Early Neolithic sites with few confirmed poppy seeds are La Lámpara (5300-5000 cal. BC), Cueva de Los Murciélagos (5300-5000 cal. BC) and Los Castillejos (5300-5000 cal. BC) in Spain [45–48]. Direct dating of the seeds of Los Castillejos revealed that they probably belonged to younger phases documented at the site [12], which makes it clear that undated sparse finds cannot be trusted to reconstruct the history of this crop. Similar observations have been made for sparse cereal finds in Mesolithic contexts [39]. In Valais, in southern Switzerland, the La Gillière site dating from 4980 to 4730 cal. BC had more than 7000 charred seeds within a hearth, pointing to an extensive use of poppy seeds [49].

In contrast to Early Neolithic, only very few charred remains were found in the Mediterranean area (incl. adjacent regions) in sites from the Middle and Late Neolithic (from 4500 to 2300 cal. BC). In NE Iberia, at Can Sadurní (northeast of the Iberian Peninsula), there are some undated charred seeds [50], and there is also indirect evidence of the use of poppy at the nearby site of the Gavà mines. Biochemical analysis indicating the presence of morphine on the human bone of an individual with two trepanations, as well as phytolith remains (parenchyma) from the poppy capsules in dental calculus, allegedly provide the oldest evidence of the consumption of opium poppy for sedative purposes, undirectly dated, around 3870-3365 cal. BC [51]. In SE France, seeds were preserved in waterlogged conditions, in some wells within dryland sites, at Les Bagnoles, Clos de Roque and Mas de Vignoles IX, dating between 4200 and 3090 cal. BC [52–54]. Chenet de Pierres (4338–4050 cal. BC), a dryland site located at a higher altitude (940 m asl) in the French Alps, also yielded poppy seeds alongside pottery of "VBQ" (Square Mouthed Vases) and Saint Uze ceramic styles (ca. 4500-4000 cal. BC) that attest influences from Northern Italy (in the east) and the Rhone valley (in the southwest) in the alpine regions of south-eastern France [55]. In Andorra, in the Pyrenees, the site of Camp del Colomer provided the evidence of opium poppy at the highest altitude (ca. 1350 m asl) in the region, associated with contexts dating ca. 4500-4000 cal. BC, and interpreted as cultivated [42].

In contrast to the Mediterranean Middle and Late Neolithic period, from 4300 cal. BC onwards, poppy is frequent in the “pile-dwelling” settlements of Northern Alpine Foreland, mostly in extreme high numbers and almost exclusively in well preserved waterlogged state. Particularly around 3000 cal. BC in settlements of the so called “Horgen” culture, they are documented in all sites. From around 2700 cal. BC onwards, poppy becomes more rare, and from the Bell Beaker period (around 2400-2300 BC ca) and the Early Bronze Age there are few sites with poppy and only in small quantities [28,56–60].

This state of the art opens many questions regarding the status of poppy in the Mediterranean area, its role after the Early Neolithic and whether opium poppy was already domesticated when it arrived to the Northern Alpine Foreland and if it arrived directly from the Mediterranean area there. Since there are only a few sites with waterlogged poppy seeds from the Middle Neolithic and none for the Late Neolithic period in the Mediterranean area it is not possible to assess if the species was domesticated or not.

In order to answer this question, a methodology to distinguish opium poppy seeds from several wild species of the genus *Papaver* was first established [61]. Discriminant analyses on morphological variables (shape, size and number of cells) showed rather good accuracy (over 70%) at classifying between modern species, including *P. somniferum* from *P. setigerum*. This method was also successfully applied to non-charred archaeological seeds, with the example of Zurich-Parkhaus Opéra layer 13 (Switzerland, dated to ca. cal. 3150 BC [62]), where the results suggested that the domestication of the plant might be ongoing during the Late Neolithic in the area [61]. In the same study, we underlined the need for additional analyses, particularly in the Mediterranean area and of more recent sites, to reach a better understanding of the timing and geographic origin of the spread and domestication of the opium poppy in Western Europe.

Here, we applied the same methodology to archaeological seeds from a selection of Prehistoric sites in the NW Mediterranean and the fringes of the Alps, including the Northern Alpine foreland, in order to address three questions:

1) Is there any relation between the changes in size and shape of the seeds and their chronology? Can we detect diachronic size and shape changes?
2) Can we establish connections between archaeological seeds found in sites from the Mediterranean area and the seeds found in the Alpine area? Furthermore, what does this tell us about the process of domestication and diffusion of opium poppy outside of the Mediterranean area?
3) Can we identify domestic *Papaver somniferum* seeds in the Neolithic archaeological assemblages and in which proportion?

Material and Methods

The modern reference collection consisted of 270 seeds belonging to seven *Papaver* taxa, 30 seeds per taxon (for details, see [61]). A total of 295 perfectly preserved waterlogged seeds from ten archaeological sites (Table 1 and Fig. 1), dating from the Early Neolithic until the Late Bronze Age (5150-1075 cal. BC), were investigated. In order to facilitate comparisons between sites, these have been grouped into six broad phases following the chronology of the Agrichange project [63]. This chronology defines the Early Neolithic (EN) from 5700 to 4500 cal. BC, Middle Neolithic (MN) from 4500 to 3300 cal. BC and Late Neolithic (LN) from 3300 to 2300 cal. BC. For the period of ca. 1050-800 cal. BC, we use the term Late Bronze Age (LBA). The Middle Neolithic period was divided into two sub-periods Middle Neolithic 1 (MN1) 4500–4000 cal. BC and Middle Neolithic 2 (MN2) 4100–3300 cal. BC. The archaeological seeds analysed in this study come from nine wetland sites and one dryland site, Les Bagnoles, with three wells with waterlogged deposits (Fig. 1). The wetland sites are all prehistoric settlements with wooden houses on the shores of lakes or islands in lakes, known as pile-dwellings [64]. All seeds are uncharred and preserved in a waterlogged state (S1). Two sites are located in the Mediterranean area (La Draga, Spain and Les Bagnoles, France), Isolino di Varese, Northern Italy, lies at the southern fringe of the Alps, and the remaining sites lie in the Northern alpine foreland, in current Switzerland (Fig. 1).

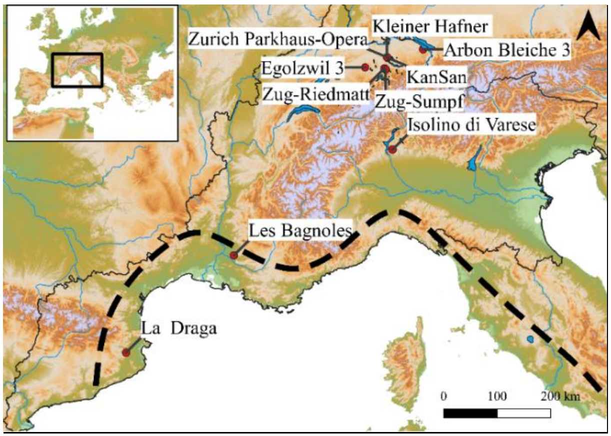

Figure 1 Neolithic and Bronze age sites (5300 to 1070 cal. BC) with uncharred poppy seeds analysed in this paper. Early Neolithic Sites (5300-4500 BC): La Draga and Isolino di Varese 1; Middle Neolithic 1 sites (4500-4000 BC): Egolzwil 3; Isolino di Varese 2; Zürich-Kleiner Hafner and Bagnoles 1; Middle Neolithic 2 sites (4000-3300 BC): Zürich-KanSan and Les Bagnoles 2; Late Neolithic sites (3300-2300 BC): Arbon Bleiche 3; Zug-Riedmatt, Zurich-Parkhaus Opéra; Late Bronze Age site: Zug-Sumpf. Native area of wild poppy delimited south of the dashed line. (Software: QGIS QGIS3.12.3, © European Union, Copernicus Land Monitoring Service [2016], European Environment Agency (EEA))

Samples were obtained from well-dated archaeological contexts (either by dendrochronology or radiocarbon dating and in one case by typology, see Table 1) and covered different temporal, geographical and environmental conditions that could be related to poppy diffusion. This selection allowed us to assess seed size and shape changes according to time and space. For the study, we only selected perfectly preserved, uncharred (waterlogged) archaeological seeds. This type of preservation retains all seeds characteristics, such as the cells and the soft yellow parts of the hilum. Scientific plant nomenclature and classifications were discussed in the previous paper [61] and follows [11,29].

Table 1 List of sites analysed in this paper, with their ID number, location, dates, number of seeds and preservation, organised by chronology (EN Early Neolithic; MN1 Middle Neolithic 1; Middle Neolithic 2, LN Late Neolithic and LBA – Late Bronze Age), for more details check S1.

Site	ID number	Localisation	Date (Median)	Number of seeds	Preservation	Period	Dated by	Bibliography
La Draga	80	NE Spain	5150	24	waterlogged	EN	^{14}C[43]	[42]
Isolino di Varese 1	72	Northern Italy	4900	21	waterlogged	EN	^{14}C [65 submitted]	[66]
Bagnoles 1, well 250	252	SE France	4150	7	waterlogged	MN1	^{14}C [67]	[68]
Isolino di Varese 2	72	Northern Italy	4150	21	waterlogged	MN1	^{14}C [65 submitted]	[66]
Egolzwil 3	205	Central Switzerland	4150	30	waterlogged	MN1	dendro-dated [69]	[70]
Zürich Kleiner Hafner layer 5	209	Central Switzerland	4150	30	waterlogged	MN1	dendro-dated [56]	[71]
Bagnoles 2, wells 990-994	252	SE France	3915	9	waterlogged	MN2	^{14}C (Martínez-Grau et al., 2020)	[68]
Zürich Kansan layer 9	220	Central Switzerland	3800	30	waterlogged	MN2	dendro-dated [72]	[73]
Arbon Bleiche 3	201	Eastern Switzerland	3375	30	waterlogged	LN	dendro-dated [74]	[75, 76]
Zug Riedmatt	227	Central Switzerland	3175	30	waterlogged	LN	Typologically dated	[77]
Zurich-Parkhaus Opéra layer 13	246	Central Switzerland	3150	33	waterlogged	LN	dendro-dated [62]	[62, 78]
Zug Sumpf	400	Central Switzerland	1075	30	waterlogged	LBA	dendro-dated ^{14}C [79]	[74, 76]

Archaeological data collection

Only seeds identified as opium poppy, *Papaver somniferum/setigerum*, were selected. Archaeobotanists made this identification based on the appearance of cell patterns, which shows the unique characteristic feature of being areolate-reticulate compared to the other taxa present in the modern reference material. The archaeological seeds were first removed from the conserving agent (a mix of thymol, ethanol, glycerine and water), cleaned with distilled water and then partially dried with an optical cloth (Hama Lens cleaning tissue). This process was necessary to prevent light reflection due to the water and the optical cloth not leaving fibres or traces on the seeds. Finally, the dried seeds were easier to position allowing to take more standardised photographs and to reduce parallax error.

All archaeological seeds' lateral view was photographed using a Leica Z16 APO Binocular Stereo Microscope with a digital camera Leica DFC 420 and the Leica Application Suite software (LAS 4.0, Leica®). The photo background and the yellow soft tissue on the hilum were removed manually using Photoshop 6 (Adobe®). A black mask was created using Photoshop, and the (x; y) coordinates of five landmarks [see 61] were recorded using ImageJ [83]. The seed size (length and width of the bounding box) was recorded using the rectangular tool in ImageJ. The length and width of the seeds were log-transformed [84,85]. The number of cells visible on the pictures was counted using the multi-point tool in Image J.

<u>Outline analysis</u>

The shape of all 295 archaeological seeds was described with outline analyses using elliptical Fourier transforms (EFT) [86] following the protocol developed in [61]. The (x; y) coordinates of the outline were obtained with the Momocs 1.3.0 [87] package in an R 4.0.0 environment [88]. Landmark n°2 was used as the initial point for each outline that corresponds to 360 points equally spaced points. The outlines were normalised for their position, size and orientation using full generalised Procrustes alignment of the landmarks [89]. The elliptic Fourier transform method consists of decomposing the outlines into a harmonic series of trigonometric functions, called harmonics, associated with coefficients [87], further used as quantitative shape variables.

<u>Morphometrics</u>

First, we analysed each category of morphometric descriptor separately: the overall distributions of seed lengths, widths, cell number values and shape were displayed using boxplots divided per period and Wilcoxon's tests were performed to test for differences between periods, sites and regions. Alpha significance level was chosen to 10^{-3}.

Boxplots were used to visualise differences between regions as regards the four descriptors (length, width, cell number and shape). Then, a new boxplot was plotted to visualise changes in seed length through time, with seed length of the sites in the y axis and their corresponding dates in the x axis. Finally, a chronological graph with the variations in length, width and number of cells through time was done.

A Principal Component Analysis (PCA) was performed on the matrix of EFT coefficients to explore shape variability. Shape variability was illustrated using boxplots showing the distribution of the scores of the seeds on the first three PCA components, which together captured 90 % of total shape variability. Shape differences between periods are mainly captured on PC3 (as seen in Fig. 2). Therefore, the three first principal components were used in on the shape analysis.

A second PCA was used to explore the overall variability of the form (size + shape) of archaeological seeds using a combination of all morphometric descriptors (length, width, the number of cells and shape coefficients). Finally, a hierarchical clustering using UPGMA on the euclidean distance matrix between PC1:3 scores and all morphometric descriptors averaged per site is presented as an unrooted tree obtained with the package ape [90].

Each archaeological seed was classified using the linear discriminant analyses (LDA) trained on the modern material [61] and using all descriptors (length, width, number of cells and shape). To cope with the unbalanced sample size in this reference collection, we used 100 permutations [61,91], sampling in each group as much seeds as in the smallest group. For each seed, the majority classification obtained along these 100 permutations was retained. The archaeological seeds were first classified into a model including all seven *Papaver* species (LDA 1), then into a model based only on the three *P. somniferum* subspecies*: P. nigrum*, *P. setigerum* and *P. somniferum* (LDA 2), and the last LDA 3, only with *P. setigerum* and *P. somniferum.* The accuracies presented are the percentages of specimens classified into the right group. The percentages calculated for each site were represented as scatter pies on a map, to visualise spatial variation and QGIS software version 3.12.3 [92]. Improvements such as increasing the visibility of words and labelling were made using Inkscape [93].

Results

<u>Results per period</u>

The distributions of length, width, cell numbers, and shape (first 3 Principal Components (PC) representing 90 % of variance) values show a slow change from the Early Neolithic to the Late Bronze (Fig. 2). Wilcoxon rank tests indicate that seed assemblages of different periods usually differ from one another regarding length and width, with the few exceptions of neighbouring periods such as no differences ($P>10^{-3}$), between the seeds of the Early Neolithic and Middle Neolithic 1, and Middle Neolithic 1 and Middle Neolithic 2 (S3). Differences, $P<10^{-3}$, in the number of cells mainly concern Middle Neolithic 2, Late Neolithic and Late Bronze periods. Changes in shape are smaller and only significant, $P<10^{-3}$, between Late Bronze Age and all the Neolithic assemblages on PC3 (Fig. 2 and S3).

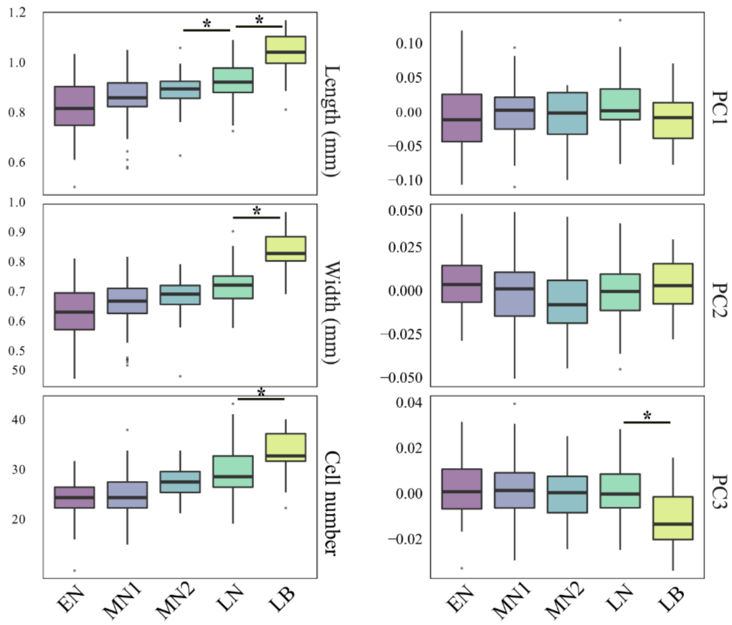

Figure 2 Boxplots comparing the length, width, cell number and the three first principal components (PC) of the poppy seeds shape from the chronological phases. **EN**: Early Neolithic Sites: Draga and Isolino di Varese 1; **MN1**: Middle Neolithic 1: Egolzwil 3, Isolino di Varese 2; Kleiner Hafner, layer 5; Bagnoles 1, well 250; **MN2**: Middle Neolithic 2: Zürich KanSan, layer 9, Les Bagnoles 2, well 990-990; **LN**: Late Neolithic: Arbon Bleiche 3; Zug Riedmatt, Zurich-Parkhaus Opéra, layer 13. **LB**: Late Bronze Age: the layer of Zug Sumpf. See also Fig. 1 and Table 1. Pairwise differences are tested using Wilcoxon rank tests, and stars indicates $P<10^{-3}$

The hierarchical clustering based on all descriptors (Fig. 3) allow to identify five clusters. The Mediterranean sites of Les Bagnoles 1 and La Draga form one cluster. The sites from the South and North of the Alps from the Early Neolithic and Middle Neolithic 1 cluster together (Isolino 1 and 2, Egolzwil 3 and Kleiner Hafner 5), while the three sites belonging to the Late Neolithic (Arbon Bleiche 3, Zug Riedmatt and Zurich-Parkhaus Opéra) and one site from Middle Neolithic 2 (Zürich KanSan 9) compose the third cluster. Late Bronze Age Zug Sumpf is isolated and distinguished from all the others. The same occurs to Les Bagnoles 2 (the younger well) that is isolated from the other seeds from Middle Neolithic 2 and Late Neolithic.

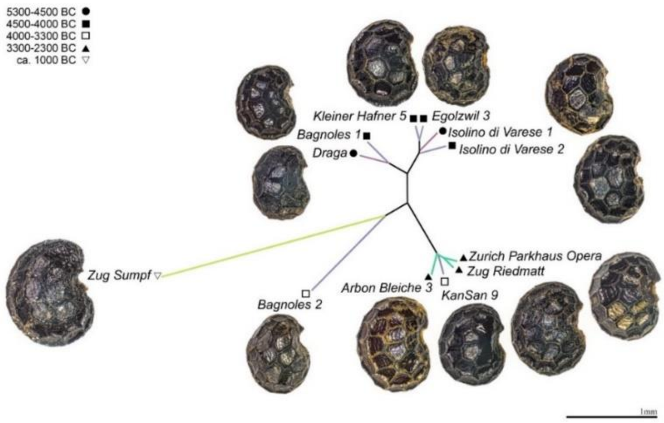

Figure 3 The unrooted tree obtained with hierarchical clustering on the euclidean distance matrix between Fourier coefficients, length, width and number of cells per site. The colours of the lines represent the period colours seen in the previous figures. Photos by Raül Soteras.

<u>Results per region</u>

Seeds also differ between regions (Fig. 4), with the length and width of assemblages from the Mediterranean being smaller than in the other regions, as demonstrated by the Wilcoxon tests. The Wilcoxon tests (S3) show statistical differences in length and width, $P<10^{-3}$, between the Mediterranean region and the other regions North and South of the Alps despite no difference in terms of the number of cells and seed shape ($P>10^{-3}$), as well as, between the Mediterranean region (La Draga + Les Bagnoles) and the South of the Alps region (Isolino). In terms of width and cell number, the assemblages from the South are different ($P<10^{-3}$) from the seeds of the North of the Alps. A clear distinction for the North of the Alps is observed in the number of cells, which is larger in this region (Fig. 3). In terms of shape, there is no significant change in the different regions.

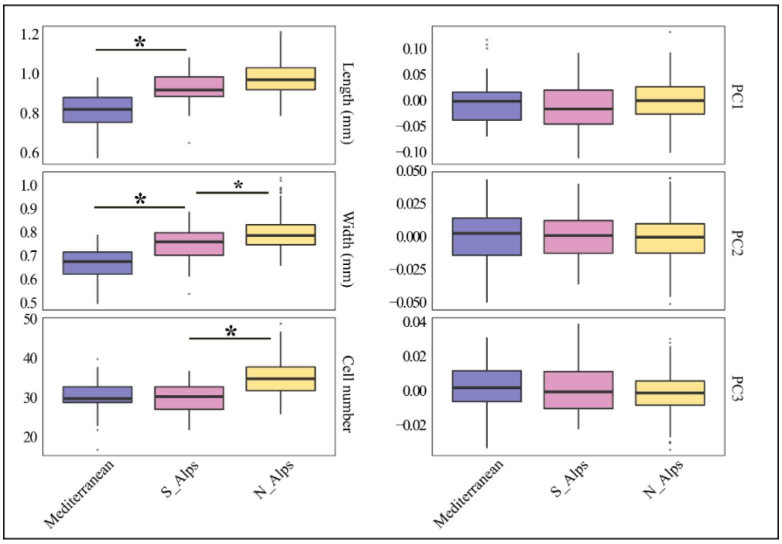

Figure 4 Box plots comparing the length, width, cell number and the three components of the three first PC scores of the outline shape analysis of the poppy seeds from different regions. Mediterranean region boxplot includes La Draga and Les Bagnoles 1 and 2; South of the Alps boxplot includes Isolino 1 and Isolino 2, and North of the Alps has all Swiss sites. Pairwise differences are tested using Wilcoxon rank tests, and stars indicate $P<10^{-3}$

Evolution of seed length per settlement phase through time and regions

Seed length is often used as a parameter to compare overall seed size changes diachronically. We addressed this comparison at a settlement phase level per site and classified sites per period phases in order to observe possibly different dynamics between regions (Fig. 5). The seeds from the North of the Alps sites show a continued increase in length from the Middle Neolithic 2 to the Late Neolithic. From the Late Neolithic (ca. 3150 cal. BC) to the Late Bronze age (ca 1075 cal. BC), a more significant increase in length has happened, as shown in Fig. 5.

However, when combining all the criteria, the estimated increase of change in the seeds (p<10-15, adj. r2 = 0.344) and the pace is 0.057 mm in length, 0.049 mm in width and 0.26 in the number of cells per millennium. (S2 - Table 1).

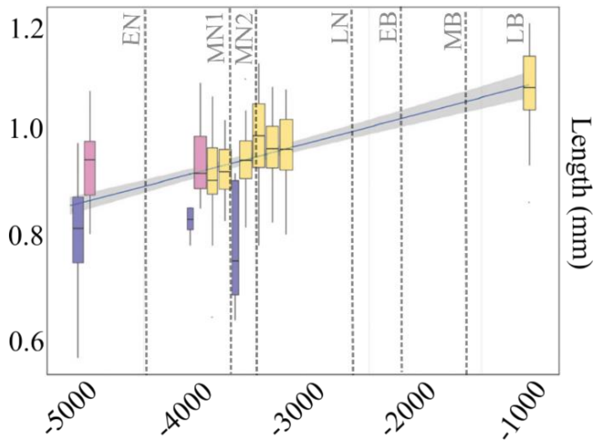

Figure 5 Boxplots with the length values per site, the average date in the continuous x-axis and regression lines. Ordered by a period as in Table 1 with all the sites analysed here, the colours are the same as in the previous regional graphs.

<u>Assignation of archaeological seeds</u>

Even though all archaeological seeds included in this study belong morphologically to the *P. somniferum* group, we used our modern reference collection from different *Papaver* species, including *P. dubium*, *P. hybridum*, *P. rhoeas* and *P. argemone*, and a predictive linear discriminant analysis to identify the archaeological seeds. LDA 1 assigned only four seeds wrongly (S2 – Fig. 1). Three seeds were attributed to *P. dubium* and one seed to *P. hybridum*. This result demonstrates the agreement between both methods (S2 – Fig.1).

Archaeological seeds were assigned with the same methodology to modern species only belonging to the *P. somniferum* group (LDA 2, Fig. 6A). Most of the seeds were assigned to *P. somniferum* and *P. setigerum.* The number of seeds allocated to *P. nigrum*, only five, is insignificant compared to the other two taxa. Only two seeds of Arbon Bleiche 3 and three seeds from Zug Sumpf were identified as the modern species of *P. nigrum* (Fig. 6A). Therefore, another LDA was performed only on the two *P. somniferum* subspecies, *P. setigerum* and *P. somniferum*. The results of LDA 3 changed slightly. The main pattern is a global increase in the proportion of seeds assigned to *P. somniferum* (Fig. 6B), especially in Isolino Varese 2. The seeds from La Draga and Les Bagnoles 2 are the most similar to *P. setigerum.* Late Bonze age site, Zug Sumpf is the only site where most seeds were assigned to modern *P. somniferum.*

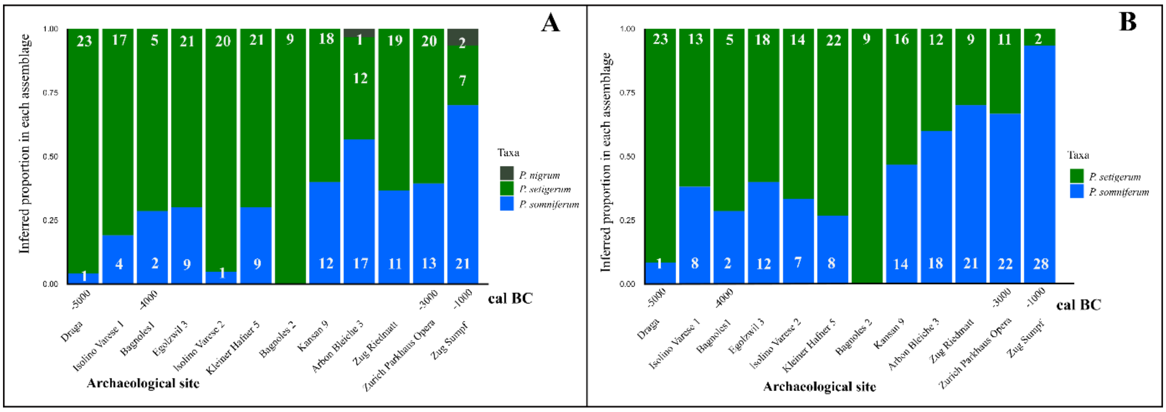

Figure 6 Assignment of archaeological seeds to modern P. somniferum morphotypes (A) LDA 2 trained on the *P. somniferum* group (*P. setigerum*, *P. somniferum* and *P. nigrum*) using all descriptors. (**B)** LDA 3 trained on the *P. somniferum* group (*P. setigerum*, *P. somniferum*) using all descriptors. The number of seeds attributed is listed on each represented colour.

<u>Geographical morphotype of poppy assemblages</u>

During the Early and Middle Neolithic 1 periods (5700-4000 cal. BC), all sites show most poppy seeds with traits similar to *P. setigerum*, especially La Draga and Les Bagnoles 1 and 2 in the Mediterranean area (Fig. 7A). In the sites from the other regions, North and South of the Alps, the proportion of seeds with *P. somniferum* traits is higher. For the Middle Neolithic 2, the only site in the Mediterranean area, Les Bagnoles 2 (the younger wells), had all nine poppy seeds assigned to *P. setigerum* (Fig. 7B). At younger sites located in Switzerland, a larger proportion of seeds is allocated to *P. somniferum*. The proportion of *P. somniferum* in this area reaches its maximum, especially in Late Bronze Age Zug-Sumpf, where most seeds are attributed to this taxon (Fig. 7A).

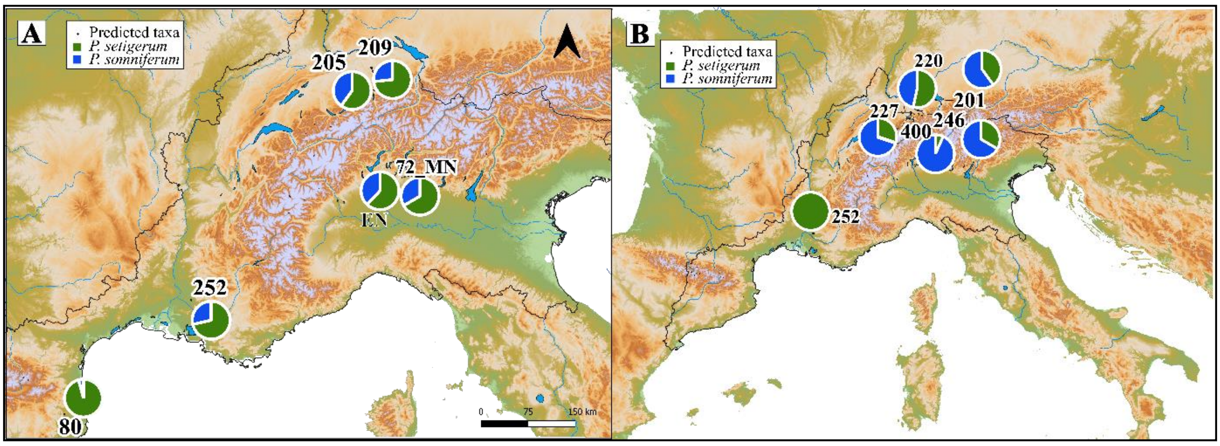

Figure 7 Map of the sites showing the proportion of seeds assigned to *P. setigerum* (green) and *P. somniferum* (blue) by LDA3 (A) Assemblages from the Early Neolithic and Middle Neolithic 1 period (5700 - 4000 cal. BC). **EN**: 80) La Draga, 72) Isolino di Varese 1. **MN1**: 72) Isolino di Varese 2; 205) Egolzwil 3, 209) Zürich Kleiner Hafner layer 5, 252) Bagnoles 1, well 250. (B) Assemblages from the Middle Neolithic 2, Late Neolithic and Bronze Age (4000-800 cal. BC). **MN2**: 252) Bagnoles 2, well 990-994, 220) Zürich Kansan layer 9; **LN**: 201 Arbon Bleiche 3, 227) Zug Riedmatt; 246) Zurich-Parkhaus Opéra layer 13 and **LBA**: 400) Zug Sumpf. (Software: QGIS3.12.3, © European Union, Copernicus Land Monitoring Service [2016], European Environment Agency (EEA)

Discussion

This paper shows the application of four descriptors: length, width, number of cells, and shape, to study poppy seeds' variability from archaeological sites dating from 5150 to 1075 cal. BC from the Mediterranean and North of the Alps regions. The morphometric studies compared archaeological seeds with modern references, assigned archaeological seeds to *P. setigerum* and *P. somniferum* and highlighted chronological and geographical changes in seed morphology.

An initial question of the study was to understand the relation between the changes in size and shape of the seeds and their chronology, and this study found that the seeds show a slow continuous change through the Early Neolithic to the Late Bronze age (Fig. 2 and Fig. 5). The Wilcoxon tests (S3) show no statistical differences in length and cell number between the early periods. In contrast, differences in width and shape are only visible on the seeds from the Late Bronze age compared with earlier periods. These results support the idea that Middle and Late Neolithic seeds outside the natural range of *P. setigerum* come from plants which were in the process of domestication.

The second question in this study sought to determine the connections between archaeological seeds found in sites in the Mediterranean area and the seeds found in the Alpine area. The most obvious finding to emerge from the analysis is that the seeds from the Mediterranean region are smaller than those found in the other regions, as confirmed by the computation of Wilcoxon rank tests (Fig. 4 - $P<10^{-3}$). These Wilcoxon tests on length and width measurements indicate that the seeds from the southern fringes of the Alps (Isolino site) are different from those of the Mediterranean region (La Draga + Les Bagnoles) but similar to those north of the Alps. This result shows that the seeds had already slightly changed their morphology compared with seeds from the native area of the wild progenitor, even in early times (Early and Middle Neolithic). This happened obviously relatively quickly when the species was brought to outside of its native area (Mediterranean). It would be interesting to know if such changes would be visible also in more northern lying early Neolithic sites like the LBK-wells with waterlogged preservation [94].

When comparing the different areas, width and cell number of the seeds from the North of the Alps are higher than those of the seeds from the South of the Alps and the Mediterranean (Fig. 4). This result suggests that the seeds from the North of the Alps differ from those within the native area. The plants from which these seeds come might be more advanced in the domestication process compared to the plants from the Mediterranean. However, these results may be somewhat limited by two aspects: the number of specimens when comparing regions and, more importantly, the absence of seeds from the Mediterranean from late periods when trying to understand the process of domestication and diffusion of opium poppy outside the Mediterranean area. The first refers to the fact that the number of seeds used is not the same for each region, as there are more seeds from the Alpine area than from the Mediterranean. This is due to the type of preservation since only uncharred and waterlogged seeds can be studied. In the Mediterranean area there are very few examples of pile dwellings and dryland sites with structures that could contain this type of preservation, for example, wells. The number of seeds per region is 40 from the Mediterranean area (3 records/2 sites), the South of the Alps (2 records/1 site) has 42 seeds, and the North of the Alps (7 records/site) has 213 seeds.

The other limitation is that no poppy seeds from the native area dating from the Late Neolithic and Bronze age have been recovered yet. Therefore, a direct assessment and comparison between seeds found in the native area and the seeds in the surroundings of the Alps is challenging. Nevertheless, the main results are that the seeds found in the native area (Mediterranean) are always smaller than those from Early Neolithic and Middle Neolithic sites in other areas. In contrast, the specimens out of the native area are larger and tend to increase from the Early Neolithic up to the Late Bronze age. However, as noted before there are gaps of hundreds of years and a linear “evolution” of the seeds size cannot be proven.

<u>Identification of *P. somniferum* in the investigated sites and the role of poppy</u>

The third question in this research was to assess if the seeds found at these sites were morphologically similar to the domestic species, *P. somniferum.* When allocating archaeological seeds to modern species of opium poppy by LDA, the seeds from the native area were mostly assigned to the wild morphotype, *P. setigerum.* In contrast, the proportion of seeds assigned to the domestic type is generally higher in the other regions. This proportion varies in terms of period, and the highest value is obtained for the seeds from the Late Bronze Age (Fig. 6 and Fig. 7).

The seeds from La Draga (ca. 5300-5150 cal. BC) in NE-Iberia are mainly allocated to the wild form: the seeds are smaller and have fewer cells than modern *P. somniferum*. The taxa spectrum at the site is dominated by cultivars such as naked wheat and barley, poppy was identified as a cultivar based on its density of finds and its ubiquity [42]. Our results indicate therefore a sort of “pre-domestication cultivation” [95] of poppy, because the seeds are morphologically wild.
In Les Bagnoles, a Middle Neolithic site located in Southern France, in the southern Rhone valley (Fig. 1) and dating to ca. 4250-3800 cal. BC, the taxa spectrum shows a dominance of naked wheat and barley for the Middle Neolithic 1 and for the Middle Neolithic 2 barley and naked wheat with an increase of glume wheats. Flax is present in all phases, while the representation of pulses is variable, mostly dominated by pea [54]. Poppy seeds are frequent in the Middle Neolithic 1 and fewer in the Middle Neolithic 2.

These seeds are assigned to *P. setigerum*, too. Especially the nine seeds from the Middle Neolithic 2 have similarities in terms of length, width and number of cells with the seeds of La Draga. In comparison, the seven seeds of Middle Neolithic 1 are larger, and some are allocated to *P. somniferum* (Fig. 2 in the Supplementary Material). Larger quantities of poppy seeds were mainly found in the oldest well 250 (ca. 4250–4050 cal. BC), some in a younger well 990 (dating to 4050–3980 cal. BC) and a few in the youngest (3940–3780 cal. BC) well 994 suggesting cultivation of poppy at the site throughout the Middle Neolithic period [54]. The seeds in this site were not well preserved despite being waterlogged, and only 16 seeds could be measured. This relatively small sample size should be extended before exploring more in detail the differences between the two Middle Neolithic phases.

Isolino Virginia, a pile dwelling site on an island in lake Varese, is located in Northern Italy, South of the Alps (Fig. 1), and has two phases of occupation, one around 4950-4700 cal. BC and one around 4250-3650 cal. BC [65]. The archaeobotanical research is still ongoing [66 submitted] but preliminary data revealed that naked wheat and naked barley dominate as crops in the first phase, while a more diverse crop spectrum is found in the second phase, also involving the presence of glume wheats. Flax is present in both phases, as well as pea (Steiner et al. *in press*). The assemblage is different from the glume wheat-dominated assemblages found in other North-eastern Italian sites [97]. Poppy has been known since the first occupation phase at Isolino and appeared in large numbers [98]. For both occupations, 21 seeds were analysed, among which eight were allocated to *P. somniferum* for the Early Neolithic period layer and seven from the Middle Neolithic layer, corresponding to less than 40% of the seeds. One possible interpretation of this result is that the domestication of the plant is ongoing, possibly due to the long period of cultivation of over 500 years (since poppy was first found at the Early Neolithic site of La Marmotta, central Italy) but also due to the location of the site, which lies outside of the natural area of distribution of wild opium poppy. The Isolino finds are the earliest poppy seeds showing some domestication traits known today.

In the seven sites North of the Alps, poppy seeds are numerous and are generally better preserved than in the other sites, particularly in comparison to La Draga and Les Bagnoles. This exceptional preservation is related to taphonomic processes in lake environments in the circumalpine area, where organic deposits are often found with excellent preservation conditions [8,99]. On the other hand, the large number of seeds means that more well-preserved remains were available. The seeds are typically found in organic detritus layers [99] accumulated under or around the (mostly stilted) houses [100,101]; in two sites, Zurich AKAD-Seehofstrasse [56] and Zug-Sumpf [102] accumulations of seeds were found within ceramic pots suggesting their storage and culinary use. High densities of several thousand poppy seeds per litre of sediment are found in several pile-dwellings, with extreme numbers mainly in sites with “Horgen” style ceramics, so e.g. in Zurich-Parkhaus Opera, Horgen-Scheller 3, Zürich-Kansan and Pfäffikon-Burg [62].

During the Middle Neolithic 1 (around 4200 cal. BC), opium poppy was brought to the Swiss Plateau and cultivated by the Swiss pile-dwelling communities with “Egolzwil” ceramic style along the same crops that were grown in Isolino, naked wheat (mostly tetraploid) and multi-rowed barley, few flax finds and several remains of pulses, especially pea [56,103,104]. The evidence of cultivation is first based on the large quantities of seeds in multiple sites in the Swiss Plateau [28,56,58–60] and secondly on the lack of the wild ancestor in the area. The LDA 3 model (Fig. 6B) allocated the poppies of the Middle Neolithic period (4500 to 3300 cal. BC) mainly to *P. setigerum*; however, the proportions are higher in Middle Neolithic 1 (over 60 % in Egolzwil 3 and layer 5 of, Zürich-Kleiner Hafner). For Middle Neolithic 2 (Zürich-Kansan), more than 50% are allocated to the domestic type (Fig. 6 and Fig. 7). This result may be explained by the fact that Egolzwil 3, Zürich Kleiner Hafner layer 5 and Zürich Kansan layer 9 sites belong probably to the earliest (archaeobotanically investigated) examples of the spread of poppy into the Swiss Plateau, which might have been brought from the NW Mediterranean.

Around the end of Middle Neolithic 2 and during Late Neolithic (Arbon Bleiche 3, Zug Riedmatt and Zurich-Parkhaus Opéra "Horgen" layers), 60 to 70 % of the seeds are inferred to be *P. somniferum* species. A comparison of these findings with previous morphometric results [61] confirms that during the Late Neolithic, poppy seeds are becoming larger and more similar to the morphotype of the domestic type. The large numbers of seeds, by far over 1000 poppy seeds per litre of sediment [24,105], found in the waterlogged archaeological sites reflects the importance of this crop. The main cereals during this period were emmer, tetraploid naked wheat and a multi-rowed barley plus high amounts of flax [58,60].

The Late Bronze age seeds from one site - Zug Sumpf - are 93 % allocated to the *P. somniferum* species according to the LDA 3. This suggests that poppy plants were fully domesticated from the morphometrical point of view provided by the seeds. The main cereals during this period are multi-rowed barley, spelt and emmer wheat, and additionally there are high amounts of broomcorn and foxtail millet and faba bean [106].

Our results suggest that opium poppy cultivation started in the Mediterranean area with morphologically wild forms. Seed morphology only changed very progressively until we find fully domesticated morphotypes in Switzerland during the Late Bronze Age. Part of this process took place – and possibly accelerated - in the Northern Alpine area, outside the distribution area of the putative wild ancestor, *P. setigerum*. In Switzerland, the seeds gradually and systematically increased in size until the Late Neolithic. The most significant change is observed in the Late Bronze Age but we cannot clearly establish where and when this change first originated. These findings hence do not assert that it was a strictly local evolution of the crop. The lack of sufficient appropriate contexts in the Mediterranean area dating to the Late Neolithic and the Bronze Age also does not allow to exclude the possibility that the domestication process also included these areas. The whole process possibly involved repeated exchanges and inter-breeding of genetic stock or cultivated varieties between the Alps and the Mediterranean areas during a very long period of time.

It is clear that this study cannot establish with certainty the domestication centre of opium poppy. For this, more research in other European areas and additional sites is needed, i.e. studying other sites with waterlogged deposits such as the above-mentioned LBK wells in Germany or the recently investigated pile-dwellings in the Central Balkans [107]. Another important prerequisite for the further investigation of this question would be to develop an additional methodology for charred remains which then would allow to trace a more comprehensive investigation of poppy domestication. Adding charred poppy remains is important for future research since the methodology used in this paper was tested only on waterlogged material [61]. Carbonisation experiments could allow assessing the possibility of classifying charred seeds. However, prior studies noted the strong effect of charring on seed shape and cells pattern [108]. Creating a new method for charred poppy seeds would maximise the chances of understanding the history of the crop by increasing the number of sites available to be studied, as there are more dry sites with charred preservation than waterlogged sites. In addition, more details of the phylogenetic and phylogeography of opium poppy from modern and ancient DNA would help track its origin(s) and dispersal.

Conclusions

In this paper, we show the application of four descriptor types (length, width, number of cells and shape) to study the variability of waterlogged archaeological poppy seeds from ten archaeological sites dating from the Early Neolithic to the Late Bronze age (5150-1075 cal. BC). Our study clearly demonstrates that wild poppy started to be cultivated alongside domestic crops such as barley and naked wheat or pulses in the western Mediterranean, and this set of crops then spread to regions North of the Alps. In the surroundings of the Alps, where the majority of our data come from, we observed an ongoing domestication process that was morphologically complete about 4000 years later. However, information from the latest Neolithic periods (Corded Ware, Bell Beaker) and the Early and Middle periods of the Bronze age from our study area and from other areas is missing, so we cannot verify continuity between the Late Neolithic and the Late Bronze Age, although the available information would make this a plausible scenario.

The findings from this study make several contributions to the current knowledge. Firstly, by the accomplishment of distinguishing archaeological seeds of opium poppy using the four descriptors. Secondly, it is the first study that provides evidence of poppy domestication and that such happened beyond the Mediterranean. It was not possible to assess the charred remains. Consequently, more work needs to be done to validate if and when domestication occurred in the Mediterranean, too, or if this is a result of separating wild poppy from its native area / natural habitat. In this aspect it would be interesting to integrate Early Neolithic (LBK) poppy seeds from wells with waterlogged preservation but also more seeds dating the Middle to Late Neolithic and Bronze age from Mediterranean sites.

In order to continue the research presented in this paper, we aim to continue developing the model with modern reference material from different regions (at best in combination with genetic data) and to expand the archaeological material to sites with waterlogged deposits in central, eastern and southern-eastern (Balkans) Europe.

The observations that have been possible for opium poppy in this paper, namely, that the domestication process is visible and traceable outside of the area of spread of the wild ancestor of the crop, might be relevant for the study of other domestication processes during the Neolithic (or also later) periods.

Funding

The Swiss National Science Foundation-funded this research as part of a SNF Professorship (AgriChange Project, PI: F. Antolín), grant number: PP00P1_170515. The Office for Urbanism of the City of Zürich has funded the archaeobotanical analyses of Zurich-Parkhaus Opéra. Allowen Evin received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation program (grant agreement No. 852573).

Acknowledgements

To the archaeologists who provided samples for archaeobotanical analysis: Raquel Piqué (La Draga), Samuel van Willigen (Les Bagnoles), Daria G. Banchieri (Isolino Virginia), Niels Bleicher (Zurich Parkhaus Opéra), Eda Gross and Gishan Schaeren (Zug-Riedmatt, Zug-Zumpf) and Urs Leuzinger (Arbon Bleiche 3).

Author Contributions

Conceptualisation: FA, LB
Data curation: AJ, VB, RS
Formal analysis: VB, LB, AJ
Funding acquisition: FA
Investigation: FA, AJ, LB
Methodology: VB, LB, AE, AJ
Project administration: FA
Resources: FA, SJ, LB
Software: AJ, VB, RS
Supervision: LB, FA
Validation: LB, VB
Visualisation: AJ, VB, FA, RS
Writing – original draft: AJ, LB, FA, AE, VB, SJ
Writing – review & editing: AJ, LB, FA, AE, VB, SJ

References

1. Fuller D. Long and attenuated: comparative trends in the domestication of tree fruits. Veg Hist Archaeobot. 2018;27: 165–176. doi:10.1007/s00334-017-0659-2
2. Willcox G. Measuring grain size and identifying Near Eastern cereal domestication: Evidence from the Euphrates valley. J Archaeol Sci. 2004;31: 145–150. doi:10.1016/j.jas.2003.07.003
3. Tanno KI, Willcox G. How fast was wild wheat domesticated? Science (80-). 2006;311: 1886. doi:10.1126/science.1124635
4. Tanno KI, Willcox G. Distinguishing wild and domestic wheat and barley spikelets from early Holocene sites in the Near East. Veg Hist Archaeobot. 2012;21: 107–115. doi:10.1007/s00334-011-0316-0
5. Terral J-F, Alonso N, Buxó R, Chatti N, Fabre L, Fiorentino G, et al. Historical biogeography of olive domestication (Olea europaea L.) as revealed by geometrical morphometry applied to biological and archaeological material. J Biogeogr. 2004;31: 63–77. doi:10.1046/j.0305-0270.2003.01019.x
6. Terral J-F, Tabard E, Bouby L, Ivorra S, Pastor T, Figueiral I, et al. Evolution and history of grapevine (Vitis vinifera) under domestication: new morphometric perspectives to understand seed domestication syndrome and reveal origins of ancient European cultivars. Ann Bot. 2010;105: 443–455. doi:10.1093/aob/mcp298
7. Allaby RG, Stevens CJ, Lucas L, Maeda O, Fuller D. Geographic mosaics and changing rates of cereal domestication. Philos Trans R Soc B Biol Sci. 2017;372: 20160429. doi:10.1098/rstb.2016.0429
8. Jacomet S. Archaeobotany: analyses of plant remains from waterlogged archaeological sites. In: Menott F, O'Sullivan A, editors. The Oxford Handbook of Wetland Archaeology. Oxford: Oxford University Press; 2013. pp. 497–514.
9. Brown TA. The role of humans in a protracted transition from hunting-gathering to plant domestication in the fertile crescent. Frontiers in Plant Science. Frontiers Media S.A.; 2018. p. 1287. doi:10.3389/fpls.2018.01287
10. Fuller D. Finding plant domestication in the Indian subcontinent. Current Anthropology. University of Chicago PressChicago, IL; 2011. doi:10.1086/658900
11. Zohary D, Hopf M, Weiss E. Domestication of Plants in the Old World: The origin and spread of domesticated plants in Southwest Asia, Europe, and the Mediterranean Basin. 4th ed. Oxford University Press; 2012. doi:10.1093/acprof:osobl/9780199549061.003.0010
12. Salavert A, Zazzo A, Martin L, Antolín F, Gauthier C, Thil F, et al. Direct dating reveals

the early history of opium poppy in western Europe. Sci Rep. 2020;10: 20263. doi:10.1038/s41598-020-76924-3
13. UNODC. World Drug Report 2020. United Nations; 2020. Available: https://wdr.unodc.org/wdr2020/field/WDR20_Booklet_3.pdf
14. Tetenyi P. Opium poppy (Papaver somniferum) Botany and Horticulture. Hortic Rev (Am Soc Hortic Sci). 1997;19: 373–408.
15. Musa Özcan M, Atalay Ç. Determination of seed and oil properties of some poppy (Papaver somniferum L.) varieties. Grasas y Aceites. 2006;57: 169–174. doi:10.3989/gya.2006.v57.i2.33
16. Lim TK. Edible Medicinal and Non-Medicinal Plants. Springer; 2013.
17. Bakels C. Der Mohn, die linearbandkeramik und das westliche mittelmeergebiet. Archäologisches korrespondenzblatt. 1982;12: 11–13.
18. Kreuz A. Die Vertreibung aus dem Paradies? Archäobiologische Ergebnisse zum Frühneolithikum im westlichen Mitteleuropa. Bericht der Römisch-Germanischen Kommission. 2012;91: 23–196.
19. Salavert A, Martin L, Antolín F, Zazzo A. The opium poppy in Europe: exploring its origin and dispersal during the Neolithic. Antiquity. 2018;92: E1. doi:10.15184/aqy.2018.154
20. Harris DR, Fuller D. Agriculture: definition and overview. Encycl Glob Archaeol. 2014; 104–113.
21. Merlin MD. On the Trail of the Ancient Opium Poppy. Rutherford: Fairleigh Dickinson University Press; 1984.
22. Neuweiler E. Nachträge urgeschichtlicher Pflanzen. Vierteljahrsschrift der Naturforschenden Gesellschaft Zürich. 1935;80: 98–122.
23. Guerra Doce E. Sobre el papel de la adormidera como posible viático en el ritual funerario de la Prehistoria Reciente peninsular. Boletín del Semin Estud Arte y Arqueol BSAA. 2002; 49–76.
24. Antolín F, Brombacher C, Kühn M, Steiner BL, Jacomet S. Archäobotanik (Makroreste): Ergebnisse der Untersuchungen der Flächenproben im Hinblick auf Taphonomie, Ackerbau, Sammelwirtschaft und Umwelt. In: Bleicher N, Harb C, editors. Zürich-Parkhaus Opéra Eine neolithische Feuchtbodensiedlung Band 3: Naturwissenschaftliche Untersuchungen. Zürich und Egg; 2017. pp. 50–92.
25. Maier U. Untersuchungen in der neolithischen Ufersiedlung Hornstaad-Hörnle IA am Bodensee. Maier U, Vogt R, editors. Siedlungsarchäologie im Alpenvorland. VI Botanische und pedologische Untersuchungen zur Ufersiedlung Hornstaad-Hörnle IA. Stuttgart: Theiss. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg Band 74; 2001.
26. De Candolle A. Origine des plantes cultivées. Paris: Laffitte Reprints; 1884.
27. Kenward H, Hall A, Jones AKG. A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged archaeological deposits. Sci Archaeol. 1980;22: 3–15.
28. Jacomet S. Neolithic plant economies in the northern Alpine Foreland from 5500-3500 cal. BC. In: Colledge S, Conolly J, editors. The Origins and Spread of Domestic Plants in Southwest Asia and Europe. Walnut Creek: Left Coast Press; 2007. pp. 221–258. Available: https://edoc.unibas.ch/15474/
29. Hammer K. Problems of Papaver somniferum-classification and some remarks on recently collected European poppy land-races. Die Kult. 1981;29: 287–296.
30. Fritsch R. Zur Samenmorphologie des Kulturmohns (Papaver somniferum L.). Die Kult. 1979;27: 217–227. doi:10.1007/BF02014652
31. Hammer K, Fritsch R. Zur Frage nach der Ursprungsart des Kulturmohns Papaver somniferum L. Die Kult. 1977;25: 113–124. doi:10.1007/BF02014808

32. Garnock-Jones PJ, Scholes P. Alkaloid content of papaver somniferum subsp. setigerum from New Zealand. New Zeal J Bot. 1990;28: 367–369. doi:10.1080/0028825X.1990.10412320
33. Jesus A, Antolín F. Evidence of the presence and use of Neolithic oil plants in the NW of the Mediterranean and the Swiss Plateau. In: Azorín MB, Piqué R, Seijo MM, López-Bultó O, editors. The missing woodland resources. Barkhuis Publishing; 2021. pp. 23–40. doi:10.2307/j.ctv23wf366.5
34. Spangenberg JE, Ferrer M, Jacomet S, Bleicher N, Schibler J. Molecular and isotopic characterization of lipids staining bone and antler tools in the Late Neolithic settlement, Zurich Opera Parking, Switzerland. Org Geochem. 2014;69: 11–25. doi:10.1016/j.orggeochem.2014.01.015
35. López Sáez J, Guerra-Doce E. El registro arqueobotánico de plantas psicoactivas en la prehistoria de la Peninsula Ibérica: una aproximación entobotánica y fitoquímica a la interpretación de la evidencia. Complutum. 2006;17: 7–24. doi:10.5209/CMPL.30574
36. Rössner C, Deckers K, Benz M, Özkaya V, Riehl S. Subsistence strategies and vegetation development at Aceramic Neolithic Körtik Tepe, southeastern Anatolia, Turkey. Veg Hist Archaeobot. 2018;27: 15–29. doi:10.1007/s00334-017-0641-z
37. Marston JM, Castellano L. Archaeobotany in Anatolia. In: Steadman SR, McMahon G, editors. The Archaeology of Anatolia Volume IV: Recent discoveries (2019-2020). Cambridge Scholars Publishing,; 2021. pp. 338–354.
38. Kislev ME, Hartmann A, Galili E. Archaeobotanical and archaeoentomological evidence from a well at Atlit-Yam indicates colder, more humid climate on the Israeli coast during the PPNC period. J Archaeol Sci. 2004;31: 1301–1310. doi:10.1016/j.jas.2004.02.010
39. Jacomet S, Vandorpe P. The search for a needle in a haystack – New studies on plant use during the Mesolithic in southwest Central Europe. J Archaeol Sci Reports. 2022;41: 103308. doi:10.1016/j.jasrep.2021.103308
40. Rottoli M. Analisi paletnobotaniche: prime risultanze,"La Marmotta", Anguillara Sabazia (RM), Scavi 1989, Appendice 1, Un abitato perilacustre di età neolitica. Bull di Paletnologia Ital. 1993;84: 305–315.
41. Bouby L, Marinval P, Durand F, Figueiral I, Briois F, Martzluff M, et al. Early Neolithic (ca . 5850-4500 cal BC) agricultural diffusion in the Western Mediterranean : An update of archaeobotanical data in SW France. PLoS One. 2020;15: 1–26. doi:10.1371/journal.pone.0230731
42. Antolín F. Local, intensive and diverse? Early farmers and plant economy in the North-East of the Iberian Peninsula (5500-2300 cal BC). Eelde: Barkhuis; 2016. Available: http://www.barkhuis.nl/product_info.php?products_id=213
43. Andreaki V, Barceló JA, Antolín F, Bogdánovic I, Gassmann P, López-Bultó O, et al. Un modelo bayesiano para la cronología del yacimiento neolítico de La Draga (Banyoles, Girona). Un caso de estudio con ChronoModel 2.0. In: Barceló JA, Morell B, editors. Métodos cronométricos en arqueología, historia y paleontología. Madrid: Dextra Editorial; 2020. pp. 399–414.
44. Bouby L, Durand F, Rousselet O, Manen C. Early farming economy in Mediterranean France: fruit and seed remains from the Early to Late Neolithic levels of the site of Taï (ca 5300–3500 cal bc). Veg Hist Archaeobot. 2019;28: 17–34. doi:10.1007/s00334-018-0683-x
45. Zapata L, Peña-Chocarro L, Pérez-Jordà G, Stika H-P. Early neolithic agriculture in the iberian peninsula. J World Prehistory. 2004;18: 283–325. doi:10.1007/s10963-004-5621-4
46. Stika H-P. Early Neolithic agriculture in Ambrona, Provincia Soria, central Spain. Veg Hist Archaeobot. 2005;14: 189–197. doi:10.1007/s00334-005-0085-8
47. Rovira N. Agricultura y gestión de los recursos vegetales en el sureste de la península

ibérica durante la prehistoria reciente.Doctoral Thesis. Universitat Pompeu Fabra. 2007.
48. Peña-Chocarro L. Early agriculture in central and southern Spain. In: Colledge S, Conolly J, editors. The Origins and Spread of Domestic Plants in Southwest Asia and Europe. Walnut Creek: Left Coast Press; 2007. pp. 173–187.
49. Martin L. Plant economy and territory exploitation in the Alps during the Neolithic (5000–4200 cal bc): first results of archaeobotanical studies in the Valais (Switzerland). Veg Hist Archaeobot. 2015;24: 63–73. doi:https://doi.org/10.1007/s00334-014-0490-y
50. Antolín F, Schäfer M. Insect Pests of Pulse Crops and their Management in Neolithic Europe. Environ Archaeol. 2020; 1–14. doi:10.1080/14614103.2020.1713602
51. Juan-Tresserras J, Villalba MJ. Consumo de la adormidera (Papaver somniferum L.) en el Neolítico Peninsular: el enterramiento M28 del complejo minero de Can Tintorer. SAGVNTVM. 1999;2: 397–404.
52. Martin L. Analyse carpologique du puits. Néolithique récent ST2096. In: Remicourt M, Andrieu-Ponel V, Audibert C, Baradat A, Battentier J, Belkacem D, et al., editors. Les occupations pré et prothistoriques du Clos de Roque, à Saint-Maximin-la-Sainte Baume, Rapport Final d'Opération. Villard de Lans; 2012. pp. 242–246.
53. Figueiral I, Séjalon P. Archaeological wells in southern France : Late Neolithic to Roman plant remains from Mas de Vignoles IX (Gard) and their implications for the study of settlement , economy and environment. Environ Archaeol. 2014;19: 23–38.
54. Jesus A, Prats G, Follmann F, Jacomet S, Antolín F. Middle Neolithic farming of open-air sites in SE France: new insights from archaeobotanical investigations of three wells found at Les Bagnoles (L'Isle-sur-la-Sorgue, Dépt. Vaucluse, France). Veg Hist Archaeobot. 2021;30: 445–461. doi:10.1007/s00334-020-00793-z
55. Martin L. Agriculture et alimentation végétale en milieu montagnard durant le Néolithique : nouvelles données carpologiques dans les Alpes françaises du Nord. Doctoral thesis. Université Paris I (Panthéon-Sorbonne) and Basel University. 2010.
56. Jacomet S, Brombacher C, Dick M. Archäobotanik am Zürichsee. Zürich: Zürcher Denkmalpflege, Monographien 7; 1989.
57. Maier U, Jacomet S. Naturapotheke. Drogen- und Medizinalpflanzen. In: Schlichtherle H, Rau S, editors. 4000 Jahre Pfahlbauten. Ostfildern: Jan Thorbecke Verlag; 2016. pp. 329–330.
58. Jacomet S. Plant economy of the northern Alpine lake dwellings - 3500-2400 cal. BC. Environ Archaeol. 2006;11: 65–85. doi:10.1179/174963106x97061
59. Jacomet S. Subsistenz und Landnutzung während des 3. Jahrtausends v. Chr. aufgrund von archäobotanischen Daten aus dem südwestlichen Mitteleuropa. In: Dörfler W, Müller J, editors. Umwelt - Wirtschaft - Siedlungen im dritten vorchristlichen Jahrtausend Mitteleuropas und Südskandinaviens Offa-Bücher 84. Neumünster; 2008. pp. 355–377.
60. Jacomet S. Plant economy and village life in Neolithic lake dwellings at the time of the Alpine Iceman. Veg Hist Archaeobot. 2009;18: 47–59. doi:10.1007/s00334-007-0138-2
61. Jesus A, Bonhomme V, Evin A, Ivorra S, Soteras R, Salavert A, et al. A morphometric approach to track opium poppy domestication. Sci Rep. 2021;11: 9778. doi:10.1038/s41598-021-88964-4
62. Bleicher N, Harb C. Zürich-Parkhaus Opéra: eine neolithische Feuchtbodenfundstelle. Band 1. Befunde, Schichten und Dendroarchäologie. Monographien der Kantonsarchäologie Zürich 48; 2015.
63. Antolín F, Häberle S, Jesus A, Martínez-Grau H, Prats G, Schäfer M, et al. The AgriChange project: an integrated on-site approach to agricultural and land-use change during the Neolithic in Western Europe. Past Glob Chang Mag. 2018;26: 26–27. doi:10.22498/pages.26.1.26
64. Schlichtherle H, Rau S. 4.000 Jahre Pfahlbauten. Ostfildern: Jan Thorbecke Verlag;

2016.

65. Antolín F, Martínez-Grau H, Steiner BL, Follmann F, Soteras R, Häberle S, et al. Neolithic occupations (c. 5200-3400 cal BC) at Isolino Virginia (Lake Varese, Italy) and the onset of the pile-dwelling phenomenon around the Alps. J Archaeol Sci Reports. 2022;42: 103375. doi:10.1016/j.jasrep.2022.103375
66. Steiner BL, Antolín F, Soteras R, Rottoli M, Banchieri DG. New archaeobotanical research at the earliest pile-dwelling of the Circumalpine area. In: Ballmer, A., Hafner, A. & Tinner W, editor. Prehistoric Wetland Sites of Southern Europe Archaeology, Chronology, Palaeoecology and Bioarchaeology. Cham: Springer International Publishing;
67. Martínez-Grau H, Antolín F, van Willigen S. Néolithique moyen type La Roberte et Néolithique moyen type Chassey sur le site des Bagnoles: relations spatiales et chronologiques. In: van Willigen S, Bailly M, Röder B, Schibler J, Schmitt A, editors. Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité). Aix-en-Provence: Presses Universitaires de Provence; 2020. pp. 270–278.
68. van Willigen S, Bailly M, Röder B, Schibler J, Schmitt A, André G, et al., editors. Les Bagnoles à L'Isle-sur-la-Sorgue : un site majeur du Néolithique moyen en Vaucluse. Aix-en-Provence: Presses universitaires de Provence; 2020.
69. Gibaja JF, Ibáñez JJ, Nielsen EH, Kienholz A, van Willigen S, Linton J. The Neolithic reaping knives from Egolzwil 3: A Mediterranean technical tradition in the late 5th millennium Swiss Neolithic. Quat Int. 2017;427: 211–224. doi:10.1016/j.quaint.2015.12.075
70. Wyss R. Steinzeitliche Bauern auf der Suche nach neuen Lebensformen : Egolzwil 3 und die Egolzwiler Kultur, Bd. 2: Die Grabungsergebnisse. Zürich: Schweizerisches Landesmuseum; 1996.
71. Suter P, Jacomet S. Zürich "Kleiner Hafner" : Tauchgrabungen 1981-1984. Zürich: Orell Füssli; 1987.
72. Brombacher C, Jacomet S. Ackerbau, Sammelwirtschaft und Umwelt: ergebnisse archäobotanischer untersuchungen. In: Schibler J, Hüster-Plogmann H, Jacomet S, Brombacher C, Gross-Klee E, Rast-Eicher A, editors. Ökonomie und Ökologie neolithischer und bronzezeitlicher Ufersiedlungen am Zürichsee Ergebnisse der Ausgrabungen Mozartstrasse, Kanalisationssanierungen Seefeld, AKAD/Pressehaus und Mythenschloss in Zürich. Zürich, Egg, Egg: Monographien der Kantonsarchäologie Zürich 20; 1997. pp. 220–279.
73. Baum T, Bleicher N, Ebersbach R, Ruckstuhl B, Walder F, Weber M. Jungsteinzeitliche Ufersiedlungen im Zürcher Seefeld. Ausgrabungen Kanalisationssanierung, Pressehaus, AKAD und Utoquai. Bad 3: Die Siedlungsgeschichte. Zürich und Egg; 2019.
74. Hosch S. Ackerbau und Sammelwirtschaft in der neolithischen Seeufersiedlung Arbon Bleiche 3 (3384-3370 v.Chr.), Kanton Thurgau, Schweiz. Doctoral Thesis. 2004.
75. Leuzinger U, editor. Die jungsteinzeitliche Seeufersiedlung Arbon : Bleiche 3 : Befunde. Frauenfeld: Archäologie im Thurgau 9. Departement für Erziehung und Kultur - Kanton Thurgau; 2000.
76. Capitani A de. Die jungsteinzeitliche Seeufersiedlung Arbon : Bleiche 3 : Funde. Frauenfeld: Departement für Erziehung und Kultur des Kantons Thurgau; 2002.
77. Gross E, Schaeren G, Villa IM. The copper axe blade of Zug-Riedmatt, Canton of Zug, Switzerland - a key to chronology and metallurgy in the second half of the fourth millennium BC. Copp axe Bl Zug-Riedmatt (cant Zug, Switzerland) – a key to Chronol Metall Second half fourth Millenn BC. 2017;40: 213–228. doi:10.11588/ai.2017.1.42486
78. Harb C, Bleicher N. Zürich-Parkhaus Opéra : eine neolithische Feuchtbodenfundstelle.

Band 2: Funde. Dübendorf: Baudirektion Kanton Zürich, Kantonsarchäologie; 2016.
79. Seifert M. Die spätbronzezeitlichen Ufersiedlungen von Zug-Sumpf. Regierungsrat des Kantons; 1996.
80. Seifert M. Die Dorfgeschichte. Zug: Kantonales Museum für Urgeschichte; 1996.
81. Seifert M. Die Funde der Grabungen 1952-1954. Kantonales Museum für Urgeschichte Zug; 1997.
82. Bauer I, Ruckstuhl B, Speck J. Die Funde der Grabungen 1923-37. Zug: Kantonales Museum für Urgeschichte Zug; 2004.
83. Schneider CA, Rasband WS, Eliceiri KW. NIH Image to ImageJ: 25 years of image analysis. Nat Methods. 2012;9: 671–675. doi:10.1038/nmeth.2089
84. Bouby L, Figueiral I, Bouchette A, Rovira N, Ivorra S, Lacombe T, et al. Bioarchaeological Insights into the Process of Domestication of Grapevine (Vitis vinifera L.) during Roman Times in Southern France. Degryse P, editor. PLoS One. 2013;8: e63195. doi:10.1371/journal.pone.0063195
85. Bonhomme V, Picq S, Ivorra S, Evin A, Pastor T, Bacilieri R, et al. Eco-evo-devo implications and archaeobiological perspectives of trait covariance in fruits of wild and domesticated grapevines. PLoS One. 2020;15: e0239863. doi:10.1371/journal.pone.0239863
86. Kuhl FP, Giardina CR. Elliptic Fourier Features of a Closed Contour. Comput Graph Image Process. 1982;18: 236–258.
87. Bonhomme V, Picq S, Gaucherel C, Claude J. Momocs : Outline Analysis Using R. J Stat Softw. 2014;56. doi:10.18637/jss.v056.i13
88. Team RC. R: A language and environment for statistical computing. Version 4.0. 2 (Taking Off Again). R Found Stat Comput Vienna, Austria. 2022.
89. Rohlf FJ, Slice DE. Extensions of the Procrustes Method for the Optimal Superimposition of Landmarks. Syst Zool. 1990;39: 40. doi:10.2307/2992207
90. Paradis E, Schliep K. ape 5.0: an environment for modern phylogenetics and evolutionary analyses in R. Bioinformatics. 2019;35: 526–528.
91. Evin A, Cucchi T, Cardini A, Strand Vidarsdottir U, Larson G, Dobney K. The long and winding road: Identifying pig domestication through molar size and shape. J Archaeol Sci. 2013;40: 735–743. doi:10.1016/j.jas.2012.08.005
92. QGIS Development Team. QGIS Version 3.12.3 QGIS Geographic Information System. Open Source Geospatial Foundation Project. QGIS Association; 2021. doi:http://www.qgis.org/
93. Harrington B. Inkscape. 2005. Available: https://www.inkscape.org/
94. Herbig C, Maier U, Stäuble H. „ Neolithische Füllhörner “ Archäobotanische Untersuchungen in fünf linienbandkeramischen Brunnen in Westsachsen. Offa. 2013;69/70: 265–293.
95. Hillman GC, Davies MS. Measured domestication rates in wild wheats and barley under primitive cultivation, and their archaeological implications. J World Prehistory. 1990;4: 157–222. doi:10.1007/BF00974763
96. Steiner BL, Antolín F, Soteras R, Rottoli M, Banchieri D. Isolino Virginia (Lake Varese, Italy). New archaeobotanical research at the earliest pile-dwelling of the Circumalpine area. In: Ballmer A, Hafner A, Tinner W, editors. Prehistoric Wetland Sites of Southern Europe Archaeology, Chronology, Palaeoecology and Bioarchaeology. Cham: Springer;
97. Rottoli M, Castiglioni E. Prehistory of plant growing and collecting in northern Italy, based on seed remains from the early Neolithic to the Chalcolithic (c. 5600–2100 cal b.c.). Veg Hist Archaeobot. 2009;18: 91–103. doi:10.1007/s00334-007-0139-1
98. Banchieri DG, Rottoli M. Isolino Virginia: una nuova data per la storia del papavero da oppio (Papaver somniferum subsp. somniferum). Sibrium. 2009;XXV: 31–49.
99. Antolín F, Steiner BL, Akeret Ö, Brombacher C, Kühn M, Vandorpe P, et al. Studying

the preservation of plant macroremains from waterlogged archaeological deposits for an assessment of layer taphonomy. Rev Palaeobot Palynol. 2017;246: 120–145. doi:10.1016/j.revpalbo.2017.06.010

100. Antolín F, Brombacher C, Kühn M, Steiner BL, Bleicher N, Jacomet S. A new look at late Neolithic plant economy from the site of Zürich-Parkhaus Opéra (Switzerland): methods, activity areas and diet. Open Serie. In: Hafner A, Dolbunova E, Mazurkevich A, Pranckenaite E, Hinz M, editors. Settling waterscapes in Europe The archaeology of Neolithic & Bronze Age pile-dwellings. Open Serie. Heidelberg: Open Series in Prehistoric Archaeology 1; 2020. pp. 157–172.
101. Maier U, Harwath A. Detecting intra-site patterns with systematic sampling strategies. Archaeobotanical grid sampling of the lakeshore settlement Bad Buchau-Torwiesen II, southwest Germany. Veg Hist Archaeobot. 2011;20: 349–365. doi:10.1007/s00334-011-0295-1
102. Jacquat C, Bauer I. Zug-Sumpf: Die Pflanzenreste aus Gefäss 1430. Tugium. 1993;9: 87–92.
103. Jacomet S. Ackerbau, Sammelwirtschaft und Umwelt der Egolzwiler- und Cortaillod-Siedlungen auf dem Kleinen Hafner in Zürich.Ergebnisse samenanalytischer Untersuchungen. In: Suter P, editor. Zürich “Kleiner Hafner” Tauchgrabungen 1981-1984. Zürich: Berichte der Zürcher Denkmalpflege, Monographien 3; 1987. pp. 144–166.
104. Bollinger T. Samenanalytische Untersuchungen der früh-jungsteinzeitlichen Seeufersiedlung Egolzwil 3. Stuttgart: Dissertationes Botanicae 221; 1994.
105. Jesus A. Crop dynamics in the Neolithic period in the NW Mediterranean area and the Swiss Plateau The role of opium poppy (P. somniferum/setigerum). 2022.
106. Jacomet S, Karg S. Ackerbau und Umwelt der Seeufersiedlungen von Zug-Sumpf im Rahmen der mitteleuropäischen Spätbronzezeit - Ergebnisse archäobotanischer Untersuchungen. 1996.
107. Holguin A, Antolín F, Charles M, Jesus A, Martínez-Grau H, Soteras R, et al. Archaeobotanical investigations at the mid-5th millennium BCE pile-dwelling site of Ploča, Mičov Grad, Lake Ohrid, North Macedonia. In: Ballmer A, Hafner A, Tinner W, editors. Prehistoric Wetland Sites of Southern Europe Archaeology, Chronology, Palaeoecology and Bioarchaeology. Cham: Springer International Publishing;
108. Märkle T, Rösch M. Experiments on the effects of carbonization on some cultivated plant seeds. Veg Hist Archaeobot. 2008;17: 257–263. doi:10.1007/s00334-008-0165-7

Supporting information captions

S1 List of archaeobotanical information for each poppy seed

S2 Fig 1 - Assignation of the 295 archaeological seeds: Benchmarking of linear discriminant analyses on all Papaver species analysed previously using all variables

S2 Table 1 - Estimation of the pace of change in length, width and number of cells per millennia

S2 Fig 2 - Boxplots with the values of length, width and cell number per site, with the average date in the continuous x-axis and regression lines. Ordered by period as in Table 1, colours are the same as the period ones shown previously.

S3 Wilcoxon tests to assess differences between periods, sites and regions

Chapter 8 Synthesis and future perspectives

This study aimed to identify and understand the crop dynamics in the North-Western Mediterranean and Switzerland during the Neolithic period. The main questions centre on how well the data was retrieved and whether the data could infer information on food and agricultural practices. 2) how waterlogged material give us a better inside of the MN communities environment and diet? and 3) how we distinguish *P. setigerum* from *P. somniferum* and which species are the seeds found in prehistory. The key aims of the research were to assess the archaeobotanical data gathered and highlight issues and patterns. The second goal was to assess the potential of waterlogged remains found at dry sites. Lastly, to create and apply modern and traditional geometric morphometric methods to distinguish the *P. setigerum/somniferum* seeds found in 10 archaeological sites.

This dissertation encompasses three different levels of research due to the questions and aims. The first level combined archaeobotanical information from the study region to establish a project synthesis. The second was an in-depth study of a specific site, Les Bagnoles, and the third level was at the super-regional level to understand the domestication of poppy.

Detailed results have been published in the three research papers (Paper 1: Jesus, Prats, et al., 2021; Paper 2: Jesus, Bonhomme, et al., 2021 and Paper 3 about the application of the geometric morphometrics on the archaeological seed), as well as in chapter 3 for the quality assessment of the data collected and chapter 4 for the overview of the archaeobotanical study. In this final section, the main results of the PhD thesis are summarised, examined in a broader context, and ideas for future research are presented. This final chapter is organised according to the research questions set out in Chapter 1.

8.1 Systematic assessment of archaeobotanical data for the study of Neolithic agriculture in the NW Mediterranean and North Alps

Extensive research was done on published and unpublished archaeobotanical reports, international and national articles, and access to the archaeobotanical database from the Integrative Prähistorische und Naturwissenschaftliche Archäologie (IPNA). This compilation resulted in 295 sites and 433 records with archaeobotanical studies from North-Eastern Iberia, South-Eastern France, Northern Italy, and Switzerland (5700-2300 cal. BC). These records then were assessed in terms of data quality. The data collection was assessed according to the seeds' context and their deposition process, how the seeds were processed, used and discarded, and if it is possible to infer information on food, agriculture and the environment. About 201 records out of 433 were classified as good quality. Therefore, the dataset has great potential.

All data were analysed regionally and chronologically. The main results show a slight decrease in the ubiquity of naked wheat and a small increase in einkorn wheat over time. Concerning regional differences, Northern Italy is distinct from the other regions. In this region, glume wheats were always predominant over free threshing wheat. Regarding chronological differences, an increase in glume wheats is visible after the Middle Neolithic period also noted at the French site of Les Bagnoles. Pea is the most common pulse in all phases in terms of pulses. However, a decrease in pulse species from the Middle Neolithic to Late Neolithic is visible. This decrease could be related to taphonomic reasons and their likelihood of being charred (Butler et al., 1999; Fuller & Harvey, 2006).

Few dry sites have oil plants during these both periods. Flax and poppy are present at most wetland sites in the Late Neolithic (80 % see Figure 4.9) and, according to researchers (Jacomet, 2006b; Karg & Märkle, 2002), in higher densities than in the previous period. Poppy and flax appear in large quantities at lakeshore sites during the Middle and Late Neolithic period. Their abundance and recurring presence are evidence of their importance. They were used for food and maybe for oil (Jesus & Antolín, 2021). Another use for flax is its fibre, as linen thread and textiles were abundant in the Late Neolithic (Leuzinger & Rast-Eicher, 2011).

The 26 most common wild plants at the archaeological sites appear in less than 40% of records in all phases (using only the charred remains). No change in their frequency over time when compared with cereals, can be seen as has been suggested for the Middle-Late Neolithic period elsewhere (Antolín & Jacomet, 2015; McClatchie et al., 2014; Schibler et al., 1997). Due to taphonomic issues, the consumption of wild edible plants may not be easy to detect. Consequently, human "diet" assumptions are vastly underestimated when interpreting the archaeobotanical data from dryland sites.

At the regional–chronological level, analyses show only fragments of the crop dynamics present in these regions and periods. The results suggest that since South-Eastern France and Northern Italy had a large diversity of crops, it might indicate interactions between these communities. This is backed up by ceramic evidence, as during the Early Neolithic, the same type of ceramic was found in North-Eastern Spain, South-Eastern France and some parts of Northern Italy. In the Middle Neolithic period, there was higher diversification of material culture, with *Vasi a bocca quadrata* (VBQ) and *Chassey* pots found throughout the four regions in the study area.

Exogenous crops (cereals, pulses and oil plants) and different pottery styles were brought to these four regions during the Neolithic period. However, the way these innovations travel, whether they were adopted or not, introduced and re-introduced, was impossible to assess at this broad scale. Nevertheless, it made it possible to do the first study. It can be continued in the future using only the good data and applying to more specific environment regions in order to see how the crops were adopted in different environments.

Nevertheless, it was possible to interpret that cereal grains, poppy and flax seeds were adapted and highly appreciated, considering the large numbers of products and by-products of their processing at the pile-dwellings on the Swiss Plateau during the Middle and Late Neolithic period.

The assessment result can improve with further access to unpublished reports, especially in Northern Italy. This comparison has never been made systematically. Therefore, this was the first time all archaeobotanical data from these regions, charred and uncharred remains, were gathered and compared, allowing us to have a clear overview of these regions.

8.2 The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal. BC)

Archaeobotanical results from the wetland site of Les Bagnoles in South-East France give a unique insight into the plants that existed and were used by prehistoric communities (4400-3500 cal. BC). At dryland sites, taphonomic issues prevent the same rich density and diversity of macroremains as in the wetlands unless fire accidents or unique contexts occur. One of these unique contexts was found at Les Bagnoles, where three wells were sampled for macroremains and held a high density of fruits and seeds per litre. This research has been presented in a number of different publications (Antolín, Delefosse, et al., 2020; Antolín, Jesus, et al., 2020; Antolín, Schimitt, et al., 2020; Follmann, 2017; Jesus, Prats, et al., 2021). In this thesis, the nature of those contexts was discussed and analysed. The wells 990 and 994 were classified as organic dump deposit types where by-products of processing of flax, poppy, pea and cereal were deposited during summertime, based on the associated weeds.

A comparison of Les Bagnoles with other Middle Neolithic sites (MN1: 4400–4000 cal. BC and MN2: 4100–3500 cal. BC) in South-East France shows that fragile remains such as chaff, pea pods, flax capsules, and poppy seeds are better preserved within wells, in a waterlogged state. The results also highlighted the importance of having a consistent sampling strategy and the imperative use of fine mesh (≤ 0.5mm) sieves when processing the samples in both wetland and dryland. The difference between dry and wet contexts at Les Bagnoles attests to the scarcity of plant information (few grains within pits compared to large quantities of pea pods, flax capsules, and several types of chaff remains found in the wells). This difference between wet and charred contexts is even more evident when comparing the archaeobotanical remains from the negative structures (such as pits and silos) from the other sites in the region with some grains (Jesus, Prats, et al., 2021).

In terms of oil plants, these were only found within wells at dryland sites preserved as uncharred. About taphonomic processes, waterlogged and charred contexts from the Middle Neolithic gave different archaeobotanical assemblages related to the type of context. However, around 4000 cal. BC (MN2), einkorn becomes more predominant in the refuse deposits at the dry sites analysed in Paper 1, including in both the type of preservation charred and uncharred.

In Paper 1, the assumption was that an increase in glume wheats corresponded to an increase in storage volume and the grains were stored in silo pits. However, an increase in storage capacity was not visible. If this assumption was valid, it could be seen in the archaeological record. In contrast, the values from the MN2 were slightly smaller than MN1 even though there were more silo pits in the second phase. It could be that other places for storing grains existed, such as cave sites or within storage vessels. The detailed results are found in Paper 1.

8.3 Status of *Papaver somniferum* in the Neolithic period and its transfer from the Mediterranean to the Alpine area

Opium poppy today is important for its use in food and in medicine; however, its importance and use are less tangible than in the past. The presence of large concentrations of seeds and the presence of such seeds in sites beyond their native area led researchers to assume that the opium poppy was an important plant during the Neolithic period in Europe (Bakels, 1982; Banchieri & Rottoli, 2009; Jacomet, 2006b; Salavert, 2010, 2011; Salavert et al., 2020).

It is unclear when and where the opium poppy was domesticated. Large quantities of seeds have been found in Europe throughout the Neolithic period and are assumed to be domestic. This thesis provides a clear overview of the opium poppy from archaeobotanical records, Historical documents (7.3) and Art and iconography (7.4) sources.

The main questions were: Is it possible to distinguish the archaeological seeds of *P. setigerum* from *P. somniferum*, and are the seeds found in the Neolithic period domesticated or not. The combination of archaeological data and morphometric studies of poppy seeds from the Neolithic period suggests that cultivation started in the Early Neolithic period. Nevertheless, a clear indication of its uses is only consistent during the Middle and Late Neolithic period, mainly due to waterlogged preservation. On the Swiss Plateau, evidence of cultivation is first based on the large quantities of seeds at numerous wetland sites (Jacomet, 2006b, 2007, 2008, 2009) and the lack of the wild ancestor in the area. High densities of poppy seeds per litre are found in several pile-dwellings, including fragments of capsules and seeds suggesting plant processing in the domestic contexts, and burnt seeds suggest culinary uses (Antolín, Brombacher, et al., 2017; Harb & Bleicher, 2016; Jacomet & Steiner, n.d.; Karg & Märkle, 2002; Maier, 2001, p. 72). It was also suggested that poppy seeds were stored in vases (Jacomet et al., 1989, p. 116).

Opium poppy seeds were assumed to be domestic during the Neolithic period; until now there were no criteria to distinguish wild from domestic taxa. A geometric morphometric protocol and criteria were designed to distinguish these species (*P. somniferum* and *P. setigerum*) and other five species commonly found at archaeological sites. The first step was to test if the protocol was suitable for this task and if it was possible to reproduce this approach. Indeed, the first tests were valid. The reproducibility tests and validation of the method were published in Paper 2. In this paper, error measurements were noted at the operator level; however, these were small enough to be able to use this approach. When comparing modern seeds of seven *Papaver* species (270 seeds) using all descriptors (shape, size and number of cells) gave 73-100 % of specimens were correctly classified using leave-one-out cross-validation. This linear discriminant analysis (LDA) model was able to correctly classify 87 % of specimens of *P. setigerum* (wild) and the *P. somniferum* (domestic).

In a second step, this model was applied to archaeological seeds from 10 sites, allowing us to infer which seeds were similar to which *Papaver* species. Out of 295 archaeological seeds, only four were not classified as *P. somniferum* or *P. setigerum* which itself shows the method works as all seeds were indeed part of the *P. somniferum* group. Then using only, the seeds of the *P. somniferum* group, the LDA was applied to the archaeological seeds from different phases and regions (5300 to 1070 cal. BC).

In terms of classification, the archaeological seeds from the Mediterranean are different from those in the North and South of the Alps. The difference is that they are smaller and have fewer number of cells. Even though some seeds from the Middle and Late Neolithic are similar to *P. somniferum* (assumed to be domestic), the higher classification percentage occurs only at the site of Zug-Sumpf. At this site, dating to the Late Bronze Age, most seeds were inferred to *be P. somniferum* (28 seeds out of 30).

Another significant result came from the chronological model (length+ width +number of cells) that estimates the change per date. These results show an increase in seed size from the Middle and Late Neolithic period to the Late Bronze Age. This outcome might be related to the increase of poppy's importance suggested by the high seed concentration and evidence of seed processing in the Swiss Plateau lakeshore sites. Unfortunately, no seeds were studied from the Early and Middle Bronze Age. Because of this gap of time, it is unclear if the domestication of poppy happened within Switzerland or if a new variety came from another region and was brought to the Zug-Sumpf site, or it could be that poppy had multiple centres of domestication. More research on this period is needed.

8.4 Main contributions of the thesis and recommendations for future work

Accurate interpretation of agriculture and diet depends on the dataset's quality. Archaeobotanical data has been published for many years, but there has not been a systematic compilation and assessment of the existing data. This systematic assessment was done for the first time in this region, and it was critical to highlight lacunae. The data classified as satisfactory and poor data can be improved in the future. In order to improve it requires the original archaeobotanist's collaboration or the national institutions that hold the original publications. Old publications should be discarded, or, if possible, a new archaeobotanical and chronological assessment should be undertaken. One of the ideas advanced in this thesis is that an entity should be responsible for regulating and supervising the publication of the archaeobotanical results. A national or regional institution from the state should keep record of the raw archaeobotanical data next to the rest of the archaeological data, which would allow other researchers to use the data. This way, if there is any update of the interpretation, new results, or new radiocarbon dates, this information is simultaneously updated with the archaeobotanical records.

The overview of the four regions' archaeobotanical data resulted in some disparities compared with other syntheses done at the national level. However, in this thesis, the combination of sites based on their broad chronology allowed us to overcome local periodization and gives a broad trend of the different crop dynamics. This could be refined by adding precise chronological dates for each site, combining their regional specificities (inner valley, high altitude sites), and comparing them in order to show a more detailed pattern. However, in this thesis, the main goal was to see the broad overview so more detail can be performed in future work and combined with only good quality archaeological records.

One of the main achievements of this thesis has been the creation of a protocol that enables archaeobotanists to distinguish wild and domestic uncharred opium poppy seeds from archaeological sites. It was possible to apply this method to key sites where the domestication process was ongoing.

Several questions were not able to be answered within this PhD and should be addressed in future work. These are mainly two: 1) Where was poppy domesticated? as the evidence from

Mediterranean domestication was infrequent (two sites), and 2) Was poppy domesticated in Switzerland? Evidence of only one site with clear domesticated traits.

For the first main question, only two sites from the Mediterranean were analysed, even though other sites exist and should be added. In order to check if these seeds from other Mediterranean sites would be classified as *P. setigerum,* such as the ones from La Draga and Les Bagnoles, it would be beneficial to add the poppy seeds from Tai, Can Sadurni and other sites from the Mediterranean area. The increase in the number of seeds from the Mediterranean will allow us to see if they are morphological, like the ones we current analysed, similar to the wild species. For this, the methodology should be adapted to charred seed remains. The other early sites with seeds from Switzerland (Zizers, La Gilliere 2) and those found during the *Linearbandkeramik* (LBK) should also be included. Nevertheless, before doing such analysis, carbonisation experiments should be conducted to see the charring effects and if it is possible to make such a distinction.

For the second question, the challenge is to understand if the results from Zug-Sumpf (the majority of the seeds are morphologically domestic) are the consequence of local domestication or were brought from another region. In order to consider this issue, more seeds from the Early and Middle Bronze Age, dating to around 2200-1350 cal. BC from Switzerland and nearby regions should be included in future analysis.

Nevertheless, this work published the compilation and assessment results of all archaeobotanical data from the NW Mediterranean and the Alpine region (Switzerland) for the first time. It is a unique reference for studying and understanding archaeobotanical information from the study area. It also created the protocol for classifying modern *Papaver* species and assigned to the archaeological seeds.

Chapter 9 References

Affolter, J., Emmenegger, L., Hafner, A., Heitz, C., Hinz, M., Stapfer, R., & Wehren, H. (2022). From flint provenance to mobility studies: New raw material determinations from Late Neolithic wetland sites at Lake Biel and Lake Constance. *Quaternary International*, *615*, 84–95. https://doi.org/10.1016/j.quaint.2021.05.027

Affolter, J., & Suter, P. (2017). Silexartefakte: Rohstoffe – Werkzeuge und (Jagd-)Waffen. In *Um 2700 v. Chr.- Wandel Und Kontinuität in Den Ufersiedlungen Am Bielersee* (pp. 290–309). Archäologischer Dienst Des Kantons Bern.

Agrostelli, M., Fontana, A., & Tecchiati, U. (2015). Castelnuovo di Teolo (Padova), scavi 2011: i dati archeobotanici e faunistici. In G. Leonardi & V. Tinè (Eds.), *Studi di Preistoria e Protostoria 2* (pp. 647–651). Istituto italiano di preistoria e protostoria.

Akeret, Ö. (2005). Plant remains from a Bell Beaker site in Switzerland, and the beginnings of Triticum spelta (spelt) cultivation in Europe. *Vegetation History and Archaeobotany*, *14*(4), 279–286. https://doi.org/10.1007/s00334-005-0071-1

Akeret, Ö., & Geith-Chauvière, I. (2003). Les macrorestes végétaux. In M.-H. Grau Bitterli, J. Affolter, & E. Fierz-Dayer (Eds.), *Plateau de Bevaix, 6. Bevaix/Treytel-À Sugiez: histoire d'un complexe mégalithique néolithique, témoins d'habitats du Campaniforme et du Bronze ancien* (pp. 311–321). Archéologie neuchâteloise 29.

Akeret, Ö., & Geith-Chauvière, I. (2006a). Annexe 11. Resultats des analyses carpologiques. In M. Bednarz, J. Kraese, P. Reynier, & J. Becze-Deák (Eds.), *Plateau de Bevaix, 2. Histoire et préhistoire d'un paysage rural: le site des Pâquiers: Vol. II* (pp. 414–417). Archéologie neuchâteloise 36.

Akeret, Ö., & Geith-Chauvière, I. (2006b). Occupations néolithiques et protohistoriques: cadre et environnement. Données carpologiques. In M. Bednarz, J. Kraese, P. Reynier, & J. Becze-Deak (Eds.), *Plateau de Bevaix, 2. Histoire et préhistoire d'un paysage rural: le site des Pâquiers* (pp. 110–111). Archéologie neuchâteloise, 36.

Akeret, Ö., & Geith-Chauvière, I. (2010). Analyses carpologiques des structures archéologiques. In R. Anastasiu & F. Langenegger (Eds.), *Plateau de Bevaix, 5. Cortaillod-Petit Ruz: impacts humains et évolution d'un terroir, du Néolithique à l'époque gallo-romaine, sur un kilomètre d'autoroute.* (p. CD ROM 3.2). Archéologie neuchâteloise 46.

Akeret, Ö., & Geith-Chauvière, I. (2011). *Plateau de Bevaix, 7. L'histoire de la relation entre hommes et plantes utiles: synthèse des données carpologiques*. Archéologique Neuchâteloise numérique 7.

Akeret, Ö., & Geith-Chauvière, I. (2016). Macrorestes végétaux des fouilles de Boudry/Chézard-Littorail, Boudry/Chézard-Cadbar et Boudry/Grandchamps-Cadbar. In C. Elmer, N. Thew, A. von Burg, & J. Kraese (Eds.), *Delta de l'Areuse. Les méandres du delta de l'Areuse au cours de l'Holocène : une histoire humaine et environnementale* (Vol. 8, pp. A2-7.). Archéologie neuchâteloise numérique 8.

Akeret, Ö., & Zibulski, P. (2010). *Verkohlte Pflanzenreste aus schnurkeramischen Gruben von Binningen-Friedhofstrasse, St. Margarethenhügel. Internal report*.

Alemany, R. E., & Starnini, E. (2016). La cultura della cerámica impressa nella Liguria di ponente (Italia settentrionale) distribuzione, cronologia e aspetti culturali. In H. B.

Rosado (Ed.), *Del Neolític a l'Edat de Bronze en el Meditarrani occidental estudis en homenatge a Bernat Martí Oliver* (Vol. 119, pp. 35–50). Diputación de Valencia = Diputació de València, Museu de Prehistòria de València.

Alonso-Eguíluz, M., Fernández-Eraso, J., & Albert, R. M. (2016). The first herders in the upper Ebro basin at Los Husos II (Álava, Spain): microarchaeology applied to fumier deposits. *Vegetation History and Archaeobotany 2016 26:1*, *26*(1), 143–157. https://doi.org/10.1007/S00334-016-0590-Y

Alonso, N. (1995). Estudi de llavors i fruits dels jaciments arqueològics de la Cova d'Anes (Prullans, la Cerdanya) i de la Cova de les Portes (Lladurs, el Solsonès) i el seu context pirinenc. In J. Guilaine (Ed.), *Cultures i medi : de la prehistòria a l'Edat Mitjana. 20 anys d'arqueologia pirinenca : homenatge al Professor Jean Guilaine : X Colloqui Internacional d'Arqueologia de Puigcerdà, del 10 al 12 de novembre de 1994, Puigcerdà i Osseja* (pp. 97–104). Patronat Francesc Eiximenis ; Ajuntament de Puigcerdà.

Alonso, N., Buxó, R., & Rovira, N. (2004). Rapport préliminaire de l'étude des semences et fruits de Port Ariane. In Isabelle Daveau (Ed.), *Port Ariane III Occupation et utilisation d'une zone humide lors des six derniers millénaires* (INRAP Médi, Vol. 1, pp. 229–255). Institut National de Recherches Archéologiques Préventives.

Anastasiu, R., & Langenegger, F. (Eds.). (2010). *Plateau de Bevaix, 5. Cortaillod-Petit Ruz: impacts humains et évolution d'un terroir, du Néolithique à l'époque gallo-romaine, sur un kilomètre d'autoroute.* Archéologie neuchâteloise 46.

Andreaki, V., Barceló, J. A., Antolín, F., Bogdánovic, I., Gassmann, P., López-Bultó, O., Morera, N., Palomo, A., Piqué, R., Revelles, J., & Terradas, X. (2020). Un modelo bayesiano para la cronología del yacimiento neolítico de La Draga (Banyoles, Girona). Un caso de estudio con ChronoModel 2.0. In J. A. Barceló & B. Morell (Eds.), *Métodos cronométricos en arqueología, historia y paleontología* (pp. 399–414). Dextra Editorial.

Angelucci, D., Boschian, G., Fontanals, M., Pedrotti, A., & Vergès, J. M. (2009). Shepherds and karst: the use of caves and rock-shelters in the Mediterranean region during the Neolithic. *World Archaeology*, *41*(2), 191–214. https://doi.org/10.1080/00438240902843659

Antolín, F. (n.d.). Estudi paleocarpològic (llavors i fruits) del jaciment d'Auvelles i l'agricultura del Neolític mitjà a la plana occidental catalana. In X. Mangado & M. Sánchez-de-la-Torre (Eds.), *L'assentament arqueològic de les Auvelles (Castelló de Farfanya, La Noguera) en el context de la mineria del sílex a la Prehistòria*. Monografies del SERP.

Antolín, F. (2008a). *Informe de la tria de residus de flotació del jaciment arqueològic de la Cova de la Pesseta*.

Antolín, F. (2008b). *Informe preliminar dels resultats de la flotació, la tria i la identificació carpològica del jaciment de Can Roqueta - Can Revella*.

Antolín, F. (2016). *Local, intensive and diverse? Early farmers and plant economy in the North-East of the Iberian Peninsula (5500-2300 cal BC)* (Vol. 2). Barkhuis.

Antolín, F. (2020). Les restes carpològiques de Cova del Toll. Una revisió dels materials estudiats per Maria Hopf. In J. Guilaine, M. Llongueras, M. Àngels Petit, & F. X. A. Oms (Eds.), *El neolític i l'edat del bronze a la cova del Toll (Moià, Barcelona): les excavacions de 1976-1977* (pp. 115–120). Universitat de Barcelona.

Antolín, F., Brombacher, C., Kühn, M., Steiner, B. L., & Jacomet, S. (2017). Archäobotanik (Makroreste): Ergebnisse der Untersuchungen der Flächenproben im Hinblick auf Taphonomie, Ackerbau, Sammelwirtschaft und Umwelt. In N. Bleicher & C. Harb (Eds.), *Zürich-Parkhaus Opéra. Eine neolithische Feuchtbodensiedlung. Band 3: Naturwissenschaftliche Untersuchungen* (Issue 50, pp. 50–92).

Antolín, F., Bultó, O. L., & Piqué, R. (2013). *Informe de la flotació i tria de sediments i anàlisi arqueobotànica del jaciment de l'escola especial meritxell (Juberri, Andorra)*.

Antolín, F., & Buxó, R. (2011a). L'explotació de les plantes: Contribució a la història de l'agricultura i de l'alimentació vegetal del neolític a Catalunya. In J. T. Galter, À. B. Lloret, & J. Chichilla (Eds.), *El poblat lacustre del neolític antic de La Draga: Excavacions de 2000-2005* (pp. 147–174). CASC-Museu d'Arqueologia de Catalunya.

Antolín, F., & Buxó, R. (2011b). Proposal for the systematic description and taphonomic study of carbonized cereal grain assemblages: A case study of an early Neolithic funerary context in the cave of Can Sadurní (Begues, Barcelona province, Spain). *Vegetation History and Archaeobotany*, *20*(1), 53–66. https://doi.org/10.1007/s00334-010-0255-1

Antolín, F., Delefosse, C., Errera, M., Follmann, F., Jacomet, S., Jesus, A., Kühn, M., Pétrequin, P., Schäfer, M., Schibler, J., Reggio, A., & van Willigen, S. (2020). Les structures attribuables au Néolithique moyen de type La Roberte (fin du Ve millénaire-début de l'Ive millénaire avant notre ère). In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 229–280). Presses Universitaires de Provence.

Antolín, F., Häberle, S., Jesus, A., Martínez-Grau, H., Prats, G., Schäfer, M., & Steiner, B. L. (2018). The AgriChange project: an integrated on-site approach to agricultural and land-use change during the Neolithic in Western Europe. *Past Global Changes Magazine*, *26*(1), 26–27. https://doi.org/10.22498/pages.26.1.26

Antolín, F., & Jacomet, S. (2015). Wild fruit use among early farmers in the Neolithic (5400–2300 cal bc) in the north-east of the Iberian Peninsula: an intensive practice? *Vegetation History and Archaeobotany*, *24*(1), 19–33. https://doi.org/10.1007/s00334-014-0483-x

Antolín, F., Jacomet, S., & Buxó, R. (2015). The hard knock life. Archaeobotanical data on farming practices during the Neolithic (5400-2300 cal BC) in the NE of the Iberian Peninsula. *Journal of Archaeological Science*, *61*, 90–104. https://doi.org/10.1016/j.jas.2015.05.007

Antolín, F., Jesus, A., Follmann, F., & Jacomet, S. (2020). Économie et alimentation. In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 316–329). Presses Universitaires de Provence.

Antolín, F., López, V., Mestre, J. M. i, & Gibaja, J. F. (2018). Bellotas y cereales. Primeras observaciones sobre el registro carpológico de una estructura del V milenio cal. ANE en el yacimiento de Pou Nou-2. *Cadernos Do GEEvH*, *7*(2), 10–28.

Antolín, F., Martínez-Grau, H., Steiner, B. L., Follmann, F., Soteras, R., Häberle, S., Prats, G., Schäfer, M., Mainberger, M., Hajdas, I., & Banchieri, D. G. (2022). Neolithic occupations (c. 5200-3400 cal BC) at Isolino Virginia (Lake Varese, Italy) and the onset of the pile-dwelling phenomenon around the Alps. *Journal of Archaeological Science: Reports*, *42*, 103375. https://doi.org/10.1016/j.jasrep.2022.103375

Antolín, F., Navarrete, V., Saña, M., Viñerta, Á., & Gassiot, E. (2018). Herders in the mountains and farmers in the plains? A comparative evaluation of the archaeobiological record from Neolithic sites in the eastern Iberian Pyrenees and the southern lower lands. *Quaternary International*, *484*, 75–93. https://doi.org/10.1016/j.quaint.2017.05.056

Antolín, F., Rodríguez, F. J. C., & López, D. I. R. (2010). *Estudi arqueobotànic de les llavors i fruits de l'excavació arqueològica corresponent als terrenys del Pla Parcial Plurimunicipal CIM "El Camp". Parcel·la PAT 18.1. (Reus, Baix Camp).*

Antolín, F., & Schäfer, M. (2020). Insect Pests of Pulse Crops and their Management in Neolithic Europe. *Environmental Archaeology*, 1–14. https://doi.org/10.1080/14614103.2020.1713602

Antolín, F., Schimitt, A., Bader, M., D'Anna, A., Delefosse, C., Errera, M., Follmann, F., Jacomet, S., Jesus, A., Kühn, M., Pétrequin, P., Reggio, A., Röder, B., Schäfer, M., Schibler, J., WH, S., Viel, L., & van Willigen, S. (2020). Les structures attribuables au Néolithique moyen de type Chassey (dernier tiers du Ve millénaire avant notre ère). In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 117–228). Presses Universitaires de Provence.

Antolín, F., Steiner, B. L., Akeret, Ö., Brombacher, C., Kühn, M., Vandorpe, P., Bleicher, N., Gross, E., Schaeren, G., & Jacomet, S. (2017). Studying the preservation of plant macroremains from waterlogged archaeological deposits for an assessment of layer taphonomy. *Review of Palaeobotany and Palynology*, *246*, 120–145. https://doi.org/10.1016/j.revpalbo.2017.06.010

Antolín, F., Steiner, B. L., & Jacomet, S. (2017). The bigger the better? On sample volume and the representativeness of archaeobotanical data in waterlogged deposits. *Journal of Archaeological Science: Reports*, *12*, 323–333. https://doi.org/10.1016/j.jasrep.2017.02.008

Arbogast, R.-M., Jacomet, S., Magny, M., & Schibler, J. (2006). The significance of climate fluctuations for lake level changes and shifts in subsistence economy during the late Neolithic (4300–2400 b.c.) in central Europe. *Vegetation History and Archaeobotany*, *15*(4), 403–418. https://doi.org/10.1007/s00334-006-0053-y

Arobba, D., & Caramiello, R. (2006a). Rassegna dei ritrovamenti paleobotanici d'interesse alimentare in Liguria tra Neolitico ed età del Ferro e variazioni d'uso del territorio. *Atti Della Società Dei Naturalisti e Matematici Di Modena*, *137*, 229–247.

Arobba, D., & Caramiello, R. (2006b). Rilievo e studio impronte vegetali da materiali archaeologici. *Infomatore Botanico Italiano*, *38*(1), 9–13.

Arobba, D., & Caramiello, R. (2009). Indagini archeobotaniche sul deposito neolitico del Riparo di Pian del Ciliegio. *Quaderni Del Museo Archeologico Del Finale*, *5*, 117–130.

Arobba, D., & Caramiello, R. (2010). *Il paesaggio vegetale tra il Neolitico medio e l' età del Rame/Bronzo antico alla foce del torrenre bisahno.pdf* (pp. 20–22).

Arobba, D., & Caramiello, R. (2014). Indagine archeobotanica sui livelli del Riparo di Rocca Due Teste presso Alpicella (Varazze, Savona). *Rivista Di Studi Liguri*, *LXXIX*, 157–166.

Arobba, D., Caramiello, R., Firpo, M., Mercalli, L., Morandi, L. F., & Rossi, S. (2018). New evidence on the earliest human presence in the urban area of Genoa (Liguria, Italy): A multi-proxy study of a mid-Holocene deposit at the mouth of the Bisagno river. *The Holocene*, *28*(12), 1918–1935. https://doi.org/10.1177/0959683618798107

Arobba, D., Lucchese, A. Del, Mellli, P., & Caramiello, R. (2014). Evidenze di scalvatura in rami di frassino del Neolitico medio a Genova. *Rivista Di Studi Liguri*, *LXXIX*, 137–141.

Arobba, D., Panelli, C., Caramiello, R., Gabriele, M., & Maggi, R. (2017). Cereal remains, plant impressions and 14C direct dating from the Neolithic pottery of Arene Candide Cave (Finale Ligure, NW Italy). *Journal of Archaeological Science: Reports*, *12*, 395–404. https://doi.org/10.1016/j.jasrep.2017.02.015

Arobba, D., & Vicino, G. (2002). Evidenze di pratiche agricole neolitiche tra i materiali provenienti dai vecchi scavi della grotta del Sanguineto o della Matta (Finale Ligure SV). *Quaderni Del Museo Archaeologico Del Finale*, *4*, 143–147.

Arobba, D., & Vicino, G. (2003). Segnalazione di macroresti botanici nel sito neolitico di S. Sebastiano di Perti (SV). *Bollettino Dei Musei Civici Genovesi*, *XIX/XXI*(55/63), 29–37.

Askitopoulou, H., Ramoutsaki, I. A., & Konsolaki, E. (2002). Archaeological evidence on the use of opium in the Minoan world. *International Congress Series*, *1242*(C), 23–29. https://doi.org/10.1016/S0531-5131(02)00769-0

Aspes, A., Fasam, L., & Visentini, P. (2002). The Late Neolithic and the early Metal age in northern Italy. *Budapest Régiségei*, *36*, 175–190.

Außerlechner, M. V. (2021). Plant use and rites at burnt offering sites in the Eastern Alps during the Bronze and Iron Ages. *Vegetation History and Archaeobotany*, *30*, 155–170. https://doi.org/10.1007/s00334-020-00816-9

Bakels, C. (1982). Der Mohn, die linearbandkeramik und das westliche mittelmeergebiet. *Archäologisches Korrespondenzblatt*, *12*, 11–13.

Banchieri, D. G., Bini, A., Rottoli, M., & Mainberger, M. (2015). Le Prealpi varesine e l' alimentazione durante la preistoria. *50ma Riunione Scientifica Dell'Istituto Italiano Di Preistoria e Protostoria , L'ambiente Fonte Di Risorse Alimentari - Sessione 2*, 2.07. http://preistoriadelcibo.iipp.it/sessione2-download.html

Banchieri, D. G., & Rottoli, M. (2009). Isolino Virginia: una nuova data per la storia del papavero da oppio (Papaver somniferum subsp. somniferum). *Sibrium*, *XXV*, 31–49.

Baudais, D., Brunier, C., Curdy, P., David-Elbiali, M., Favre, S., Gallay, A., May, O., Moinat, P., Mottet, M., Voruz, J.-L., & Winiger, A. (1990). Le Néolithique de la région de Sion (Valais). Un bilan. *Bulletin Du Centre Genevois d'Anthropologie*, *2*, 5–56.

Baudais, D., Grudler, A., & Lundström-Baudais, K. (1997). Les paléosemeces du niveau VIII et leur répartition spatiale. In P. Pétrequin (Ed.), *Les sites littoraux néolithiques des Clairvaux-les-Lacs et de Chalain (Jura) III: Chalain Station 3, 3200-2900 av. J.-C., Vol. 2* (pp. 723–732). Editions de la Maison des Sciences de l'Homme.

Beeching, A. (2011). Habitats pérennes ou précaires au Néolithique. *Techniques & Culture*, *56*, 48–61. https://doi.org/10.4000/tc.5333

Beeching, A., Berger, J. F., Brochier, J.-L., Ferber, F., Helmer, D., & Sidi Maamar, H. (2000). Chasséens : agriculteurs ou éleveurs, sédentaires ou nomades ? Quels types de milieux, d'économies et de sociétés ? In M. Leduc, N. Valdeyron, & J. Vaquer (Eds.), *Sociétés et*

Espaces, Rencontres Méridionales de Préhistoire Récente, 3ème session, Toulouse, 1998 (pp. 59–79). Archives d'Écologie Préhistorique.

Beeching, A., Nicod, P.-Y., Thiercelin, F., & Voruz, J.-L. (1997). Le Saint-Uze, un style céramique non-chasséen du cinquième millénaire dans le bassin rhodanien. In C.Constantin, D. Mordant, & D. Simonin (Eds.), *La Culture de Cerny: nouvelle économie, nouvelle société au Néolithique* (pp. 575–592). Association pour la promotion de la recherche archéologique en Ile-de-France.

Behn, P. (1986). The Use of Opium in the Bronze Age in the Eastern Mediterranean. *Listy Filologické / Folia Philologica*, *109*(4), 193–III. http://www.jstor.org/stable/23462630

Besse, M., & Piguet, M. (Eds.). (2011). *Le site préhistorique du Petit-Chasseur (Sion, Valais) 10. Un hameau du Néolithique moyen*. Cahiers d'archéologie romande 124. https://archive-ouverte.unige.ch/unige:17565

Biagi, P., & Nisbet, R. (1987). Ursprung der Landwirtschaft in Norditalien. *ZFA. Zeitschrift Für Archäologie*, *21*(1), 11–24.

Binder, D., Battentier, J., Bouby, L., Brochier, J.-É., Carré, A., Cucchi, T., Girdland-Flink, L., Goude, G., Gourichon, L., Guillon, S., Hamon, C., & Thiébault, S. (2020). First farming in the north-western Mediterranean: evidence from Castellar-Pendimoun during the sixth millennium BCE. In K. J. Gron, L. Sorensen, & P. Rowley-Conwy (Eds.), *Farmers at the Frontier: A Pan European Perspective on Neolithisation* (pp. 145–159). Oxbow Books.

Binder, D., Cade, C., Desse-Berset, N., Dubar, M., Gassin, B., Grenet, M., Helmer, D., Marinval, P., Regert, M., & Thiébault, S. (2004). Un chantier archéologique à la loupe: Villa Giribaldi. *Nice:[Catalogue d'exposition 23 Octobre 2004-4 Janvier 2005], Nice, Nice-Musées*.

Binder, D., Lepére, C., & Maggi, R. (2008). Archéologies transfrontalières (Alpes du Sud, Côte d'Azur, Ligurie, Piémont) : bilan et perspectives de recherche. In *Bulletin du Musée d'anthropologie préhistorique de Monaco : suppl. 1* (pp. 49–62). Musée d'anthropologie préhistorique de Monaco.

Birks, H. H. (2002). Plant Macrofossils. In J. P. Smol, H. J. B. Birks, W. M. Last, R. S. Bradley, & K. Alverson (Eds.), *Tracking Environmental Change Using Lake Sediments - Terrestrial, Algal, and Siliceous Indicators* (pp. 49–74). Springer Netherlands. https://doi.org/10.1007/0-306-47668-1_4

Bishop, R. R. (2019). Experiments on the effects of charring on hazelnuts and their representation in the archaeological record. *Journal of Archaeological Science: Reports*, *26*(October 2018), 101839. https://doi.org/10.1016/j.jasrep.2019.05.004

Blanchard, V. (Ed.). (2019). *Royaumes oubliés : de l'empire hittite aux Araméens*. Louvre éditions.

Bleicher, N., & Harb, C. (2015). *Zürich-Parkhaus Opéra: eine neolithische Feuchtbodenfundstelle. Band 1. Befunde, Schichten und Dendroarchäologie*. Monographien der Kantonsarchäologie Zürich 48.

Boardman, S., & Jones, G. (1990). Experiments on the Effects of Charring on Cereal Plant Components. *Journal of Archaeological Science*, *17*, 1–11.

Bocquet-Appel, J.-P., Naji, S., Linden, M. Vander, Kozlowski, J. K., Vander Linden, M., &

Kozlowski, J. K. (2009). Detection of diffusion and contact zones of early farming in Europe from the space-time distribution of 14C dates. *Journal of Archaeological Science*, *36*(3), 807–820. https://doi.org/10.1016/j.jas.2008.11.004

Bogaard, A., Arbogast, R.-M., Ebersbach, R., Fraser, R. A., Knipper, C., Krahn, C., Schäfer, M., Styring, A., & Krause, R. (2016). The Bandkeramik settlement of Vaihingen an der Enz, Kreis Ludwigsburg (Baden-Württemberg): an integrated perspective on land use, economy and diet. *Germania : Anzeiger Der Römisch-Germanischen Kommission Des Deutschen Archäologischen Instituts*, *94*(1–2), 1–60. https://doi.org/10.11588/GER.2016.39068

Bojnanský, V., & Fargašová, A. (2007). *Atlas of seeds and fruits of Central and East-European flora: the Carpathian Mountains region*. Springer.

Bollinger, T. (1994). *Samenanalytische Untersuchungen der früh-jungsteinzeitlichen Seeufersiedlung Egolzwil 3*. Dissertationes Botanicae 221.

Bonani, G., Ivy, S. D., Hajdas, I., Niklaus, T. R., & Suter, M. (1994). AMS 14C age determinations of tissue, bone, and grass samples from the Otztal Ice Man. *Radiocarbon*, *36*(2), 247–250. https://doi.org/10.1017/S0033822200040534

Bonhomme, V., Forster, E., Wallace, M., Stillman, E., Charles, M., & Jones, G. (2017). Identification of inter- and intra-species variation in cereal grains through geometric morphometric analysis, and its resilience under experimental charring. *Journal of Archaeological Science*, *86*, 60–67. https://doi.org/10.1016/j.jas.2017.09.010

Bonnaire, E. (2019). Observation carpologique. In V. Sophie (Ed.), *SAUSHEIM, Haut-Rhin Lieudit Mittelhoetzleinfeld Rue des Primevères, rue de la Hardt, rue des Vosges Un paléosol mésolithique et une crémation du Néolithique moyen.* (pp. 33–34). Rapport de diagnostic préventif Archéologie Alsace.

Borrell, F., Josep, B., & Bosch, J. (2013). Las minas de Variscita de Gavà (Barcelona) y las redes de circulación en el Neolítico. *Rubricatum: Revista Del Museu de Gavà*, *5*(315–322). https://raco.cat/index.php/Rubricatum/article/view/269767

Borrello, M. A. (2014). La culture de Lagozza : attributs et assemblages céramiques entre le milieu du Ve et le milieu du IVe millénaire en Italie centre-septentrionale. *Notizie Archeologiche Bergomensi*, *22*, 5–30.

Borrello, M. A., & van Willigen, S. (2013). Identités céramiques et groupes néolithiques dans les Alpes occidentale. In M. A. Borrello (Ed.), *Les Hommes préhistoriques et les Alpes* (Issue 2011, pp. 59–68). BAR International Series 2476.

Bosch, J., & Santacana, J. (2009). *Blat, metalls i cabdills. Catalunya del neolític a la iberització*. Rafael Dalmau, editor.

Bosi, G., Berti, P., Maioli, M., Costantini, F., Bandini Mazzanti, M., & Mazzanti, M. B. (2006). Applicazioni morfobiometriche in campo archeo-carpologico: primi dati su Papaver somniferum nell'Alto Medioevo di Ferrara. *Atti Della Società Dei Naturalisti e Matematici Di Modena*, *137*(137), 373–387.

Bouby, L. (1996). Annexe 6 : Donnés carpologiques du site d'Encombres. In C. Amiel, I. Carrère, & É. Mahieu (Eds.), *Premières données sur l'habitat chasséen d'Encombres, Quarante* (pp. 55–60). Document final d'opération de diagnostic, SRA Languedoc-Roussillon, AFAN.

Bouby, L. (1999). Rapport d'étude carpologique. In A. Vignaud (Ed.), *Les jardins de Vert Parc, Castelnau-le-Lez, 34. Un habitat Néolithique moyen de culture chasséenne* (pp. 77–80). DFS, AFAN, inédit.

Bouby, L. (2004). 5.1. Rapport d'évalution carpologique. In G. Loison, V. Fabre, & Isabelle Villemeur (Eds.), *Rocade Nord de Béziers (Hérault) Le Crès - Habitats préshistoriques en bordure de l'Orb* (Vol. 3, pp. 389–390). Institut National de Recherches Archéologiques Préventives.

Bouby, L. (2005). Etude carpologique du site néolithique final et chalcolithique de Puech Haut à Paulhan (Hérault). In L. Carozza, C. Georjon, & A. Vignaud (Eds.), *La fin du Néolithique et les débuts de la métallurgie en Languedoc central: les habitats de la colline du Puech Haut (Paulhan-Hérault)* (pp. 517–524). Archives d'Écologie Préhistorique/INRAP.

Bouby, L. (2009). Les restes carpologiques des couches 60 à 47. In J.-L. Voruz, S. Bonnardin, L. Chaix, L. Bouby, P. Chiquet, & E. Al. (Eds.), *La grotte du Gardon (Ain), volume I: le site et la séquence néolithique des couches 60 à 47* (pp. 227–230). Archives d'Écologie Préhistorique.

Bouby, L. (2016). Les données carpologiques. In F. Convertini (Ed.), *Languedoc-Roussillon, Hérault Ligne Grande Vitesse - Contournement Nîmes-Montpellier secteur 4 - Montpellier, La Cavalade Du Néolithique moyen à l'Antiquité tardive: occupations néolithiques et Bronze ancien, sépultures néolithiques, fosse et enclos de l'* (Vol. 1, pp. 325–331). Rapport d'opération, fouille archéologique Inrap Méditerranée.

Bouby, L. (2020). Analyses carpologiques. In R. Guilbert-Berger, P. Chevillot, A. Hasler, S. Négroni, P. Poirier, I. Rodet-Belarbi, & J.-P. Sargiano (Eds.), *Une occupation du Néolithique final , Quartier Sainte Anne à Alleins (Bouches-du-Rhône).* (p. 147). Rapport final d'opération de fouille préventive Inrap Midi Méditerranée.

Bouby, L., Dietsch-Sellami, M.-F., Martin, L., Marinval, P., & Wiethold, J. (2018). Ressources végétales et économie de subsistance au Néolithique en France (6000-2000 av. J.-C.). In J. Guilaine & D. Garcia (Eds.), *La Protohistoire de la France* (pp. 141–152). Hermann.

Bouby, L., & Durand, F. (2016). Rapport d'analyses carpologiques. In A. Raux (Ed.), *Languedoc-Roussillon, Gard, Aubord - ZAC de la Farigoule 2* (pp. 181–183). Rapport d'opération, fouille archéologique Inrap Méditerranée.

Bouby, L., Durand, F., Rousselet, O., & Manen, C. (2019). Early farming economy in Mediterranean France: fruit and seed remains from the Early to Late Neolithic levels of the site of Taï (ca 5300–3500 cal bc). *Vegetation History and Archaeobotany*, *28*(1), 17–34. https://doi.org/10.1007/s00334-018-0683-x

Bouby, L., & Figueiral, I. (2014). Les ressources végétales du Néolithique ancien nîmois : Mas de Vignoles X et Mas Neuf. In T. Perrin, C. Manen, & P. Séjalon (Eds.), *Le Néolithique ancien de la plaine de Nîmes (Gard, France)* (pp. 339–344). Toulouse, Archives d'Ecologie préhistorique.

Bouby, L., & Léa, V. (2006). Exploitation de la vesce commune (Vicia sativa L.) au Néolithique moyen dans le Sud de la France. Données carpologiques du site de Claparouse (Lagnes, Vaucluse). *Comptes Rendus - Palevol*, *5*(8), 973–980. https://doi.org/10.1016/j.crpv.2006.07.007

Bouby, L., Marinval, P., Durand, F., Figueiral, I., Briois, F., Martzluff, M., Perrin, T., Valdeyron, N., Vaquer, J., Guilaine, J., & Manen, C. (2020). Early Neolithic (ca . 5850-4500 cal BC) agricultural diffusion in the Western Mediterranean : An update of archaeobotanical data in SW France. *PLOS ONE*, *15*(4), 1–26. https://doi.org/10.1371/journal.pone.0230731

Bouby, L., Marinval, P., & Rovira, N. (2020). Late Neolithic plant subsistence and farming activities on the southern margins of the Massif Central (France). *Holocene*, *30*(5), 599–617. https://doi.org/10.1177/0959683619895576

Bouby, L., Rovira, N., & Rousselet, O. (2010). Ressources agricoles dans les sites de plein air du Néolithique final des Grands causses et de la vallée de l' Hérault : données carpologiques. In M.-P. Ruas, A. Bouchette, L. Bouby, & N. Rovira (Eds.), *Plants, products and practices: dissemination and adoption of novelty in pre-industrial societies, (acts renc. Archéobotanique, Montpellier, oct. 2010), (MAM HS n ° 8)* (pp. 15–30). Monographie d'Archéologie Méditerranéenne - Special Edition.

Bouchette, A. (2012). Données carpologiques. In J.-P. Sargiano (Ed.), *La Bastide Neuve III à Velaux (Bouchesdu-Rhône) : occupations du début du Néolithique moyen à la Protohistoire.* (pp. 158–160). Rapport de fouille Inrap Méditerranée.

Brandolini, A., & Heun, M. (2019). Genetics of brittleness in wild, domesticated and feral einkorn wheat (Triticum monococcum L.) and the place of origin of feral einkorn. *Genetic Resources and Crop Evolution*, *66*(2), 429–439. https://doi.org/10.1007/s10722-018-0721-7

Brandolini, A., Volante, A., & Heun, M. (2016). Geographic differentiation of domesticated einkorn wheat and possible Neolithic migration routes. *Heredity*, *117*(3), 135–141. https://doi.org/10.1038/hdy.2016.32

Brochier, J.-É., Beeching, A., Maamar Sidi, H., & Vital, J. (1999). Les grottes bergeries des Préalpes et le pastoralisme alpin, durant la fin de la Préhistoire. In A. Beeching (Ed.), *Circulations et identités culturelles alpines à la fin de la préhistoire. Matériaux pour une étude. Programme CIRCALP 1997- 1998* (pp. 77–114). Agence Rhône-Alpes pour les Sciences Humaines (Travaux du Centre d'Archéologie Préhistorique de Valence ; 2).

Brombacher, C. (1997). Archaeobotanical investigations of Late Neolithic lakeshore settlements (Lake Biel, Switzerland). *Vegetation History and Archaeobotany*, *6*(3), 167–186. https://doi.org/10.1007/BF01372569

Brombacher, C. (2000). Archäobotanische Untersuchungen. In A. Hafner & P. Suter (Eds.), *-3400. Die Entwicklung der Bauerngesellschaften im 4. Jahrtausend v.Chr. am Bielersee (aufgrund der Rettungsgrabungen von Nidau und Sutz-Lattrigen). Ufersiedlungen am Bielersee – Band 6* (pp. 155–168). Berner Lehrmittel- und Medienverlag.

Brombacher, C. (2005). Makrorestanalysen: Landwirtschaft und Umwelt. In A. Hafner & P. J. Suter (Eds.), *Lüscherz - innere Dorfstation. Ausschnitte einer jungneolithischen Ufersiedlung* (Vol. 6B, pp. 420–427). Archäologischer Dienst des Kantons Bern.

Brombacher, C. (2007). Archäobotanische Untersuchungen. In A. Hafner & P. Suter (Eds.), *-3400. Die Entwicklung der Bauerngesellschaften im 4. Jahrtausend v.Chr. am Bielersee (aufgrund der Rettungsgrabungen von Nidau und Sutz-Lattrigen). Ufersiedlungen am Bielersee – Band 6* (pp. 61–64). Berner Lehrmittel- und Medienverlag. https://www.erz.be.ch/erz/de/index/kultur/archaeologie.html

Brombacher, C. (2020). Botanische Makroreste. In C. Heitz, R. Haab, H. Hüster Plogmann, R. Krebs, L. Matile, P. Rentzel, J. Schibler, A. Hafner, C. Brombacher, F. Ginella, & J.

Affolter (Eds.), *Abseits der grossen Seen : Archäologie und Erhaltung der neolithischen Unesco-Welterbestätte Seedorf, Lobsigesee* (pp. 272–286). Archäologischer Dienst des Kanton Bern.

Brombacher, C., & Dick, M. (1987). Die Untersuchung der botanischen Makroreste. In E. Gross, C. Brombacher, M. Dick, & K. Diggelmann (Eds.), *Zürich "Mozartstrasse", Neolithische und bronzezeitliche Ufersiedlungen* (pp. 198–212). Berichte der Zürcher Denkmalpflege, Monographien, Band 4).

Brombacher, C., & Jacomet, S. (1997). Ackerbau, Sammelwirtschaft und Umwelt: ergebnisse archäobotanischer untersuchungen. In J. Schibler, H. Hüster-Plogmann, S. Jacomet, C. Brombacher, E. Gross-Klee, & A. Rast-Eicher (Eds.), *Ökonomie und Ökologie neolithischer und bronzezeitlicher Ufersiedlungen am Zürichsee. Ergebnisse der Ausgrabungen Mozartstrasse, Kanalisationssanierungen Seefeld, AKAD/Pressehaus und Mythenschloss in Zürich* (pp. 220–279). Monographien der Kantonsarchäologie Zürich 20.

Brombacher, C., & Jacomet, S. (2003). Ackerbau, Sammelwirtschaft und Umwelt. In H. Zwahlen (Ed.), *Die jungneolithische Siedlung Port-Stüdeli* (pp. 66–86). Ufersiedlungen am Bielersee 7.

Brombacher, C., & Klee, M. (2009). Vestiges carpologiques non carbonisés et carbonisés des dépôts protohistoriques de Delémont-En La Pran. In N. Pousaz, M. Guélat, L. Frei Paroz, & V. Piuz Loubier (Eds.), *Environnement alluvial et premières installations humaines entre Mésolithique récent et âge du Bronze* (pp. 77–90). Cahier d'archéologie jurassienne 22.

Brombacher, C., & Schlumbaum, A. (2017). Archäobotanische untersuchungen zu Umwelt und Wirtschaft. In P. Suter, J. Affolter, M. Bode, C. Brombacher, J. Francuz, I. Löffler, M. Maggetti, E. Marti-Grädel, A. Rast-Eicher, J. Schibler, A. Schlumbaum, & S. Ulrich-Bochsler (Eds.), *Um 2700 v. Chr. - Wandel und Kontinuität in den Ufersiedlungen am Bielersee* (pp. 148–159). Ufersiedlungen am Bielersee Band 1.

Brombacher, C., & Vandorpe, P. (2012). Untersuchungen zu Wirtschaft und Umwelt aus der mittelneolithischen Fundstelle von Zizers Gr-Friedau. In A. Boschetti-Maradi, A. de Capitani, S. Hochuli, & U. Niffeler (Eds.), *Form, Zeit und Raum : Grundlagen für eine Geschichte aus dem Boden : Festschrift für Werner E. Stöckli zu seinem 65. Geburtstag.* (Vol. 50, pp. 95–104). Antiqua 50.

Brownstein, M. J. (1993). A brief history of opiates, opioid peptides, and opioid receptors. *Proceedings of the National Academy of Sciences*, *90*(12), 5391–5393. https://doi.org/10.1073/pnas.90.12.5391

Brozio, J. P., Dörfler, W., Feeser, I., Kirleis, W., Klooß, S., & Müller, J. (2014). A Middle Neolithic well from Northern Germany: a precise source to reconstruct water supply management, subsistence economy, and deposition practices. *Journal of Archaeological Science*, *51*, 135–153. https://doi.org/10.1016/j.jas.2013.03.029

Bundesamt fuer Umwelt BAFU. (2019). *The National Data and Information Centre on the Swiss Flora*. Info Flora. https://www.infoflora.ch/de/

Burri-Wyser, E., & Winiger, A. (2016). Architecture et structuration de l'espace des villages du Cortaillod sur le Plateau suisse entre 4400 et 3350 av. J.-C. In T. Perrin, P. Chambon, J. F. Gibaja, & G. Goude (Eds.), *Le Chasséen, des Chasséens… Retour sur une culture nationales et ses parallèles, Sepulcres de fossa, Cortaillod, Lagozza. Actes du colloque* *international tenu à Paris (France) du 18 au 20 novembre 2014* (pp. 317–330). Archives d'Écologie Préhistorique.

Butler, A., Tesfay, Z., D'Andrea, C., & Lyons, D. (1999). The Ethnobotany of Lathyrus Sativus L. in the Highlands of Ethiopia. In M. van der Veen (Ed.), *The Exploitation of Plant Resources in Ancient Africa* (pp. 123–136). Springer US. https://doi.org/10.1007/978-1-4757-6730-8_11

Buxó, R. (1997). *Arqueologia de las plantas : la explotación económica de las semillas y los frutos en el marco mediterráneo de la Península Ibérica.* Critica.

Buxó, R. (2003). Environnment, économie et population du site des Vautes. Approche carpologique des échantillons issus de la fouille. In J. Guilaine & G. Escallon (Eds.), *Les Vautes (Saint-Gély du Fesc, Hérault) et la fin du Néolithique en Languedoc oriental* (pp. 145–146). Archives d'Ecologie Préhistorique.

Buxó, R. (2006). Les restes des semences et fruits archéologiques de la grotte de Montou. *Études Roussillonnaises*, *XXII*, 1–10.

Buxó, R. (2007). Crop evolution: new evidence from the Neolithic of west Mediterranean Europe. In S. Colledge & J. Conolly (Eds.), *The Origins and Spread of Domestic Plants in Southwest Asia and Europe* (pp. 171–188). Left Coast Press.

Buxó, R., i Ortiz, M. C., & Villalba, M. J. (1991). Llavors i fruits en un conjunt funerari situat en la galeria d'acces a la mina 28 del complex miner de Can Tintorer. *Cypsela*, *10*, 65–72.

Cabanis, M. (2014). Archéobotanique. In E. Néré (Ed.), *Chens-sur-Léman, Haute-Savoie, Rhône-Alpes Le Pré d'Ancy, rue du Léman - Tome 1: texte* (pp. 181–191). Rapport de Fouille Inrap Auvergne-Rhône-Alpes.

Cabanis, M. (2018). Analyses archéobotaniques. In C. Ramponi (Ed.), *Quincieux, Rhône, Auvergne-Rhône-Alpes Grange Rouge - A 46N - section Anse-Genay Tome I Données administratives, Introduction générale, Résultats :Paléoenvironnement, Préhistoire - Texte et annexes scientifiques* (pp. 134–137). Rapport de fouille Inrap Auvergne-Rhône-Alpes.

Cacho Quesada, C., Papi Rodes, C., Sánchez-Barriga Fernández, A., & Alonso Mathias, F. (1996). La cestería decorada de la cueva de los Murciélagos (Albuñol, Granada). *Complutum*, *6*(1), 105–105. https://doi.org/10.5209/CMPL.30999

Canton-Alvarez, J. A. (2019). A Gift from the Buddhist Monastery: The Role of Buddhist Medical Practices in the Assimilation of the Opium Poppy in Chinese Medicine during the Song Dynasty (960–1279). *Medical History*, *63*(4), 475–493. https://doi.org/10.1017/mdh.2019.45

Cappers, R. T. J. (1993). Seed dispersal by water: a contribution to the interpretation of seed assemblages. *Vegetation History and Archaeobotany*, *2*, 173–186. https://doi.org/10.1007/BF00198588

Caraglio, A. (2018). Los emplazamientos topográficos de poblados durante el Tercer Milenio A.C. en la Europa Occidental: Líneas comparadas entre Cataluña y la Provenza. *Cuadernos de Prehistoria y Arqueología*, *44*, 35–57. https://doi.org/10.15366/cupauam2018.44.002

Carolan, J. C., Hook, I. L. I., Chase, M. W., Kadereit, J., & Hodkinson, T. R. (2006).

Phylogenetics of Papaver and related genera based on DNA sequences from ITS nuclear ribosomal DNA and plastid trnL intron and trnL-F intergenic spacers. *Annals of Botany*, *98*(1), 141–155. https://doi.org/10.1093/aob/mcl079

Carozza, L., Vialet, P., Bouchette, A., & Chevillot, P. (1999). L'habitat de plaine Neolithique final du Bousquetas à Paulhan (Herault). *Bulletin de La Société Préhistorique Française*, *96*(1), 39–51.

Carra, M. (2012). *Per una storia della cerealicoltura in Italia settentrionale dal Neolitico all'Età del Ferro: strategie adattive e condizionamenti ambientali. Doctoral Thesis*. Università di Bologna.

Carra, M. (2019). I resti vegetali nelle strutture antropiche. In C. Longhi (Ed.), *Tracce di preistoria nel mantovano ~ Il sito di Canedole di Roverbella - Sovrappasso 100, Archeologia preventiva e valorizzazione del territorio 8.* (pp. 55–60). Sicograf.

Carugati, M. G. (1993). Il Neolitico Antico in Friuli attraverso lo studio dei resti vegetali carbonizzati di tre siti: Fagnigola (Pn), Valer (PN) e Sammardenchia (UD). *Quaderni Friulani Di Archeologia*, *III*, 15–22.

Caruso Fermé, L., Mineo, M., Ntinou, M., Remolins, G., Mazzucco, N., & Gibaja, J. F. (2021). Woodworking technology during the early Neolithic: First results at the site of La Marmotta (Italy). *Quaternary International*, *593–594*(November), 399–406. https://doi.org/10.1016/j.quaint.2020.10.067

Castellano, L., & Perego, R. (2018). I pozzi. Le analisi antracologiche e carpologiche. In G. de Gattis, P. Curdy, A. M. Ferroni, F. Martinet, R. P. Keller, L. Raiteri, L. Sarti, G. Zidda, & F. Mezzena (Eds.), *Area megalitica Saint-Martin-de- Corléans. Una visione aggiornata, Documenti 13* (pp. 233–241). Le Château Edizioni.

Castelletti, L., Castiglioni, E., Leoni, L., & Rottoli, M. (1998). Resti botanici dai contesti del Neolitico medio-recente. *Bulletino Di Paletnologia Italiana*, *89*, 191–200.

Castelletti, L., & Maspero, A. (1992). Analisi di resti vegetali di Campo Ceresole del Vhò di Piadena e di altri siti neolitici padani. *Natura Bresciana, Annali Del Museo Civico Di Storia Naturale, Brescia*, *27*, 289–305.

Castelletti, L., & Motella de Carlo, S. (1998). L'uomo e le piante nella Preistoria. L'analisi dei resti macroscopici vegetali. In L. Mercando & M. Venturino Gambari (Eds.), *Archeologia in Piemonte - La Preistoria I* (pp. 41–56). Umberto Allemandi & C.

Castiglioni, E., Cottini, M., & Rottoli, M. (2008). Aspects of Bell Beaker and Chalcolithic economy in Northern Italy. In M. Baioni, V. Leonini, D. Lo Vetro, F. Martini, R. P. Keller, & L. Sarti (Eds.), *Bell Beaker in everyday life : proceedings of the 10th meeting «Archéologie et Gobelets» (Florence - Siena - Villamora sul Clisi, May 12-15, 2006)* (pp. 147–150). Museo e Istituto Fiorentino di Preistoria "Paolo Graziosi."

Castiglioni, E., & Rottoli, M. (2015). I resti botanici da Maserà - via Bolzani , Monselice - via Valli e Este - località Meggiaro nel quadro del Neolitico medio-recente e dell ' Eneolitico in Italia settentrionale. In S. Bonomi, G. Gambacurta, L. Callegaro, N. Modica, E. Bianchin, & P. Zanovello (Eds.), *Dinamiche insediative nel territorio dei Colli Euganei dal Paleolitico al Medioevo - Atti del Convegno di Studi di archeologia e territorio* (pp. 86–92). Convegno di studi archeologia e territorio, Parco regionale dei Colli euganei.

Castiglioni, E., & Tecchiati, U. (2005). Ricerche archeobotaniche nei livelli della tarda Età del

Rame di Velturno-Tanzgasse in Val d'Isarco (BZ). *Atti Acc. Rov. Agiati*, *V*(VIII), 505–528.

Cavulli, F. (2003). Sottostrutture antropiche di età neolitica: un contributo all'analisi interpretativa. In P. Bellintani (Ed.), *Archeologie sperimentali, Atti del Convegno, Terme di Comano (Trento), 13-15 settembre 2001* (pp. 427–435). Provincia autonoma, Ufficio beni archeologici, 2003.

Cavulli, F., & Pedrotti, A. (2001). L'insediamento del Neolitico antico di Lugo di Grezzana: la palizzata lignea. *Preistoria Alpina*, *37*(37), 11–24.

Chambon, P., & Leclerc, J. (Eds.). (2003). *Les pratiques funéraires néolithiques avant 3500 av. J.-C. en France et dans les régions limitrophes*. Société Préhistorique Française.

Charles, M., Forster, E., Wallace, M., & Jones, G. (2015). "Nor ever lightning char thy grain" 1 : establishing archaeologically relevant charring conditions and their effect on glume wheat grain morphology. *STAR: Science & Technology of Archaeological Research*, *1*(1), 1–6. https://doi.org/10.1179/2054892315y.0000000008

Chovanec, Z., Bunimovitz, S., & Lederman, Z. (2015). Is there opium here? – Analysis of cypriot Base Ring juglets from Tel Beth-Shemesh, Israel. *Mediterranean Archaeology and Archaeometry*, *15*(2), 175–189. https://doi.org/10.5281/zenodo.16609

Chovanec, Z., Rafferty, S. M., & Swiny, S. (2012). Opium for the Masses. *Ethnoarchaeology*, *4*(1), 5–36. https://doi.org/10.1179/eth.2012.4.1.5

Clottes, J., Coularou, J., Giraud, J.-P., Rouzaud, F., & Duday, H. (1980). Nouvelles découvertes à Villeneuve-Tolosane (Haute-Garonne). *Archeologia Paris*, *142*, 61–62.

Cockin, G., & Furestier, R. (Eds.). (2009). *A8 Saint-Maximin, Chemin de Barjols à Saint Maximin-la-Sainte-Baume (Var), région Provence, Alpes-Côte-d'Azur*. Rapport final d'opération, Oxford Archéologie, Aix-en-Provence, Service Régional de l'Archéologie.

Colledge, S., & Conolly, J. (2014). Wild plant use in European Neolithic subsistence economies: a formal assessment of preservation bias in archaeobotanical assemblages and the implications for understanding changes in plant diet breadth. *Quaternary Science Reviews*, *101*, 193–206. https://doi.org/10.1016/j.quascirev.2014.07.013

Colledge, S., Conolly, J., & Shennan, S. (2004). Archaeobotanical Evidence for the Spread of Farming in the Eastern Mediterranean. *Current Anthropology*, *45*(S4), S35–S58. https://doi.org/10.1086/422086

Colledge, S., Conolly, J., & Shennan, S. (2005). The evolution of Neolithic farming from SW Asian origins to NW European limits. *European Journal of Archaeology*, *8*(2), 137–156. https://doi.org/10.1177/1461957105066937

Contreras, D., Hiriart, E., Bondeau, A., Kirman, A., Guiot, J., Bernard, L., Suarez, R., & Van Der Leeuw, S. (2018). Regional paleoclimates and local consequences: Integrating GIS analysis of diachronic settlement patterns and processbased agroecosystem modeling of potential agricultural productivity in Provence (France). *PLoS ONE*, *13*(12), 1–27. https://doi.org/10.1371/journal.pone.0207622

Coste, A., Duday, H., Gutherz, X., & Roudil, J. L. (1987). Les sépultures de la baume Bourbon à Cabrières (Gard). In J. Guilaine (Ed.), *Premières communautés paysannes en Méditerranée occidentale : actes du Colloque International du C.N.R.S. (Montpellier, 26-29 avril 1983)* (pp. 531–535). Éditions du CNRS Paris.

Cottini, M., Ferrari, A., Pellegatii, P., Petrucci, G., Rottoli, M., & Tasca, G. (1997). *Bannia-Palazzine sopra (Fiume Veneto, Pordenone): scavo 1995*. Atti della Società per la Preistoria e Protostoria della Regione Friuli-Venizia Giulia 10.

Courtin, J., & Erroux, J. (1974). Aperçu sur l'agriculture préhistorique dans le Sud-Est de la France. *Bulletin de La Société Préhistorique Française*, *71*(1), 321–334.

Coward, F., Shennan, S., Colledge, S., Conolly, J., & Collard, M. (2008). The spread of Neolithic plant economies from the Near East to northwest Europe: a phylogenetic analysis. *Journal of Archaeological Science*, *35*(1), 42–56. https://doi.org/10.1016/j.jas.2007.02.022

Cristiani, E., Pedrotti, A., & Gialanella, S. (2009). Tradition and innovation between the Mesolithic and Early Neolithic in the Adige Valley (Northeast Italy). New data from a functional and residues analyses of trapezes from Gaban rockshelter. *Documenta Praehistorica*, *36*(1), 191–205. https://doi.org/10.4312/dp.36.12

Curdy, P. (2007). Prehistoric settlement in middle and high altitudes in the Upper Rhone Valley (Valais-Vaud, Switzerland): A summary of twenty years of research. *Preistoria Alpina*, *42*(December), 99–108.

Czajkowska, B. I., Bogaard, A., Charles, M., Jones, G., Kohler-Schneider, M., Mueller-Bieniek, A., & Brown, T. A. (2020). Ancient DNA typing indicates that the "new" glume wheat of early Eurasian agriculture is a cultivated member of the Triticum timopheevii group. *Journal of Archaeological Science*, *123*, 1–5. https://doi.org/10.1016/j.jas.2020.105258

de Vareilles, A., Bouby, L., Jesus, A., Martin, L., Rottoli, M., Vander Linden, M., & Antolín, F. (2020). One sea but many routes to Sail. The early maritime dispersal of Neolithic crops from the Aegean to the western Mediterranean. *Journal of Archaeological Science: Reports*, *29*(April 2019), 102140. https://doi.org/10.1016/j.jasrep.2019.102140

Degasper, N., Mottes, E., & Rottoli, M. (2006). Recenti indagini nel sito neolitico de la Vela di Trento. In B. Bagolini, A. Pessina, & P. Visentini (Eds.), *Preistoria dell'Italia settentrionale : studi in ricordo di Bernardino Bagolini : atti del convegno, Udine, 23-24 settembre 2005. Museo Friulano di Storia Naturale 53* (pp. 143–168). Edizioni del Museo friulano di storia naturale.

Degasperi, N., & Steffè, G. (Eds.). (2019). *Il villaggio neolitico di Lugo di Romagna - Fornace Gattelli : strutture, ambiente, culture*. Istituto italiano di preistoria e protostoria.

Della Casa, P. (2007). Transalpine pass routes in the Swiss Central Alps and the strategic use of topographic resources. *Preistoria Alpina*, *42*, 109–118.

Demoule, J. P. (2012). Rescue archaeology: A european view. *Annual Review of Anthropology*, *41*(March), 611–626. https://doi.org/10.1146/annurev-anthro-092611-145854

Denaire, A., Doppler, T., Nicod, P.-Y., & van Willigen, S. (2011). Espaces culturels, frontières et interactions au 5ème millénaire entre la plaine du Rhin supérieur et les rivages de la Méditerranée. *Annuaire d'Archéologie Suisse*, *94*, 21–59.

Denaire, A., Jeunesse, C., & Lefranc, P. (2011). Chronologie absolue de la séquence Hinkelstein-Grossgartach-Roessen-Bischheim dans le sud de la plaine du Rhin supérieur et le nord de la Franche-Comté à la lumière des dernières données. In A. Denaire, C. Jeunesse, & P. Lefranc (Eds.), *Nécropoles et enceintes danubiennes du Ve millénaire* *dans le Nord-Est de la France et le Sud-Ouest de l'Allemagne, actes de la table ronde internationale de Strasbourg organisée le 2 juin 2010 à la Maison interuniversitaire des sciences de l'homme-Alsace* (pp. 9–30). Université de Strasbourg. Monographies d'archéologie du Grand Est 5.

Denaire, A., Lefranc, P., Wahl, J., Bronk Ramsey, C., Dunbar, E., Goslar, T., Bayliss, A., Beavan, N., Bickle, P., & Whittle, A. (2017). The Cultural Project: Formal Chronological Modelling of the Early and Middle Neolithic Sequence in Lower Alsace. *Journal of Archaeological Method and Theory*, *24*(4), 1072–1149. https://doi.org/10.1007/S10816-016-9307-X/FIGURES/28

Denaire, A., & van Willigen, S. (2020). Les structures et leur attribution culturelle. In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schimitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 101–116). Presses Universitaires de Provence.

Dennell, R. W. (1992). The origins of European crop agriculture. In P. J. Watson & W. Cowan (Eds.), *The Origins of Crop Agriculture* (pp. 71–100). Smithsonian Institute Publications.

Dietsch, M.-F. F. (1996). Gathered fruits and cultivated plants at Bercy (Paris), a Neolithic village in a fluvial context. *Vegetation History and Archaeobotany*, *5*(1–2), 89–97. https://doi.org/10.1007/BF00189438

Dittbrenner, A., Lohwasser, U., Mock, H. P., & Börner, A. (2008). Molecular and phytochemical studies of Papaver somniferum in the context of infraspecific classification. *Acta Horticulturae*, *799*, 81–88. https://doi.org/10.17660/ActaHortic.2008.799.9

Dittbrenner, A., Mock, H. P., Börner, A., & Lohwasser, U. (2009). Variability of alkaloid content in Papaver somniferum L. *Journal of Applied Botany and Food Quality*, *82*(2), 103–107.

Dubesset, D., Bouchet, M., Poirier, P., Rodet-Belarbi, I., Sargiano, J.-P., Sivan, O., & Wattez, J. (2018). *Un habitat du Néolithique final dans les Hautes-Alpes à Gap, village automobile de Lachaup (HautesAlpes). Rapport final d'opération, fouille préventive*. Inrap Méditerranée.

Erroux, J. (1971). Quelquels bles archeologiques du midi de la France 1965-1970. *Acta Museorum Agriculrurae Pragae*, *VI*, 19–35.

Erroux, J. (1985). Les macrorestes végétaux. In H. Baills, D. Serge, & C. Jacques (Eds.), *La grotte d ' Engorner Contribution à la connaissance du Néolithique est- pyrénéen* (pp. 69–72). Université de Perpignan.

Erroux, J. (1988). Etude des grains, fruits et graines de la grotte de Saint-Marcel (Ardèche). *Ardèche Archeologie*, *5*, 42–45.

Evett, D., & Renfrew, J. (1971). L'agricoltura neolitica italiana: una nota sui cereali. *Rivista Di Scienze Preistoriche*, *26*, 403–409.

Favre, P. (2002). Archäobotanik. In C. Achour-Uster, U. Eberli, R. Ebersbach, & P. Favre (Eds.), *Die Seeufersiedlungen in Horgen. Die neolithischen und bronzezeitlichen Fundstellen Dampfschiffsteg und Scheller* (Vol. 36, pp. 150–180). Monographien des Kantonsarcheologie 36.

Festi, D., Tecchiati, U., Steiner, H., & Oeggl, K. (2011). The Late Neolithic settlement of Latsch, Vinschgau, northern Italy: Subsistence of a settlement contemporary with the Alpine Iceman, and located in his valley of origin. *Vegetation History and Archaeobotany*, *20*(5), 367–379. https://doi.org/10.1007/s00334-011-0308-0

Figueiral, I. (2010). Les vestiges végétaux carbonisés : carpologie et anthracologie. In M. Gandelin (Ed.), *Autoroute A75 - Section Béziers - Pézenas Hérault, Valros Roquessols Un habitat ouvert du Néolithique final - Rapport final d' opération Fouille archéologique* (pp. 198–202). Inrap Méditerranée.

Figueiral, I. (2012). Les vestiges végétaux carbonisés. In H. Vergély, R. Haurillon, & G. Sanchez (Eds.), *Les occupations humaines du Barreau de la Devèze Sud Vol.1* (pp. 402–406). Rapport final d'opération. Fouille archéologique. Inrap Méditerranée.

Figueiral, I. (2015). L'apport de l'archéobotanique. In D. Dubesset & O. Sivan (Eds.), *Étude géoarchéologique d'une séquence du Néolithique moyen : Villa Lympia, 20 rue Fodéré à Nice (Alpes-Maritimes), Rapport de fouille archéologique* (pp. 99–107). Inrap Méditerranée.

Figueiral, I. (2016). Les restes végétaux carbonisés. In F. Convertini & C. Georjon (Eds.), *Le Champ du Poste (Carcassonne, Aude). Une succession d'occupations du début du Néolithique moyen à l'âge du Bronze ancien.* (pp. 239–242). Inrap Méditerranée.

Figueiral, I. (2018). Les restes végétaux carbonisés. In F. Convertini & C. Georjon (Eds.), *Le Champ du Poste (Carcassonne, Aude). Une succession d'occupations du début du Néolithique moyen à l'âge du Bronze ancien.* (pp. 239–242). Archives d'Ecologie Préhistorique.

Figueiral, I. (2019). La carpologie : Les semences de la fosse 3001. In C. Rigeade (Ed.), *Bouc-Bel-Air, avenue des Noyers à Final, (Bouches-du-Rhône). Vol . I* (pp. 223–227). Rapport d'opération, fouille archéologique Méditerranée. Inrap Midi.

Figueiral, I., Fabre, L., & Chabal, L. (2013). The answer is deep down in the well : charcoal and waterlogged wood from archaeological wells in southern France. In F. Damblon (Ed.), *Proceedings of the Fourth International Meeting of Anthracology Brussels, 8–13 September 2008 Royal Belgian Institute of Natural Sciences* (pp. 83–92). BAR International Series 2486.

Figueiral, I., & Ivorra, S. (2017). L'exploitation des ressources végétales d'après la Carpologie et l'Anthracologie. In Anne Hasler (Ed.), *Provence - Alpes - Côte d'Azur Bouches-du-Rhône, Trets ZAC de La Burlière, «des premières communautés paysannes à la fin du Néolithique»* (Vol. 1, pp. 125–135). Rapport final d'opération. Fouille archéologique. Inrap Méditerranée.

Figueiral, I., & Rousselet, O. (2015). Méthodes d'étude des restes végétaux : graines / fruits et charbons de bois. In M. Gandelin (Ed.), *Autoroute A75 - Section Béziers - Pézenas, Hérault, Valros et Montblanc, « Aire de Repos de Valros »,Les occupations du Néolithique et du Bronze ancien* (Vol. 3, pp. 214-216;329-333).

Figueiral, I., & Séjalon, P. (2014). Archaeological wells in southern France : Late Neolithic to Roman plant remains from Mas de Vignoles IX (Gard) and their implications for the study of settlement , economy and environment. *Environmental Archaeology*, *19*(1), 23–38.

Filipović, D., Meadows, J., Corso, M. D., Kirleis, W., Alsleben, A., Akeret, Ö., Bittmann, F., Bosi, G., Ciută, B., Dreslerová, D., Effenberger, H., Gyulai, F., Heiss, A. G., Hellmund, M., Jahns, S., Jakobitsch, T., Kapcia, M., Klooß, S., Kohler-Schneider, M., … Zerl, T. (2020). New AMS 14C dates track the arrival and spread of broomcorn millet cultivation and agricultural change in prehistoric Europe. *Scientific Reports*, *10*(1), 13698. https://doi.org/10.1038/s41598-020-70495-z

Filipović, D., Meadows, J., Wiethold, J., Jahns, S., Bittmann, F., & Kirleis, W. (2018). Before and after: millet cultivation and the transformation of prehistoric crop production in northern Germany. *Antiquity*, *92*(365), 1–6. https://doi.org/10.15184/aqy.2018.225

Follmann, F. (2017). *Les Bagnoles: botanische makroreste aus drei brunnen des südfranzösischen néolithique moyen und ihre bedeutung für ernährung und landwirtschaft*. Basel Universität.

Fredskild, B. (1978). Seeds and Fruits of the Neolithic Settlement Weier, Switzerland. *Botanisk Tidsskrift*, *72*, 189–201.

Fritsch, R. (1979). Zur Samenmorphologie des Kulturmohns (Papaver somniferum L.). *Die Kulturpflanze*, *27*(2), 217–227. https://doi.org/10.1007/BF02014652

Fuller, D., & Harvey, E. L. (2006). The archaeobotany of Indian pulses: identification, processing and evidence for cultivation. *Environmental Archaeology*, *11*(2), 219–246. https://doi.org/10.1179/174963106x123232

Fuller, D., Stevens, C. J., & McClatchie, M. (2014). Routine activities, tertiary refuse and labor organization: social inferences from everyday archaeobotany. In M. Savard, C. Lancelotti, & M. Madella (Eds.), *Ancient plants and people, contemporary trends in archaeology.* (pp. 174–217). University of Arizona Press.

Gaastra, J. S., de Vareilles, A., & Vander Linden, M. (2022). Bones and Seeds: An Integrated Approach to Understanding the Spread of Farming across the Western Balkans. *Environmental Archaeology*, *27*(1), 44–60. https://doi.org/10.1080/14614103.2019.1578016

Gallay, A. (2008). *Des Alpes au Léman : images de la préhistoire* (2nd editio). Infolio.

Garcia, F. J. C., & Montaña, M. M. (2009). Habitations et habitats au début du Néolithique en Catalogne (5500-3500 av. J.-C.). In A. Beeching & I. Sénépart (Eds.), *De la maison au village. L'habitat néolithique dans le Sud de la France et le Nord-Ouest méditerranéen, actes de la table ronde (Marseille, 23-24 mai 2003) Musée d'Histoire de la Ville de Marseille, Mémoire 48* (pp. 73–86). Société Préhistorique Française.

Garnock-Jones, P. J., & Scholes, P. (1990). Alkaloid content of papaver somniferum subsp. setigerum from New Zealand. *New Zealand Journal of Botany*, *28*(3), 367–369. https://doi.org/10.1080/0028825X.1990.10412320

Gassiot Ballbè, E., Mazzucco, N., Clemente Conte, I., Rodríguez Antón, D., Obea Gómez, L., Quesada Carrasco, M., & Díaz Bonilla, S. (2017). The Beginning of High Mountain Occupations in the Pyrenees. Human Settlements and Mobility from 18,000 cal BC to 2000 cal BC. In J. Catalan, J. Ninot, & M. Aniz (Eds.), *High Mountain Conservation in a Changing World. Advances in Global Change Research, vol 62.* (pp. 75–105). Springer International Publishing. https://doi.org/10.1007/978-3-319-55982-7_4

Gattis, G. de, Curdy, P., Ferroni, A. M., Martinet, F., Keller, R. P., Raiteri, L., Sarti, L., Zidda, G., & Mezzena, F. (Eds.). (2018). *Area megalitica Saint-Martin-de- Corleans. Una visione aggiornata , Documenti 13*. Le Château Edizioni.

Gernigon, K. (2016a). Sphère d'interactions, complexe culturel: clefs de lecture de la variabilité géographique des expressions stylistiques du Chasséen. In T. Perrin, P. Chambon, J. F. Gibaja, & G. Goude (Eds.), *Le Chasséen, des Chasséens… Retour sur une culture nationales et ses parallèles, Sepulcres de fossa, Cortaillod, Lagozza. Actes du colloque international tenu à Paris (France) du 18 au 20 novembre 2014* (pp. 29–45). Archives d'Écologie Préhistorique. https://hal-univ-tlse2.archives-ouvertes.fr/hal-02097713

Gernigon, K. (2016b). Les villages avant les maisons ? La néolithisation de l'Europe au prisme de la maisonnée. *Palethnologie*, *8*. https://doi.org/10.4000/palethnologie.460

Gibaja, J. F., Ibáñez, J. J., Nielsen, E. H., Kienholz, A., van Willigen, S., & Linton, J. (2017). The Neolithic reaping knives from Egolzwil 3: A Mediterranean technical tradition in the late 5th millennium Swiss Neolithic. *Quaternary International*, *427*, 211–224. https://doi.org/10.1016/j.quaint.2015.12.075

Giligny, F., & Sénépart, I. (2018). Construire et habiter au Néolithique. In J. Guilaine & D. Garcia (Eds.), *La Protohistoire de la France* (pp. 27–51). Hermann.

Gnepf Horisberger, U., Deschler-Erb, S., Kühn, M., & Spörri, D. (2005). Die ältest Baarer Werkstatt? Das schnurkeramische Grubenhaus an der Früebergstrasse in Baar. *Tugium*, *21*, 115–137.

Gobbo, I. (2010). *Archeobotanica di siti mesolitici, neolitici ed eneolitici di pianura dell'Emilia Romagna. Doctoral Thesis*. Università degli Studi di Ferrara.

Grauso, L., de Falco, B., Motti, R., & Lanzotti, V. (2021). Corn poppy, Papaver rhoeas L.: a critical review of its botany, phytochemistry and pharmacology. *Phytochemistry Reviews*, *20*(1), 227–248. https://doi.org/10.1007/s11101-020-09676-7

Guedes, J. D. A., & Spengler, R. N. (2014). Sampling strategies in paleoethnobotanical analysis. In J. M. Marston, J. D. A. Guedes, & C. Warinner (Eds.), *Method and Theory in Paleoethnobotany* (pp. 77–94). University Press of Colorado. https://doi.org/10.5876/9781607323167.c005

Guerra, M. R., de Lagrán, I. G. M., & Garrido-Pena, R. (2012). *El Neolítico en la Península Ibérica y su contexto europeo*. Cátedra.

Guilaine, J. (2004). Les Campaniformes et la Méditerranée. *Bulletin de La Société Préhistorique Française*, *101*(2), 239–249. https://doi.org/10.3406/BSPF.2004.12991

Guilaine, J., & Manen, C. (2007). From Mesolithic to early Neolithic in the western Mediterranean. In A. Whittle & V. Cummings (Eds.), *Going over: The Mesolithic-Neolithic Transition in the North-West Europe* (pp. 21–51). Oxford University Press. https://doi.org/10.5871/bacad/9780197264140.003.0003

Guilaine, J., Manen, C., Vigne, J.-D., & Ambert, P. (2007). *Pont de Roque-Haute: nouvaux regards sur la néolithisation de la France méditerrannéenne*. Archives d'Écologie Préhistorique.

Gunz, P. (2020). Geometric Morphometrics. In M. P. Richards & K. Britton (Eds.), *Archaeological Science An Introduction* (pp. 198–212). Cambridge University Press. https://doi.org/10.1017/9781139013826.009

Gustafsson, S. (2000). Carbonized cereal grains and weed seeds in prehistoric houses-an experimental perspective. *Journal of Archaeological Science*, *27*(1), 65–70.

https://doi.org/10.1006/jasc.1999.0441

Haas, J. N., Karg, S., & Starnberger, R. (2007). Vegetationswandel, Klima und prähistorische Landwirtschaftssysteme im Umfeld der Pfahlbausiedlung Pfyn Breitenloo. In U. Leuzinger & J. N. Haas (Eds.), *Breitenloo - die jungsteinzeitliche Pfahlbausiedlung* (pp. 111–134). Departement für Erziehung und Kultur des Kantons Thurgau.

Hadipour, M., Kazemitabar, S. K., Yaghini, H., & Dayani, S. (2020). Genetic diversity and species differentiation of medicinal plant Persian Poppy (Papaver bracteatum L.) using AFLP and ISSR markers. *Ecological Genetics and Genomics*, *16*, 100058. https://doi.org/10.1016/j.egg.2020.100058

Hafner, A. (2012). Archaeological Discoveries on Schnidejoch and at Other Ice Sites in the European Alps. *ARCTIC*, *65*(5), 189–202. https://doi.org/10.14430/arctic4193

Hafner, A., & Suter, P. (2001). Das Neolithikum der Schweiz im 4. Jahrtausend v.Chr. - Traditionen, Einflüsse und Entwicklungen. *Archäologische Informationen*, *24*(2), 291–309. https://doi.org/10.11588/ai.2001.2.13680

Hafner, A., & Suter, P. (2003). Das Neolithikum Schweiz. *Journal of Neolithic Archaeology*. https://doi.org/10.12766/jna.2003.4

Hallavant, C. (2013). Note carpologique. In Julien Vial (Ed.), *Aéropole Gap-Tallard (Hautes-Alpes), Habitat chasséen et emsemble monumental de l'Age du Fer en Moyenne Durance - Rapport final d'opération archéologique Préventive* (Vol. 1, pp. 75–76). HADÈS.

Hammer, K. (1981). Problems of Papaver somniferum-classification and some remarks on recently collected European poppy land-races. *Die Kulturpflanze*, *29*(1), 287–296.

Hammer, K., & Fritsch, R. (1977). Zur Frage nach der Ursprungsart des Kulturmohns Papaver somniferum L. *Die Kulturpflanze*, *25*(1), 113–124. https://doi.org/10.1007/BF02014808

Hamon, C., & Manen, C. (2021). The Mechanisms of Neolithisation of Western Europe: Beyond a South/North Approach. *Open Archaeology*, *7*(1), 718–735. https://doi.org/10.1515/opar-2020-0164

Harb, C., & Bleicher, N. (2016). *Zürich-Parkhaus Opéra : eine neolithische Feuchtbodenfundstelle. Band 2: Funde.* Baudirektion Kanton Zürich, Kantonsarchäologie.

Harrington, B. (2005). *Inkscape*. https://www.inkscape.org/

Harris, S. (2014). Flax fibre: Innovation and Change in the Early Neolithic A Technological and Material Perspective. *Textile Society of America 2014 Biennial Symposium Proceedings: New Directions: Examining the Past, Creating the Future, Los Angeles, California, September 10–14, 2014*, *Paper 913*, 10.

Heer, O. (1866). Treatise on the plants of the lake dwellings. In F. Keller (Ed.), *Plants and seeds of the lake dwellings* (pp. 336–350). Longmans.

Heiss, A. G. (2014). Ceremonial Foodstuffs from Prehistoric Burnt-Offering Places in the Alpine Region. In A. Chevalier, E. Marinova, & L. Peña-Chocarro (Eds.), *Plants and People: Choices and Diversity through Time - Early agricultural remnants and technical heritage (EARTH) : 8,000 years of resilience and innovation, volume 1.* (pp. 343–384). Oxford: Oxbow Books.

Heiss, A. G., Antolín, F., Bleicher, N., Harb, C., Jacomet, S., Kühn, M., Marinova, E., Stika, H.-P., & Valamoti, S.-M. (2017). State of the (t)art. Analytical approaches in the investigation of components and production traits of archaeological bread-like objects, applied to two finds from the Neolithic lakeshore settlement Parkhaus Opéra (Zürich, Switzerland). *PLoS ONE*, *12*(8), 1–30. https://doi.org/10.1371/journal.pone.0182401

Heiss, A. G., & Oeggl, K. (2009). The plant macro-remains from the Iceman site (Tisenjoch, Italian-Austrian border, eastern Alps): New results on the glacier mummy's environment. *Vegetation History and Archaeobotany*, *18*(1), 23–35. https://doi.org/10.1007/s00334-007-0140-8

Herbig, C., & Maier, U. (2011). Flax for oil or fibre? Morphometric analysis of flax seeds and new aspects of flax cultivation in Late Neolithic wetland settlements in southwest Germany. *Vegetation History and Archaeobotany*, *20*(6), 527–533. https://doi.org/10.1007/s00334-011-0289-z

Herbig, C., Maier, U., & Stäuble, H. (2013). „ Neolithische Füllhörner " Archäobotanische Untersuchungen in fünf linienbandkeramischen Brunnen in Westsachsen. *Offa*, *69/70*, 265–293.

Hillman, G. C., Mason, S., de Moulins, D., & Nesbitt, M. (1996). Identification of archaeological remains of wheat: the 1992 London workshop. *Circaea*, *12*(2), 195–209.

Hnila, P. (2002). Some remarks on the Opium Poppy in Ancient Anatolia. In R. Aslan, D. Thumm, F. Schweizer, G. Kastl, & S. Blum (Eds.), *Mauerschau. Festschrift fur Manfred Korfmann Band 1* (pp. 315–328). Verlag Bernhard Albert Greiner.

Hoffstadt, J., & Maier, U. (1999). Handelsbeziehungen während des Jungneolithikums im westlichen Bodenseeraum am Beispiel der Fundplätze Mooshof und Hornstaad Hörnle IA. *Archäologisches Korrespondenzblatt*, *29*(1), 21–34.

Hopf, M. (1971). Vorgeschichliche Pflanzenreste aus Ostspanien. *Sonderdruck Aus Den Madrider Mitteilungen*, *12*, 101–114.

Hopf, M. (1975). Fosses Neolithiques D'Entzheim (Bas-Rhin). *Revue Archéologique de l'Est et Du Centre-Est*, *XXVI*, 115–117.

Hosch, S. (2004). *Ackerbau und Sammelwirtschaft in der neolithischen Seeufersiedlung Arbon Bleiche 3 (3384-3370 v.Chr.), Kanton Thurgau, Schweiz. Doctoral Thesis*.

Hosch, S., & Jacomet, S. (2001). New aspects of archaeobotanical research in Central European Neolithic Lake Dwelling Sites. *Environmental Archaeology*, *6*(1), 59–71. https://doi.org/10.1179/env.2001.6.1.59

Hosokawa, K., Shibata, T., Nakamura, I., & Hishida, A. (2004). Discrimination among species of Papaver based on the plastid rpl16 gene and the rpl16-rpl14 spacer sequence. *Forensic Science International*, *139*(2–3), 195–199. https://doi.org/10.1016/j.forsciint.2003.11.001

Hrishi, N. J. (1960). Cytogenetical studies on Papaver somniferum L. and Papaver setigerum DC. and their hybrid. *Genetica*, *XXXI*, 1–130.

Hubbard, R. N. L. B., & Clapham, A. (1992). Quantifying macroscopic plant remains. *Review of Palaeobotany and Palynology*, *73*(1–4), 117–132. https://doi.org/10.1016/0034-6667(92)90050-Q

Hügin, U., & Michel-Tobler, C. (2004). Oberrieden ZH-Riet - eine frühhorgenzeitliche Siedlung. *Jahrbuch Der Schweizerischen Gesellschaft Für Ur- Und Frühgeschichte*, *87*, 7–31. https://www.e-periodica.ch/digbib/view?pid=jas-003%3A2004%3A87%3A%3A10#10

Ivanova, M., De Cupere, B., Ethier, J., & Marinova, E. (2018). Pioneer farming in southeast Europe during the early sixth millennium BC: Climate-related adaptations in the exploitation of plants and animals. *PLoS ONE*, *13*(5), e0197225. https://doi.org/10.1371/journal.pone.0197225

Jacomet, S. (1981). Neue Untersuchungen botanischer Grossreste an jungsteinzeitlichen Seeufersiedlungen im Gebiet der Stadt Zürich (Schweiz). *Zeitschrift Für Archäologie*, *15*, 125–140.

Jacomet, S. (1986a). Kulturpflanzenfunde aus der neolithischen Seeufersiedlung Cham-St. Andreas (Zugersee). *Jahrbuch Der Schweizerischen Gesellschaft Für Ur- Und Frühgeschichte*, *69*, 55–62.

Jacomet, S. (1986b). Zur Morphologie subfossiler Samen und Früchte aus postglazialen See- und Kulturschichtsedimenten der neolithischen Siedlungsplätze "AKAD-Seehofstrasse" und "Pressehaus" am untersten Zürichsee. *Botanica Helvetica*, *96*(2), 159–204. https://www.e-periodica.ch/cntmng?type=pdf&pid=bhl-002:1986:96::336

Jacomet, S. (1987). Ackerbau, Sammelwirtschaft und Umwelt der Egolzwiler- und Cortaillod-Siedlungen auf dem Kleinen Hafner in Zürich.Ergebnisse samenanalytischer Untersuchungen. In P. Suter (Ed.), *Zürich "Kleiner Hafner". Tauchgrabungen 1981-1984* (Vol. 3, pp. 144–166). Berichte der Zürcher Denkmalpflege, Monographien 3.

Jacomet, S. (1996). *Untersuchung der botanischen Makroreste aus dem neolithischen (Horgener K.) Grubenhaus von Neftenbach- Aspach, FK 86, Brandstelle B. unpublished*.

Jacomet, S. (2004). Archaeobotany: A vital tool in the investigation of lake-dwellings. In F. Menotti (Ed.), *Living on the Lake in Prehistoric Europe: 150 Years of Lake-Dwelling Research* (pp. 162–177). Abingdon. https://doi.org/10.4324/9780203583203

Jacomet, S. (2006a). *Identification of cereal remains from archaeological sites*. Basel University.

Jacomet, S. (2006b). Plant economy of the northern Alpine lake dwellings - 3500-2400 cal. BC. *Environmental Archaeology*, *11*(1), 65–85. https://doi.org/10.1179/174963106x97061

Jacomet, S. (2007). Neolithic plant economies in the northern Alpine Foreland from 5500-3500 cal. BC. In S. Colledge & J. Conolly (Eds.), *The Origins and Spread of Domestic Plants in Southwest Asia and Europe* (pp. 221–258). Left Coast Press. https://edoc.unibas.ch/15474/

Jacomet, S. (2008). Subsistenz und Landnutzung während des 3. Jahrtausends v. Chr. aufgrund von archäobotanischen Daten aus dem südwestlichen Mitteleuropa. In W. Dörfler & J. Müller (Eds.), *Umwelt - Wirtschaft - Siedlungen im dritten vorchristlichen Jahrtausend Mitteleuropas und Südskandinaviens. Offa-Bücher 84* (pp. 355–377).

Jacomet, S. (2009). Plant economy and village life in Neolithic lake dwellings at the time of the Alpine Iceman. *Vegetation History and Archaeobotany*, *18*(1), 47–59. https://doi.org/10.1007/s00334-007-0138-2

Jacomet, S. (2013). Archaeobotany: analyses of plant remains from waterlogged archaeological sites. In F. Menott & A. O'Sullivan (Eds.), *The Oxford Handbook of*

Wetland Archaeology (pp. 497–514). Oxford University Press.

Jacomet, S. (2014). Crop diversity in Southwestern central Europe from the neolithic onwards. In A. Chevalier, E. Marinova, & L. Peña-Chocarro (Eds.), *Plants and People: Choices and Diversity through Time - Early agricultural remnants and technical heritage (EARTH) : 8,000 years of resilience and innovation, volume 1.* (pp. 82–139). Oxbow Books. https://doi.org/10.1201/b19281

Jacomet, S. (2020). Environnement végetal naturel et paysage. In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 60–77). Presses Universitaires de Provence.

Jacomet, S., & Brombacher, C. (2005). Reconstructing intra-site patterns in Neolithic lakeshore settlements: the state of archaeobotanical research and future prospects. In P. Della Casa & M. Trachsel (Eds.), *WES'04. Wetland economies and societies. Proceedings of the International Conference Zurich, 10-13 March 2004* (pp. 69–94). Collectio Archaeologica 3.

Jacomet, S., Brombacher, C., & Dick, M. (1989). *Archäobotanik am Zürichsee.* Zürcher Denkmalpflege, Monographien 7.

Jacomet, S., Brombacher, C., & Dick, M. (1991). Palaeoetnobotanical work on Swiss Neolithic and Bronze Age lake dwellings over the past ten years. In J. Renfrew (Ed.), *New light on early farming: recent developments in palaeoethnobotany. Proceedings of the 7th Symposium of the IWGP. Cambridge 1986* (pp. 256–276). Edinburgh University Press.

Jacomet, S., & Kreuz, A. (1999). *Archäobotanik. Aufgaben, Methoden und Ergebnisse vegetations- und agrargeschichtlicher Forschung*. Ulmer.

Jacomet, S., & Schlichtherle, H. (1984). Der kleine Pfahlbauweizen Oswald Heer's - Neue Untersuchungen zur Morphologie neolithischer Nacktweizen-Ähren. In W. A. van Zeist & W. A. Casparie (Eds.), *Plants and Ancient Man: Studies in Palaeoethnobotany: Proceedings of the Sixth Symposium of the International Work Group for Palaeoethnobotany, Groningen, 30 May - 3 June 1983* (pp. 153–176). A.A. Balkema.

Jacomet, S., & Steiner, B. L. (n.d.). *Archäobotanik des «Pfyn» (4. Jt. BCE) im Rahmen des Jungneolithikums in Mitteleuropa: Eine Fallstudie der Seeufersiedlung Risch, Oberrisch-Aabach am Zuger See (Kt. Zug), mit spezieller Berücksichtigung der Erhaltungsproblematik).*

Jacomet, S., & Wagner, C. (1987). Verkohlte Pflanzenreste aus der Horgener Kulturschicht von Zug-Vorstadt 26. *Jahrbuch Der Schweizerischen Gesellschaft Für Ur- Und Frühgeschichte*, *70*, 175–180.

Jallot, L., & Gutherz, X. (2014). Le Néolithique final en Languedoc oriental et ses marges : 20 ans après. In I. Sénépart, F. Leandri, J. Cauliez, T. Perrin, & É. Thirault (Eds.), *Chronologie de la Préhistoire récente dans le Sud de la France Actualité de la recherche, Actes des 10e Rencontres méridionales de Préhistoire récente Porticcio (20) - 18 au 20 octobre 2012* (pp. 137–158). Archives d'Écologie Préhistorique.

Jesus, A. (2016). *Negotiating Personhood: disposal of animal remains in mortuary practices at the beginning of the adoption of domestic animals in South Scandinavia and Netherlands*. Leiden University.

Jesus, A., & Antolín, F. (2021). Evidence of the presence and use of Neolithic oil plants in the NW of the Mediterranean and the Swiss Plateau. In M. B. Azorín, R. Piqué, M. M. Seijo, & O. López-Bultó (Eds.), *The missing woodland resources* (Vol. 4, pp. 23–40). Barkhuis Publishing. https://doi.org/10.2307/j.ctv23wf366.5

Jesus, A., Bonhomme, V., Evin, A., Ivorra, S., Soteras, R., Salavert, A., Antolín, F., & Bouby, L. (2021). A morphometric approach to track opium poppy domestication. *Scientific Reports*, *11*(1), 9778. https://doi.org/10.1038/s41598-021-88964-4

Jesus, A., Prats, G., Follmann, F., Jacomet, S., & Antolín, F. (2021). Middle Neolithic farming of open-air sites in SE France: new insights from archaeobotanical investigations of three wells found at Les Bagnoles (L'Isle-sur-la-Sorgue, Dépt. Vaucluse, France). *Vegetation History and Archaeobotany*, *30*(4), 445–461. https://doi.org/10.1007/s00334-020-00793-z

Jesus, A., Tereso, J. P., & Gaspar, R. (2020). Interpretative trajectories towards the understanding of negative features using Terraço das Laranjeiras Bronze Age site as a case study. *Journal of Archaeological Science: Reports*, *30*, 102222. https://doi.org/10.1016/j.jasrep.2020.102222

Jeunesse, C., van Willigen, S., & Denaire, A. (2019). Les sépultures de type Chamblandes et la géographie des systèmes funéraires en Europe centrale et occidentale au 5ème millénaire avant J.-C. In M. Maffi, L. Bronzoni, & P. Mazzieri (Eds.), *Le quistioni nostre paletnologiche più importanti… Trent'anni di tutela e ricerca preistorica in Emilia occidentale, Atti del Convegno di Studi in onore di Maria Bernabò Brea* (pp. 65–80). Archeotravo Cooperativa Sociale - Museo Civico Archeologico di Travo - Parco Archeologico Villaggio Neolitico di Travo. https://hal.archives-ouvertes.fr/hal-02550076

Jones, G. (1990). The application of present-day cereal processing studies to charred archaeobotanical remains. *Circaea*, *6*(2), 91–96.

Jones, G. (1991). Numerical analysis in archaeobotany. In W. Van Zeist, K. Wasylikowa, & K.-E. Behre (Eds.), *Progress in old world palaeoethnobotany: A retrospective view on the occasion of 20 years of the International Work Group for Palaeoethnobotany* (pp. 63–80). Balkema.

Jones, G., Jones, H., Charles, M., Jones, M., Colledge, S., Leigh, F. J., Lister, D. A., Smith, L. M. J., Powell, W., & Brown, T. A. (2012). Phylogeographic analysis of barley DNA as evidence for the spread of Neolithic agriculture through Europe. *Journal of Archaeological Science*, *39*(10), 3230–3238. https://doi.org/10.1016/j.jas.2012.05.014

Jones, G., Valamoti, S.-M., & Charles, M. (2000). Early crop diversity: A "new" glume wheat from northern Greece. *Vegetation History and Archaeobotany*, *9*(3), 133–146. https://doi.org/10.1007/BF01299798

Jones, H., Lister, D. L., Cai, D., Kneale, C. J., Cockram, J., Peña-Chocarro, L., & Jones, M. (2016). The trans-Eurasian crop exchange in prehistory: Discerning pathways from barley phylogeography. *Quaternary International*, *426*, 26–32. https://doi.org/10.1016/j.quaint.2016.02.029

Jones, M. (1991). Sampling in paleoethnobotany. In W. Van Zeist, K. Wasylikowa, & K.-E. Behre (Eds.), *Progress in old world palaeoethnobotany: A retrospective view on the occasion of 20 years of the International Work Group for Palaeoethnobotany* (pp. 53–80). Balkema.

Jørgensen, G. (1975). Triticum aestivum s.l. from the Neolithic Site of Weier in Switzerland.

Folia Quaternaria, *46*, 7–21.

Juan-Tresserras, J., & Villalba, M. J. (1999). Consumo de la adormidera (Papaver somniferum L.) en el Neolítico Peninsular: el enterramiento M28 del complejo minero de Can Tintorer. *SAGVNTVM*, *2*, 397–404.

Kadereit, J. (1988). Sectional affinities and geographical distribution in the genus Papaver L.(Papaveraceae). *Beiträge Zur Biologie Der Pflanzen*, *63*, 139–156.

Kadereit, J. (1997). The genus Papaver L. in the mediterranean area. *Lagascalia*, *19*(1), 83–92.

Kadereit, J., Preston, C. D., & Valtueña, F. J. (2011). Is Welsh Poppy, Meconopsis cambrica (L.) Vig. (Papaveraceae), truly a Meconopsis ? *New Journal of Botany*, *1*(2), 80–88. https://doi.org/10.1179/204234811X13194453002742

Karg, S. (2002). *Archäobotanische Funde aus den neolithischen Seeufersiedlungen von Concise-sous-Colachoz am Neuenburger See. Ergebnisse zur Pflanzenkenntnis und Umwelt im 4. und 3. Jahrtausend BC ,unpublished report*.

Karg, S., & Märkle, T. (2002). Continuity and changes in plant resources during the Neolithic period in western Switzerland. *Vegetation History and Archaeobotany*, *11*(1), 169–176. https://doi.org/10.1007/s003340200018

KewScience. (2017a). *Papaver rhoeas L.* Plants of the World Online. http://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:306058-2

KewScience. (2017b). *Papaver somniferum subsp. setigerum (DC.) Arcang.* Plants of the World Online. http://www.plantsoftheworldonline.org/taxon/urn:lsid:ipni.org:names:60453010-2

Kirleis, W., Dal Corso, M., & Filipović, D. (Eds.). (2022). *Millet and What Else?* Sidestone Press. https://library.oapen.org/handle/20.500.12657/54262

Kirleis, W., & Fischer, E. (2014). Neolithic cultivation of tetraploid free threshing wheat in Denmark and Northern Germany: Implications for crop diversity and societal dynamics of the Funnel Beaker Culture. *Vegetation History and Archaeobotany*, *23*(S1), 81–96. https://doi.org/10.1007/s00334-014-0440-8

Kislev, M. E. (1989). Origins of the cultivation of Lathyrus sativus and L. cicera (fabaceae). *Economic Botany*, *43*(2), 262–270. https://doi.org/10.1007/BF02859868

Kislev, M. E., Hartmann, A., & Galili, E. (2004). Archaeobotanical and archaeoentomological evidence from a well at Atlit-Yam indicates colder, more humid climate on the Israeli coast during the PPNC period. *Journal of Archaeological Science*, *31*(9), 1301–1310. https://doi.org/10.1016/j.jas.2004.02.010

Knorzer, K.-H. (1971). Prahistorische Mohnsamen in Rheinland. *Bonner Jahrbücher*, *171*, 34–39.

Kolb, C. C. (2014). Provenance Studies in Archaeology. In *Encyclopedia of Global Archaeology* (pp. 6172–6181). Springer New York. https://doi.org/10.1007/978-1-4419-0465-2_327

Koschel, K. (1996). Opium alkaloids in a cypriote Base Ring I Vessel (Bilbil) of the Middle Bronze Age from Egypt. *Ägypten Und Levante/Egypt and the Levant*, *6*, 159–166. http://www.jstor.org/stable/23788872

Kreuz, A. (2007). Archaeobotanical perspectives on the beginning of agriculture north of the Alps. In S. Colledge & J. Conolly (Eds.), *The Origins and Spread of Domestic Plants in Southwest Asia and Europe* (pp. 275–310). Left Coast Press.

Kreuz, A. (2012). Die Vertreibung aus dem Paradies? Archäobiologische Ergebnisse zum Frühneolithikum im westlichen Mitteleuropa. *Bericht Der Römisch-Germanischen Kommission*, *91*(2010), 23–196.

Kreuz, A., & Marinova, E. (2017). Archaeobotanical evidence of crop growing and diet within the areas of the Karanovo and the Linear Pottery Cultures: a quantitative and qualitative approach. *Vegetation History and Archaeobotany*, *26*(6), 639–657. https://doi.org/10.1007/s00334-017-0643-x

Kreuz, A., Marinova, E., Schäfer, E., & Wiethold, J. (2005). A comparison of Early Neolithic crop and weed assemblages from the Linearbandkeramik and the Karanovo Culture: differences and similarities. *Die Neolithisierung Mitteleuropas : Internationale Tagung, Mainz 24. Bis 26. Juni 2005 = The Spread of the Neolithic to Central Europe : International Symposium, Mainz 24 June--26 June 2005*, *14*(4), 237–258. https://doi.org/10.1007/s00334-005-0080-0

Kreuz, A., Märkle, T., Marinova, E., Rösch, M., Schäfer, E., Schamuhn, S., & Zerl, T. (2014). The Late Neolithic Michelsberg culture - Just ramparts and ditches? A supraregional comparison of agricultural and environmental data. *Prahistorische Zeitschrift*, *89*(1), 72–115. https://doi.org/10.1515/pz-2014-0006

Kreuz, A., Pomázi, P., & Bánffy, E. (2020). Hungarian Neolithic landscapes, crops and diet – Signs of cultural decisions? *Quaternary International*, *560–561*(June), 102–118. https://doi.org/10.1016/j.quaint.2020.06.008

Kreuz, A., & Schäfer, E. (2002). A new archaeobotanical database program. *Vegetation History and Archaeobotany*, *11*(1–2), 177–180. https://doi.org/10.1007/s003340200019

Krikorian, A. D. (1975). Were the opium poppy and opium known in the ancient near east? *Journal of the History of Biology*, *8*(1), 95–114. https://doi.org/10.1007/BF00129597

Krikorian, A. D., & Ledbetter, M. C. (1975). Some observations on the cultivation of opium poppy (Papaver Somniferum L.) for its latex. *The Botanical Review*, *41*(1), 30–103. https://doi.org/10.1007/BF02860836

Kritikos, P., & Papadaki, S. (1967a). The history of the poppy and of opium and their expansion in antiquity in the eastern Mediterranean area. *Bulletin on Narcotics*, *19*(3), 17–35. https://www.unodc.org/unodc/en/data-and-analysis/bulletin/bulletin_1967-01-01_3_page004.html

Kritikos, P., & Papadaki, S. (1967b). *UNODC - Bulletin on Narcotics - 1967 Issue 3 - 003*. https://www.unodc.org/unodc/en/data-and-analysis/bulletin/bulletin_1967-01-01_3_page004.html

Kühn, M., & Schlumbaum, A. (2015). *Reinach BL Fleischbachstrasse (56.84.37): Verkohlte Samen/Früchte und Holzkohlen aus zwei neolithischen Gruben. unpublished*.

Léa, V. (2005). Raw, pre-heated or ready to use: discovering specialist supply systems for flint industries in mid-Neolithic (Chassey culture) communities in southern France. *Antiquity*, *79*(303), 51–65. https://doi.org/10.1017/S0003598X00113699

Leducq, A., Rordorf Duvaux, M., & Tréhoux, A. (2009). *Plateau de Bevaix, 3 : Bevaix/Le*

Bataillard : occupations terrestres en bordure de marais. Archéologie neuchâteloise 41. Office et musée cantonal d'archéologie de Neuchâtel.

Lefranc, P., Chenal, F., Denaire, A., Guthmann, É., & Schneider-Schwien, N. (2017). « L'habitat et les sépultures du Néolithique ancien rubané d'Entzheim « Les Terres de la Chapelle » (Bas-Rhin) ». In *Revue archéologique de l'Est [En ligne]* (Vol. 66). http://journals.openedition.org/rae/9826

Leuzinger, U. (Ed.). (2000). *Die jungsteinzeitliche Seeufersiedlung Arbon : Bleiche 3 : Befunde*. Archäologie im Thurgau 9. Departement für Erziehung und Kultur - Kanton Thurgau.

Leuzinger, U., & Rast-Eicher, A. (2011). Flax processing in the Neolithic and Bronze Age pile-dwelling settlements of eastern Switzerland. *Vegetation History and Archaeobotany*, *20*(6), 535–542. https://doi.org/10.1007/s00334-011-0286-2

Lippi, M. M., Florenzano, A., Rinaldi, R., Allevato, E., Arobba, D., Bacchetta, G., Bal, M. C., Mazzanti, M. B., Benatti, A., Beneš, J., Bosi, G., Buonincontri, M., Caramiello, R., Castelletti, L., Castiglioni, E., Celant, A., Clò, E., Costantini, L., Pasquale, G. Di, … Mercuri, A. M. (2018). The Botanical Record of Archaeobotany Italian Network - BRAIN: a cooperative network, database and website. *Flora Mediterranea*, *28*, 365–376. https://doi.org/10.7320/FlMedit28.365

Lister, D. L., Jones, H., Oliveira, H. R., Petrie, C. A., Liu, X., Cockram, J., Kneale, C. J., Kovaleva, O., & Jones, M. (2018). Barley heads east: Genetic analyses reveal routes of spread through diverse Eurasian landscapes. *PLOS ONE*, *13*(7), e0196652. https://doi.org/10.1371/journal.pone.0196652

Liu, X., Jones, M. K., Zhao, Z., Liu, G., & O'Connell, T. C. (2012). The earliest evidence of millet as a staple crop: New light on neolithic foodways in North China. *American Journal of Physical Anthropology*, *149*(2), 283–290. https://doi.org/10.1002/AJPA.22127

Livarda, A., & Kotzamani, G. (2013). The archaeobotany of Neolithic and Bronze age Crete: synthesis and prospects. *Annual of the British School at Athens*, *108*(2013), 1–29. https://doi.org/10.1017/S0068245413000063

Lodwick, L. (2017). Agricultural innovations at a Late Iron Age oppidum: Archaeobotanical evidence for flax, food and fodder from Calleva Atrebatum, UK. *Quaternary International*, *460*, 198–219. https://doi.org/10.1016/j.quaint.2016.02.058

Lodwick, L. (2019). Sowing the Seeds of Future Research: Data Sharing, Citation and Reuse in Archaeobotany. *Open Quaternary*, *5*(1), 1–15. https://doi.org/10.5334/oq.62

López, D. I. R. (2007). *Estudi arqueobotànic de les llavors i fruits a l'assentament arqueològic de Mas d'en Boixos (Pacs del Penedès, Alt Penedès)*.

López, D. I. R. (2013a). *Informe arqueobotànic de les llavors i fruits carbonitzades a l'assentament de Mas d'en Boixos 1 (Pacs del Penedès, Alt Penedès). Campanya de l'any 2008*.

López, D. I. R. (2013b). *Informe del tractament de les mostres de sediment i estudi arqueobotànic de les llavors i fruits de l'excavació arqueològica dels jaciments de Mas Pujó, La Serreta i Cinc Ponts (Vilafranca del Penedès, Alt Penedès)*.

López, D. I. R. (2018). *Informe arqueobotànic de les llavors i fruits (carpologia) de les* *mostres de sediment de la intervenció arqueològica del «Projecte de Campa de vehicles provisional a la zona de la futura Zal del Port de Tarragona» (Vila-seca, Tarragonès).*

López, D. I. R., & Cantero, F. J. (2009). *Estudi arqueobotànic de les llavors i fruits a jaciment de la Teuleria dels Àlbers-1 (La Granada, Alt Penedès).*

López Sáez, J., & Guerra-Doce, E. (2006). El registro arqueobotánico de plantas psicoactivas en la prehistoria de la Peninsula Ibérica: una aproximación entobotánica y fitoquímica a la interpretación de la evidencia. *Complutum*, *17*(17), 7–24. https://doi.org/10.5209/CMPL.30574

Lundström-Baudais, K. (1977). *Etude des macro-fossils des sites littoraux d'Auvernier "Brise-Lames", Clairvaux et Charavines. Thesis Doctoral*.

Lundström-Baudais, K. (1986). Étude paléoethnobotanique de la station III de Clairvaux. In P. Pétrequin (Ed.), *Les Sites Littoraux Néolithiques de Clairvaux-Les-Lacs (Jura) - Tome I. Problématique générale, L'exemple de la Station III* (pp. 311–404). Éditions de la Maison des sciences de l'homme.

Lundström-Baudais, K. (1989). Les macrorestes végétaux du niveau V de la Motte-aux-Magnins. In P. Pétrequin (Ed.), *Les Sites Littoraux Néolithiques de Clairvaux-Les-Lacs (Jura) II Le Néolithique moyen* (pp. 417–439). Éditions de la Maison des Sciences de l'Homme.

Lundström-Baudais, K. (1995). Étude des paléosemences de la station II. In P. Pétrequin (Ed.), *Les Sites Littoraux Néolithiques de Clairvaux-Les-Lacs (Jura) II Le Néolithique moyen* (pp. 193–194). Editions de la Maison des sciences de l'homme.

Lundström-Baudais, K. (2000). Les paléosemences des fosses néolithiques du Petit-Chasseur IV. In M. Besse (Ed.), *Sion, Petit-Chasseur (Valais): un hameau du Néolithique moyen. Rapport préliminaire*.

Lundström-Baudais, K. (2010). Paléo-ethnobotanique à Charavines-les-Baigneurs. Récolte des éléments et méthodes d'étude. In A. Bocquet (Ed.), *Les villages néolithiques de Charavines DVD* (pp. 24–39). Fontaine de Siloé.

Lundström-Baudais, K. (2015). Les graines carbonisées de Saint-Paul-Trois-Châteaux/les Moulins. In A. Beeching (Ed.), *Saint-Paul-Trois-Châteaux (Drône) Site funéraire du Néolithique moyen chasséen - Etat préliminaire de la publication*.

Lundström-Baudais, K., & Martin, L. (2011). Les paléosemences des fosses néolithiques du Petit-Chasseur IV. In M. Besse & M. Piguet (Eds.), *Le site préhistorique du Petit-Chasseur (Sion, Valais) 10: un hameau du néolithique moyen* (pp. 261–267). Cahiers d'archéologie romande 124.

Lüning, J. (2000). *Steinzeitliche Bauern in Deutschland : die Landwirtschaft im Neolithikum*. Universitätsforschungen zur prähistorischen Archäologie Bd. 58, R. Habelt.

Maier, U. (1996). Morphological studies of free-threshing wheat ears from a Neolithic site in southwest Germany, and the history of the naked wheats. *Vegetation History and Archaeobotany*, *5*(1–2), 39–55. https://doi.org/10.1007/BF00189434

Maier, U. (2001). Untersuchungen in der neolithischen Ufersiedlung Hornstaad-Hörnle IA am Bodensee. In U. Maier & R. Vogt (Eds.), *Siedlungsarchäologie im Alpenvorland. VI Botanische und pedologische Untersuchungen zur Ufersiedlung Hornstaad-Hörnle IA*. Theiss. Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg

Band 74.

Maier, U., & Harwath, A. (2011). Detecting intra-site patterns with systematic sampling strategies. Archaeobotanical grid sampling of the lakeshore settlement Bad Buchau-Torwiesen II, southwest Germany. *Vegetation History and Archaeobotany*, *20*(5), 349–365. https://doi.org/10.1007/s00334-011-0295-1

Manen, C., & Hamon, C. (2018). Les mécanismes de la néolithisation de la France. In J. Guilaine & D. Garcia (Eds.), *La Protohistoire de la France* (pp. 11–26). Hermann éditeurs. https://hal.archives-ouvertes.fr/hal-01910726

Manen, C., Perrin, T., Guilaine, J., Bouby, L., Bréhard, S., Briois, F., Durand, F., Marinval, P., & Vigne, J.-D. (2018). The Neolithic transition in the western Mediterranean: a complex and non-linear diffusion process—The radiocarbon record revisited. *Radiocarbon*, *61*(2), 1–41. https://doi.org/10.1017/RDC.2018.98

Manen, C., Perrin, T., Raux, A., Binder, D., Bourdonnec, F.-X. Le, Briois, F., Convertini, F., Dubernet, S., Escallon, G., Gomart, L., Guilaine, J., Hamon, C., Philibert, S., & Queffelec, A. (2019). Le sommet de l'iceberg? Colinsation pionnière et néolithisation de la France méditerranéenne. *Bulletin de La Societé Préhistorique Française*, *116*, 317–361.

Manen, C., Vigne, J., Loirat, D., & Bouby, L. (2001). L' Aspre del Paradis à Corneilla-del-Vercol (Pyrénées-Orientales) : contribution à l'étude du Néolithique ancien et final roussillonnais. *Bulletin de La Société Préhistorique Française*, *98*, 505–528.

Marchesini, M., Gobbo, I., Marvelli, S., Rottoli, M., & Regola, E. (2016). Ambiente e agricoltura tra VI e IV millennio a.C. in Emilia Romagna. *Preistoria e Protostoria Dell'Emilia Romagna, Studi Di Preistoria e Protostoria 3*, 159–168.

Marinova, E., & Valamoti, S.-M. (2014). Crop diversity and choices in the prehistory of SE Europe: the archaeobotanical evidence from Greece and Bulgaria. In A. Chevalier, E. Marinova, & L. Peña-Chocarro (Eds.), *Plants and People: Choices and Diversity through Time - Early agricultural remnants and technical heritage (EARTH) : 8,000 years of resilience and innovation, volume 1.* (pp. 64–74). Oxbow Books; Oxford.

Marinval, P. (1988a). *Cueillette, agriculture et alimentation végétale de l'epipaléolithique jusqu'au 2e âge du fer en France méridionale : apports palethnographiques de la carpologie. Doctoral thesis*. Ecole des Hautes Etudes en Sciences Sociales.

Marinval, P. (1988b). *L'alimentation végétale en France : du mésolithique jusqu'à l'âge du fer*. Editions du Centre nationale de la recherche scientifique.

Marinval, P. (1993). Analyse Carpologique du Roc de Dourgne. In M. Barbaza (Ed.), *Dourgne : derniers chasseurs-collecteurs et premiers éleveurs de la Haute-Vallée de l'Aude* (pp. 415–416). Centre d'anthropologie des sociétés rurales, Archéologie en Terre d'Aude.

Marinval, P. (2003). L'ensemble carpologique du site bizien de la Salle (Carcassonne, Aude). *Bulletin de La Société Préhistorique Française*, *100*(2), 353–355.

Marinval, P. (2007a). Dades complementàries sobre l'economia vegetal de l'Epipaleolític i el Mesolític de la Balma de la Margineda. In J. Guilaine, M. Barbaza, & M. Martzluff (Eds.), *Les excavacions a la balma de la Margineda (1979-1991), Volum IV* (pp. 480–491). Edicions del Govern d'Andorra.

Marinval, P. (2007b). Premières données sur l'économie végétale. In J. Guilaine, C. Manen, & J. D. Vigne (Eds.), *Pont de Roque Haute. Nouveaux regards sur la néolithisation de la France méditerranéenne.* (pp. 215–217). Archives d'Ecologie Préhistorique.

Marinval, P. (2008). Analyse carpologique. In J. Coularou, F. Jallet, A. Colomer, & J. Balbure (Eds.), *Boussargues : une enceinte chalcolithique des garrigues du Sud de la France* (pp. 181–198). Ecole des Hautes Etudes en Sciences Sociales.

Märkle, T. (2000). *Die Wildpflanzen der Cortaillod moyen- zeitlichen Besiedlung von Concise-sous- Colachoz, Kt. Waadt, Schweiz. Doctoral thesis*. Universität Tübingen.

Märkle, T., & Rösch, M. (2008). Experiments on the effects of carbonization on some cultivated plant seeds. *Vegetation History and Archaeobotany*, *17*(S1), 257–263. https://doi.org/10.1007/s00334-008-0165-7

Marston, J. M. (2014). Ratios and Simple Statistics in Paleoethnobotanical Analysis: Data Exploration and Hypothesis Testing. In J. M. Marston, J. D. A. Guedes, & C. Warinner (Eds.), *Method and Theory in Paleoethnobotany* (pp. 163–179). University Press of Colorado. https://doi.org/10.5876/9781607323167.c009

Martin, L. (2010). *Agriculture et alimentation végétale en milieu montagnard durant le Néolithique : nouvelles données carpologiques dans les Alpes françaises du Nord. Doctoral thesis*. Université Paris I (Panthéon-Sorbonne) and Basel University.

Martin, L. (2012). Analyse carpologique du puits. Néolithique récent ST2096. In M. Remicourt, V. Andrieu-Ponel, C. Audibert, A. Baradat, J. Battentier, D. Belkacem, E. Blaise, M. Dousse, S. Bonnardin, & J.-B. Caverne (Eds.), *Les occupations pré et prothistoriques du Clos de Roque, à Saint-Maximin-la-Sainte Baume, Rapport Final d'Opération.* (pp. 242–246).

Martin, L. (2015). Plant economy and territory exploitation in the Alps during the Neolithic (5000–4200 cal bc): first results of archaeobotanical studies in the Valais (Switzerland). *Vegetation History and Archaeobotany*, *24*(1), 63–73. https://doi.org/https://doi.org/10.1007/s00334-014-0490-y

Martin, L. (2018). Analyse carpologique. In M. Marmara, M. Laroche, A. Ajas, J. Battentier, A. Chauvin, N. Clément, P. Dutreuil, N. Garnier, A. Garnotel, G. Hervé, L. Martin, E. Martin-Kobierzyki, J. Pech, J. Recchia-Quiniou, M. Remicourt, A. Renaud, A. Rivalan, J. Ros, M. Rué, … L. Viel (Eds.), *LE Clos de Roques/Route de Barjols Saint-Maximin-la-sainte-baume (VAR). Rapport Final d' Opération. Tome 2. Etudes spécialisées* (pp. 665–669). Paléotime.

Martin, L., Bouby, L., Marinval, P., Dietsch-Sellami, M.-F., Rousselet, O., Cabanis, M., Durand, F., & Figueiral, I. (2016). L'exploitation des ressources végétales durant le Chasséen : un bilan des données carpologiques en France entre 4400 et 3500 avant notre ère. In T. Perrin, P. Chambon, J. F. Gibaja, & G. Goude (Eds.), *Le Chasséen, des Chasséens… Retour sur une culture nationales et ses parallèles, Sepulcres de fossa, Cortaillod, Lagozza. Actes du colloque international tenu à Paris (France) du 18 au 20 novembre 2014* (pp. 259–272). Archives d'Écologie Préhistorique.

Martin, L., Delhon, C., Thiébault, S., & Pelletier, D. (2012). Plant exploitation and diet in altitude during Mesolithic and Neolithic: Archaeobotanical analysis from a hunting camp in the Chartreuse massif (l'Aulp-du-Seuil, Isère, France). *Review of Palaeobotany and Palynology*, *185*, 26–34. https://doi.org/10.1016/j.revpalbo.2012.07.011

Martin, L., Jacomet, S., & Thiebault, S. (2008). Plant economy during the Neolithic in a mountain context: the case of "Le Chenet des Pierres" in the French Alps (Bozel-Savoie, France). *Vegetation History and Archaeobotany*, *17*(S1), 113–122. https://doi.org/10.1007/s00334-008-0191-5

Martínez-Grau, H., Antolín, F., & van Willigen, S. (2020). Néolithique moyen type La Roberte et Néolithique moyen type Chassey sur le site des Bagnoles: relations spatiales et chronologiques. In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 270–278). Presses Universitaires de Provence.

Martínez-Grau, H., Morell-Rovira, B., & Antolín, F. (2021). Radiocarbon Dates Associated to Neolithic Contexts (Ca. 5900 – 2000 Cal BC) from the Northwestern Mediterranean Arch to the High Rhine Area. *Journal of Open Archaeology Data*, *9*(0). https://doi.org/10.5334/JOAD.72

Martinoli, D., & Brombacher, C. (2006). *Ergebnisse der archäobotanischen Untersuchung einer Getreideprobe aus der neolitihischen Seeufersiedlung Steckborn-Turgi (2006.001), unpublish report*.

Martinoli, D., & Jacomet, S. (2002). Pflanzenfunde aus Cham-Eslen: Erste Ergebnisse zur Versorgung mit pflanzlichen Nahrungsmitteln. In E. Gross-Klee & S. Hochuli (Eds.), *Die jungsteinzeitliche Doppelaxt von Cham-Eslen. Gesamtbericht über einen einzigartigen Fund aus dem Zugersee* (pp. 76–77). TUGIUM 18.

Martins, H., Oms, F. X., Pereira, L., Pike, A. W. G., Rowsell, K., & Zilhão, J. (2015). Radiocarbon Dating the Beginning of the Neolithic in Iberia: New Results, New Problems. *Journal of Mediterranean Archaeology*, *28*(1), 105–131. https://doi.org/10.1558/jmea.v28i1.27503

Mauvilly, M., Antenen, I., Brombacher, C., Gassmann, P., Guélat, M., Morina-Curty, L., Olive, C., Pillonel, D., Richoz, I., & Studer, J. (1997). Frasses »Praz au Doux« (FR), un site du Hallstatt ancien en bordure de rivière. *Archäologie Der Schweiz*, *20*(3), 112–125. https://doi.org/10.5169/seals-16701

Mauvilly, M., Braillard, L., Rentzel, P., & Vandorpe, P. (2010). Villeneuve/La Baume: un exemple de fréquentation des abris naturels fribourgeois. *Cahiers d'Archéologie Fribourgeoise CAF*, *12*, 4–29.

McClatchie, M., Bogaard, A., Colledge, S., Whitehouse, N. J., Schulting, R. J., Barratt, P., & McLaughlin, T. R. (2014). Neolithic farming in north-western Europe: archaeobotanical evidence from Ireland. *Journal of Archaeological Science*, *51*, 206–215. https://doi.org/10.1016/j.jas.2012.10.022

Menotti, F. (Ed.). (2004). *Living on the lake in prehistoric Europe: 150 years of lake-dwelling research*. Abingdon. https://doi.org/10.4324/9780203583203

Menotti, F. (2015). Lakeside dwellings in the Circum-Alpine region. In C. Fowler, J. Harding, & D. Hofmann (Eds.), *The Oxford Handbook of Neolithic Europe* (pp. 291–307). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199545841.013.008

Menotti, F., & O'Sullivan, A. (Eds.). (2013). *The Oxford Handbook of Wetland Archaeology*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199573493.001.0001

Mercuri, A. M., Allevato, E., Arobba, D., Bandini Mazzanti, M., Bosi, G., Caramiello, R., Castiglioni, E., Carra, M., Celant, A., Costantini, L., Di Pasquale, G., Fiorentino, G., Florenzano, A., Guido, M., Marchesini, M., Mariotti Lippi, M., Marvelli, S., Miola, A., Montanari, C., … Rinaldi, R. (2015). Pollen and macroremains from Holocene archaeological sites: A dataset for the understanding of the bio-cultural diversity of the Italian landscape. *Review of Palaeobotany and Palynology*, *218*(1), 250–266. https://doi.org/10.1016/j.revpalbo.2014.05.010

Merlin, M. D. (1984). *On the Trail of the Ancient Opium Poppy*. Fairleigh Dickinson University Press.

Merlin, M. D. (2003). Archaeological Evidence for the Tradition of Psychoactive Plant Use in the Old World. *Economic Botany*, *57*(3), 295–323. https://doi.org/10.3732/ajb.1400340

Mermod, O. (2000). *Die endneolithische Seeufersiedlung Saint-Blaise/Bains des Dames NE Botanische Untersuchungen zur Vegetation, Landwirtschaft und Ernährung in der Auvernier Cordé-Kultur (2640-2450 BC). Doctoral Thesis* [ETH Zürich]. https://doi.org/10.3929/ethz-a-004040666

Mermod, O. (2007). *Saint-Blaise/Bains des Dames 4. Archäobotanik einer Endneolithischen Seeufersiedlung: Vegetation, Ackerbau, Ernährung. Archéologie*. Neuchâteloise numérique 2.

Merrillees, R. S. (1962). Opium Trade in the Bronze Age Levant. *Antiquity*, *36*(144), 287–292. https://doi.org/10.1017/S0003598X00036814

Merrillees, R. S. (1992). The Absolute Chronology of the Bronze Age in Cyprus : A Revision. *Bulletin of the American Schools of Oriental Research: Studies in the Chronology of the Ancient Near East*, *288*(Nov), 47–52.

Mestre, J. M. i, & Tarrús, J. (2016). Las estructuras de hábitat en Catalunya durante el Neolítico medio: entre el Chassey y los Sepulcres de Fossa. In T. Perrin, P. Chambon, J. F. Gibaja, & G. Goude (Eds.), *Le Chasséen, des Chasséens… Retour sur une culture nationales et ses parallèles, Sepulcres de fossa, Cortaillod, Lagozza. Actes du colloque international tenu à Paris (France) du 18 au 20 novembre 2014* (pp. 289–302). Archives d'Écologie Préhistorique.

MicrosoftCorporation. (2018). *Microsoft Excel*. https://office.microsoft.com/excel

Midgley, M. (2008). *The megaliths of northern Europe*. Routledge.

Moinat, P., & Chambon, P. (Eds.). (2007). *Les cistes de Chamblandes et la place des coffres dans les pratiques funéraires du Néolithique moyen occidental. Actes du colloque de Lausanne, 12 et 13 mai 2006*. Cahiers d'archéologie romande 110. Société préhistorique française, Mémoire XLIII.

Molist, M., Bach, A. G., Borrell, F., Ríos, P., Bosch, J., Perrin, T., Chambon, P., & Goude, G. (2016). El Chassense y los" Sepulcres de Fossa" de Cataluña: relaciones complejas entre culturas arqueológicas vecinas. In T. Perrin, P. Chambon, J. F. Gibaja, & G. Goude (Eds.), *Le Chasséen, des Chasséens… Retour sur une culture nationales et ses parallèles, Sepulcres de fossa, Cortaillod, Lagozza. Actes du colloque international tenu à Paris (France) du 18 au 20 novembre 2014* (pp. 143–157). Archives d'Écologie Préhistorique.

Motella de Carlo, S. (2014). Tracce del paesaggio vegetale La scoperta di legni, semi e frutti bruciati. In M. V. Gambari (Ed.), *La Memoria del Passato Castello di Annone tra archeologia e storia, Archeologia Piemonte 2* (pp. 409–416). LineLab.

Motella de Carlo, S., & Venturino Gambari, M. (2004). Dalle floreste al campi, ambiente, risorse e economia nel neolitico dell' Italia Nord-occidentale. *Bulletin d'etudes Prehistoriques et Archeologiques Alpines*, *XV*, 125–142.

Mottes, E. (2013). il neolitico dell'Alto Garda: aspetti culturali e dinamiche insediative nel quadro della Preistoria del territorio sudalpino centro-orientale. In G. Pietro Brogiolo (Ed.), *APSAT 3. Paesaggi Storici del Sommolago* (pp. 89–115). SAP Società Archeologica s.r.l.

Mottes, E., Petrucci, G., Rottoli, M., & Visentini, P. (2009). Evolution of the Square Mouthed Pottery Culture in Trentino-Alto-Adige, Veneto and Friuli: cultural, chronological, palaeoeconomic and environmental aspects. *Gortiana*, *31*, 97–124.

Mottes, E., & Rottoli, M. (2006). I resti carpologici del sito neolitico de la vela di Trento (Campagne di Scavo 1975 e 1976). In A. Pessina & P. Visentini (Eds.), *Preistoria dell'Italia settentrionale. Studi in ricordo di Bernardino Bagolini, Atti del Convegno, Udine settembre 2005* (pp. 129–142). Museo Friulano di Storia Naturale.

Motuzaitė Matuzevičiūtė, G., & Liu, X. (2021). Prehistoric Agriculture in China: Food Globalization in Prehistory. In *Oxford Research Encyclopedia of Environmental Science* (Issue June, pp. 1–23). Oxford University Press. https://doi.org/10.1093/acrefore/9780199389414.013.168

Néré, E. (Ed.). (2014). *Chens-sur-Léman, Haute-Savoie, Rhône-Alpes Le Pré d'Ancy, rue du Léman - Tome 1: texte*. Rapport de Fouille Inrap Auvergne-Rhône-Alpes.

Nesbitt, M. (2001). Wheat evolution: integrating archaeological and biological evidence. In P. Caligari & P. E. Brandham (Eds.), *Wheat taxonomy: the legacy of John Percival* (Vol. 3, Issue Linnean Special Issue, pp. 37–59). Linnean Society.

Neveu, E., & Zech-Matterne, V. (2016). Étude carpologique de Clairvaux VII. In P. Pétrequin & A.-M. Pétrequin (Eds.), *Clairvaux et le "Néolithique Moyen Bourguignon"* (Vol. 2, pp. 1279–1353). Presse Universitaire de Franche-Comté, Centre de Recherche Archéologique de la Vallée de l'Ain.

Nielsen, E. H. (1997). Fällanden ZH-Usserriet: Zum Übergangsbereich Spätmesolithikum-Frühneolithikum in der Schweiz. *Jahrbuch Der Schweizerischen Gesellschaft Für Ur-Und Frühgeschichte*, *80*, 57–84.

Nisbet, R. (1985). Aspetti cronologici dell'agricoltura neolitica nell'Italia settentrionale. *Atti Del Secondo Congresso Nazionale Della Società Italiana Di Ecologia (Padova, 25-28 Giugno 1984)*, 943–945.

Nisbet, R. (1995). I resti macrobotanici - Ostiano Dugali Altri. In P. Biagi (Ed.), *L'insediamento neolitico di Ostiano-Dugali Alti (Cremona) nel suo contesto ambientale ed economico.* (pp. 104–106). Museo Civico di Scienze Naturale di Brescia. Monografie di Natura Bresciana 22.

Nisbet, R. (2008). Wood use and agriculture at Villandro-Villanders (Bolzano/Bozen, Alto Adige/South Tyrol): the charred remains from Mesolithic to Middle Ages. *Atti Della Società per La Preistoria e Protostoria Della Regione Friuli-Venezia Giulia, 16 (2006/07)*, 75–131.

Nisbet, R., Rottoli, M., Arobba, D., Panelli, C., Rossi, S., & Maggi, R. (n.d.). Pratiche agricole e paesaggi del primo Neolitico. Nuovi dati dalle Arene Candide. *Preistoria e Protostoria Della Liguria, Riunione Scientifica Ist. Preist. Protost. It., Genova, 16-19*

Ottobre 2018.

Oeggl, K., Kofler, W., Schmidl, A., Dickson, J. H., Egarter-Vigl, E., & Gaber, O. (2007). The reconstruction of the last itinerary of "Ötzi", the Neolithic Iceman, by pollen analyses from sequentially sampled gut extracts. *Quaternary Science Reviews*, *26*(7–8), 853–861. https://doi.org/10.1016/j.quascirev.2006.12.007

Oh, J.-H., Ha, I. J., Lee, M. Y., Kim, E.-O., Park, D., Lee, J.-H., Lee, S.-G., Kim, D.-W., Lee, T.-H., Lee, E.-J., & Kim, C.-K. (2018). Identification and metabolite profiling of alkaloids in aerial parts of Papaver rhoeas by liquid chromatography coupled with quadrupole time-of-flight tandem mass spectrometry. *Journal of Separation Science*, *41*(12), 2517–2527. https://doi.org/10.1002/jssc.201701402

OJEU. (2014). Scientific Opinion on the risks for public health related to the presence of opium alkaloids in poppy seeds. *Official Journal of European Union*. http://doi.wiley.com/10.2903/j.efsa.2011.2405

Oliveira, H. R., Jacocks, L., Czajkowska, B. I., Kennedy, S. L., & Brown, T. A. (2020). Multiregional origins of the domesticated tetraploid wheats. *PLoS ONE*, *15*(1). https://doi.org/10.1371/journal.pone.0227148

Oliveira, H. R., Jones, H., Leigh, F., Lister, D. L., Jones, M., & Peña-Chocarro, L. (2011). Phylogeography of einkorn landraces in the Mediterranean basin and Central Europe: population structure and cultivation history. *Archaeological and Anthropological Sciences*, *3*(4), 327–341. https://doi.org/10.1007/s12520-011-0076-x

Oms Arias, X., López-García, J. M., Mangado, X., Martín, P., Mendiela, S., Morales, J. I., Pedro, M., Rodríguez, A., Rodríguez-Cintas, À., & Yubero, M. (2013). Hàbitat En Cova I Espai Pels Ramats Ca. 6200-6000 BP: Dades Preliminars De La Cova Colomera (Prepirineu De Lleida) Durant El Neolític Antic. *Sagvntvm*, *45*, 25–38. https://doi.org/10.7203/SAGVNTVM.45.2007

Oms, F. X. A., Àngels Petit, M., I. Morales, J., & Soledad García, M. (2016). Le processus de néolithisation dans les Pyrénées orientales. Occupation du milieu, culture matérielle et chronologie. *Bulletin de La Société Préhistorique Française*, *109*(4), 651–670. https://doi.org/10.3406/bspf.2012.14201

Pagnoux, C., Bouby, L., Ivorra, S., Petit, C., Valamoti, S.-M., Pastor, T., Picq, S., & Terral, J.-F. (2015). Inferring the agrobiodiversity of Vitis vinifera L. (grapevine) in ancient Greece by comparative shape analysis of archaeological and modern seeds. *Vegetation History and Archaeobotany*, *24*(1), 75–84. https://doi.org/10.1007/s00334-014-0482-y

Pallarés, M., Bordas, A., & Mora, R. (1997). El proceso de neolitización en los Pirineos Orientales. Un modelo de continuidad entre los cazadores-recolectores neolíticos y los primeros grupos agropastoriles. *Trabajos de Prehistoria*, *54*(1), 121–141. https://doi.org/10.3989/tp.1997.v54.i1.382

Palomo, A., Gibaja Bao, J. F., Piqué Huerta, R., Bosch Lloret, A., Chinchilla Sánchez, J., & Tarrús, J. (2011). Harvesting cereals and other plants in Neolithic Iberia: the assemblage from the lake settlement at La Draga. *Antiquity*, *85*(329), 759–771.

Pals, J. P., & Voorrips, A. (1979). Seed, fruits and charcoals from two prehistoric sites in northern Italy. *Archaeo-Physika*, *8*, 217–235.

Pearsall, D. M. (2015). *Paleoethnobotany : a handbook of procedures* (Third edit). Left Coast Press, Inc.

Peña-Chocarro, L., Pérez-Jordà, G., & Morales, J. (2018). Crops of the first farming communities in the Iberian Peninsula. *Quaternary International*, *470*, 369–382. https://doi.org/10.1016/j.quaint.2017.06.002

Peña-Chocarro, L., & Zapata, L. (1999). History and traditional cultivation of Lathyrus sativus L. and Lathyrus citera L. in the Iberian peninsula. *Vegetation History and Archaeobotany*, *8*(1–2), 49–52. https://doi.org/10.1007/BF02042842

Perego, R. (2016). Il paesaggio agricolo al tempo dei pozzi. In R. P. Keller, P. Curdy, A. M. Ferroni, & L. Sarti (Eds.), *Area megalitica Saint-Martin-de-Corléans parco archeologioco e museo guida breve* (p. 20). Regione autonoma Valle d'Aosta.

Pérez-Jordà, G., Peña-Chocarro, L., Mateos, J. M., & Zapata, L. (2017). Evidence for early crop management practices in the Western Mediterranean: Latest data, new developments and future perspectives. In O. García Puchol & D. C. Salazar García (Eds.), *Times of Neolithic transition along the Western Mediterranean* (pp. 171–197). Springer International Publishing.

Perrin, T. (Ed.). (2016). *Le Chasséen, des Chasséens ... : retour sur une culture nationale et ses parallèles, Sepulcres de fossa, Cortaillod, Lagozza : actes du colloque international tenu à Paris (France) du 18 au 20 novembre 2014*. Archives d'écologie préhistorique.

Pessina, A. (2001). Nouvelles données Sur le Néolithique ancien de l'Italie Nord-Orientale. In P. Marinval (Ed.), *Histoire d'Hommes. Histoires de plantes (Hommages au professeur Jean Erroux). Rencontres d'Archéobotanique de Toulouse* (pp. 105–118).

Pessina, A., & Tiné, V. (2008). *Archeologia del Neolitico: l'Italia tra VI e IIV millennio AC*. Carocci.

Pétrequin, P., Pétrequin, A.-M., Cinquetti, M., Errera, M., Fábregas Velcarce, R., Authier, E., Jallet, F., Pailler, Y., Prodçeo, F., & Sheridan, A. (2019). Rings and axeheads of Alpine jades: imports to and exports from the Gulf of Morbihan during the 5th millennium and the beginning of the 4th millennium. In G. Querré, S. Cassen, & E. Vigier (Eds.), *La parure en callaïs du Néolithique européen* (pp. 445–464). Archaeopress Publishing Ltd.

Petrovska, B. (2012). Historical review of medicinal plants′ usage. *Pharmacognosy Reviews*, *6*(11), 1. https://doi.org/10.4103/0973-7847.95849

Piening, U. (1980). Botanische Bearbeitung der verkohlten Getreidereste. In A. Furger (Ed.), *Die neolithischen Ufersiedlungen von Twann Die Siedlungsreste der Horgener Kultur* (Vol. 7, pp. 132–133; Tafel 16).

Piening, U. (1981). Die verkohlten Kulturpflanzenreste aus den Proben der Cortaillod- und Horgener Kultur. In B. Ammann, T. Bollinger, S. Jacomet, H. Liese-Kleiber, & U. Piening (Eds.), *Die neolithischen Ufersiedlungen von Twann* (Vol. 14, pp. 69–88; Tabelle 18). Staatlicher Lehrmittelverlag.

Piguet, M. (2011). Les sites du Néolithique moyen valaisan. In M. Besse & M. Piguet (Eds.), *Le site préhistorique du Petit-Chasseur (Sion, Valais) 10. Un hameau du Néolithique moyen* (pp. 107–123).

Pini, R., Castellano, L., Perego, R., Ravazzi, C., & Rizzi, Ag. (2016). Un insediamento perilacustre del Tardo Neolitico – Età del Rame a Fimon Le Fratte. Successione sedimentaria, stratigrafia pollinica e macroresti vegetali. In E. B. Citton (Ed.), *Nuove ricerche nelle Valli di Fimon. L'insediamento del tardo Neolitico de Le Fratte di Arcugnano* (pp. 169–193).

Popescu, I., & Caudullo, G. (2016). Prunus mahaleb in Europe : distribution , habitat , usage and threats. In J. San-Miguel-Ayanz, D. de Rigo, G. Caudullo, H. D. T., & A. Mauri (Eds.), *European Atlas of Forest Tree Species* (p. 143).

Popescu, I., Caudullo, G., Houston Durrant, T., & de Rigo, D. (2016). Cornus sanguinea in Europe: distribution, habitat, usage and threats. In *European atlas of forest tree species. Publications Office of the European Union, Luxembourg, e019631+. http://forest. jrc. ec. europa. eu/media/atlas/Cornus_sanguinea. pdf* (p. 84). https://pfaf.org/user/plant.aspx?latinname=Cornus+sanguinea

Popper, V. (1988). Selecting Quantitative Measurements in Paleoethnobotany. In C. Hastorf & V. Popper (Eds.), *Current palaeoethnobotany: analytical methods and cultural interpretations of archaeological plant remains.* (pp. 53–71). University of Chicago Press, Chicago.

Prat, B. (2013). Etudes spécialisées. In B. Gourlin & K. Khémiri (Eds.), *ZAC Les Chalus II Lot 1- Forcalquier (Alpes-de Haute-Provence) Provence-Alpes-Côte d'Azur. Volume I: Texte* (pp. 126–127). Rapport final d'opération. Fouille archéologiques préventive.Chronoterre Archéologie.

Pyankov, V. I., Ziegler, H., Akhani, H., Deigele, C., & Lüttge, U. (2010). European plants with C4 photosynthesis: geographical and taxonomic distribution and relations to climate parameters. *Botanical Journal of the Linnean Society*, *163*(3), 283–304. https://doi.org/10.1111/J.1095-8339.2010.01062.X

Ramón, B., & Canal, D. (2008). L'agricultura i l'alimentació vegetal. *Quarhis*, *4*, 54–56.

Ramponi, C. (Ed.). (2018). *Quincieux, Rhône, Auvergne-Rhône-Alpes Grange Rouge - A 46N - section Anse-Genay Tome I Données administratives, Introduction générale, Résultats :Paléoenvironnement, Préhistoire - Texte et annexes scientifiques*. Rapport de fouille Inrap Auvergne-Rhône-Alpes.

Ramstein, M., Cornelissen, M., Schimmelpfennig, D., Rentzel, P., Affolter, J., Albrecht, J., Anselmetti, F., Bläsi, H., Brönnimann, D., Ginella, F., Häberle, S., Raumer, J. von, Stopp, B., Thew, N., & Vandorpe, P. (2020). Der Dolmen von Oberbipp, Steingasse: Archäologische und naturwissenschaftliche Untersuchung eines spätneolithischen Megalithgrabes. *Archäologie Bern : Jahrbuch Des Archäologischen Dienstes Des Kantons Bern*, 93–201.

Reed, K. (2015). From the field to the hearth: plant remains from Neolithic Croatia (ca. 6000–4000 cal bc). *Vegetation History and Archaeobotany*, *24*(5), 601–619. https://doi.org/10.1007/s00334-015-0513-3

Reed, K., & Rottoli, M. (2014). Agricoltura neolitica in Friuli e Dalmazia. In P. Visentini & E. Podrug (Eds.), *Adriatico senza confini via di comunicazione e crocevia di popoli nel 6000 a.C.* (pp. 155–165). Museo Friulano Storia Naturale; Multilingual edizione.

Reingruber, A., & Thissen, L. (2009). Depending on14c data: Chronological frameworks in the neolithic and chalcolithic of southeastern europe. *Radiocarbon*, *51*(2), 751–770. https://doi.org/10.1017/s0033822200056071

Renfrew, C., & Bahn, P. (2016). *Archaeology: Theories, Methods, and Practice* (Seventh ed). Thames and Hudson Ltd.

Renfrew, J. (1973). *Palaeoethnobotany. The prehistoric food plants of the Near East and Europe*. Methuen & Co LTD.

Rigert, E., Ebneter, I., Ebersbach, R., Akeret, Ö., & Leuzinger, U. (2005). Die Epi-Rössener Siedlung von Sevelen SG-Pfäfersbüel. *Jahrbuch Der Schweizerischen Gesellschaft Für Ur- Und Frühgeschichte*, *88*, 41–86.

Rigert, E., Jacomet, S., Hosch, S., Hüster-Plogmann, H., Rentzel, P., Pümpin, C., & Affolter, J. (2005). Eine Fundstelle der Glockenbecherzeit in Wetzikon ZH-Kempten, Tösstalstrasse 32-36. *Jahrbuch Der Schweizerischen Gesellschaft Für Ur- Und Frühgeschichte*, *88*, 87–118.

Riley, J., Eisenberg, E., Müller-Schwefe, G., Drewes, A. M., & Arendt-Nielsen, L. (2008). Oxycodone: a review of its use in the management of pain. *Current Medical Research and Opinion*, *24*(1), 175–192. https://doi.org/10.1185/030079908X253708

Rivollat, M., Réveillas, H., Mendisco, F., Pemonge, M.-H., Justeau, P., Couture, C., Lefranc, P., Féliu, C., & Deguilloux, M.-F. (2016). Ancient mitochondrial DNA from the middle neolithic necropolis of Obernai extends the genetic influence of the LBK to west of the Rhine. *American Journal of Physical Anthropology*, *161*(3), 522–529. https://doi.org/10.1002/ajpa.23055

Robinson, D., & Rasmussen, P. (1989). Botanical Investigations at the Neolithic Lake Village at Weier, North East, Switzerland: Leaf Hay and Cereals as Animal Fodder. In A. Milles, D. Williams, & N. Gardner (Eds.), *The Beginnings of Agriculture* (pp. 149–163). BAR International Series 496.

Ronch, F. Da, Caudullo, G., Durrant., T. H., & Rigo, D. de. (2016). Cornus mas in Europe: distribution, habitat, usage and threats. In J. San-Miguel-Ayanz, D. de Rigo, G. Caudullo, T. H. Durrant, & A. Mauri (Eds.), *European Atlas of Forest tree species* (pp. 82–83). Publication Office of the European Union, Luxembourg.

Ros, J. (2018). Rapport de l'analyse carpologique in PRAE Charles Cros las Trincados. In A. Gaillard (Ed.), *PRAE Charles Cros LAs Trincados Région Occitanie - Cépie (Aude) Volume 5 Études spécialisées données biologiques et paléo-environnementales* (pp. 185–200). Drac sra occitanie. ACTER Archéologie. Mosaïques Archéologie. Rapport final d'opération - Fouille préventive.

Ros, J., Evin, A., Bouby, L., & Ruas, M.-P. (2014). Geometric morphometric analysis of grain shape and the identification of two-rowed barley (Hordeum vulgare subsp. distichum L.) in southern France. *Journal of Archaeological Science*, *41*, 568–575. https://doi.org/10.1016/j.jas.2013.09.015

Rössner, C., Deckers, K., Benz, M., Özkaya, V., & Riehl, S. (2018). Subsistence strategies and vegetation development at Aceramic Neolithic Körtik Tepe, southeastern Anatolia, Turkey. *Vegetation History and Archaeobotany*, *27*(1), 15–29. https://doi.org/10.1007/s00334-017-0641-z

Rottoli, M. (1993). Analisi paletnobotaniche: prime risultanze,"La Marmotta", Anguillara Sabazia (RM), Scavi 1989, Appendice 1, Un abitato perilacustre di età neolitica. *Bullettino Di Paletnologia Italiana*, *84*, 305–315.

Rottoli, M. (2019). Analisi archeobotaniche: agricoltura, raccolta e uso del legno. In N. Degasperi & G. Steffè (Eds.), *Il villaggio neolitico di Lugo di Romagna - Fornace Gattelli : strutture, ambiente, culture* (pp. 315–337). Istituto italiano di preistoria e protostoria.

Rottoli, M., & Castiglioni, E. (2009). Prehistory of plant growing and collecting in northern Italy, based on seed remains from the early Neolithic to the Chalcolithic (c. 5600–2100 cal b.c.). *Vegetation History and Archaeobotany*, *18*(1), 91–103. https://doi.org/10.1007/s00334-007-0139-1

Rottoli, M., Cavulli, F., & Pedrotti, A. (2015). L'agricoltura di Lugo di Grezzana (Verona): considerazioni preliminari. *Studi Di Preistoria e Protostoria 2 - Preistoria e Protostoria Del Veneto*, 109–116.

Rottoli, M., & Regola, E. (2011). L'agricoltura in Italia settentrionale nel V millennio aC: nuovi dati dal sito di via Guidorossi a Parma. *Rivista Di Studi Liguri*, *77*, 55–62.

Roushannafas, T., Bogaard, A., & Charles, M. (2022). Geometric morphometrics sheds new light on the identification and domestication status of 'new glume wheat' at Neolithic Çatalhöyük. *Journal of Archaeological Science*, *142*(December 2021), 105599. https://doi.org/10.1016/j.jas.2022.105599

Rousselet, O. (2009). Etude carpologique. In M. Donnelly & R. Furestier (Eds.), *A8 Rousset/ Le Plan à Rousset (Bouches-du-Rhône) Région Provence-Alpes-Côte d'Azur,* (pp. 136–139). Rapport final d'opération, Fouilles archéologiques préventives. Oxford archéologie méditerranée.

Rousselet, O. (2011). Analyse carpologique. In B. Sendra, B. Gourlin, & G. Cockin (Eds.), *ZAC Saint-Antoine 2. Saint-Aunès (Hérault), Languedoc-Roussillon. Rapport final d'opération* (pp. 264–272). Fouilles archéologiques préventives.

Rousselet, O. (2012). Une exceptionnelle concentration de carporestes de céréales de l'Espace d'activités. In X. Margarit, M. Orgeval, J. Mayca, M. Margail, T. Castin, J. Battentier, & A. Caraglio (Eds.), *Le site néolithique final de Ponteau Bouches-du-Rhône)* (pp. 81–85). Rapport de synthèse 2012 de fouille archéologique programmée triennale.

Rovira, N. (2007). *Agricultura y gestión de los recursos vegetales en el sureste de la península ibérica durante la prehistoria reciente.Doctoral Thesis*. Universitat Pompeu Fabra.

Sabato, D., Masi, A., Pepe, C., Ucchesu, M., Peña-Chocarro, L., Usai, A., Giachi, G., Capretti, C., & Bacchetta, G. (2015). Archaeobotanical analysis of a Bronze Age well from Sardinia: A wealth of knowledge. *Plant Biosystems - An International Journal Dealing with All Aspects of Plant Biology*, *149*(1), 205–215. https://doi.org/10.1080/11263504.2014.998313

Salamini, F., Özkan, H., Brandolini, A., Schäfer-Pregl, R., & Martin, W. (2002). Genetics and geography of wild cereal domestication in the Near East. *Nature Reviews Genetics*, *3*(6), 429–441. https://doi.org/10.1038/nrg817

Salavert, A. (2010). Le pavot (Papaver somniferum) à la fin du 6e millénaire av. J.-C. en Europe occidentale. *Anthropobotanica*, *1*(3), 3–16.

Salavert, A. (2011). Plant economy of the first farmers of central Belgium (Linearbandkeramik, 5200–5000 b.c.). *Vegetation History and Archaeobotany*, *20*(5), 321–332. https://doi.org/10.1007/s00334-011-0297-z

Salavert, A. (2017). Agricultural Dispersals in Mediterranean and Temperate Europe. In *Oxford Research Encyclopedia of Environmental Science*. Oxford University Press. https://doi.org/10.1093/acrefore/9780199389414.013.307

Salavert, A., Martin, L., Antolín, F., & Zazzo, A. (2018). The opium poppy in Europe: exploring its origin and dispersal during the Neolithic. *Antiquity*, *92*(364), E1.

https://doi.org/10.15184/aqy.2018.154

Salavert, A., Zazzo, A., Martin, L., Antolín, F., Gauthier, C., Thil, F., Tombret, O., Bouby, L., Manen, C., Mineo, M., Mueller-Bieniek, A., Piqué, R., Rottoli, M., Rovira, N., Toulemonde, F., & Vostrovská, I. (2020). Direct dating reveals the early history of opium poppy in western Europe. *Scientific Reports*, *10*(1), 20263. https://doi.org/10.1038/s41598-020-76924-3

Salzani, A. L., Paola, P., Martina, C., Cavulli, F., Angelucci, D., Salzani, L., Pedrotti, A., Salzani, P., Cavulli, F., Carotta, M., Angelucci, D., & Salzani, L. (2015). L'insediamento di Lugo di Grezzana (Verona) nel quadro del primo Neolitico padano alpino. *Studi Di Preistoria e Protostoria 2*, 95–107.

Sánchez-Quinto, F., Malmström, H., Fraser, M., Girdland-Flink, L., Svensson, E. M., Simões, L. G., George, R., Hollfelder, N., Burenhult, G., Noble, G., Britton, K., Talamo, S., Curtis, N., Brzobohata, H., Sumberova, R., Götherström, A., Storå, J., & Jakobsson, M. (2019). Megalithic tombs in western and northern Neolithic Europe were linked to a kindred society. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(19), 9469–9474. https://doi.org/10.1073/PNAS.1818037116

Sargiano, J.-P., van Willigen, S., D'Anna, A., Renault, S., Hunger, K., Woerle-Soares, M., & Gaday, R. (2010). Les Bagnoles à l'Isle-sur-la-Sorgue (Vaucluse). Aspects nouveaux dans le Néolithique moyen du midi de la France. *Gallia Préhistoire*, *52*, 193–239. https://www.persee.fr/doc/galip_0016-4127_2010_num_52_1_2473

Saul, H., Madella, M., Fischer, A., Glykou, A., Hartz, S., & Craig, O. E. (2013). Phytoliths in Pottery Reveal the Use of Spice in European Prehistoric Cuisine. *PLoS ONE*, *8*(8), 1–5. https://doi.org/10.1371/journal.pone.0070583

Savard, M. (2000). *Etude de l'assemblage carpologique de la Baume de Fontbrégoua (Var) du Paléolithique final au Chasséen récent. Doctoral thesis*. Mémoire de DEA : Environnement et archéologie : Paris 1.

Scarborough, J. (1995). The opium poppy in Hellenistic and Roman medicine. In *Drugs and Narcotics in History* (pp. 4–23). Cambridge University Press. https://doi.org/10.1017/CBO9780511599675.002

Schaal, C. (2000). *Etude carpologique d'un village neolithique : Ia station 19 de Chalain (Jura) au 30eme siecle av. J.-C.* Universite de Franche-Comte.

Schaal, C. (2007). Étude archéobotanique préparatoire sur le site de la station XIV de Clairvaux-les-Lacs (Jura, France). *Archaeologia Mosellana*, *7*, 655–667.

Schaal, C. (2011). Analyses carpologiques. In S. Francisco (Ed.), *BERGHEIM, Haut-Rhin, « Saulager » , zone d'activité du Muehlbach (tranche 4, 2 ème phase) Un site domestique du Néolithique ancien* (pp. 42–43). Rapport de diagnostic. Pôle d'Archéologie.

Schaal, C. (2012). Données sur les pratiques agriColes au néolithique ancien : étude carpologique du site rubané de soultz « Florival ». In T. Logel (Ed.), *Soultz-haut-rhin, Aire d'activités du Florival, Tranche 1, Un bâtiment du Néolithique ancien, des occupations de l'âge du Fer et de la période moderne (XVI ème siècle)* (pp. 142–152). Rapport de Fouille Préventive Pôle d'Archéologie.

Schaal, C., & Pétrequin, P. (2016). Approche archéobotanique du Néolithique moyen de Clairvaux. In P. Pétrequin & A.-M. Pétrequin (Eds.), *Clairvaux et le "Néolithique Moyen Bourguignon"* (pp. 1193–1277). Presse Universitaire de Franche-Comté, Centre de

Recherche Archéologique de la Vallée de l'Ain.

Schibler, J., & Jacomet, S. (2010). Short climatic fluctuations and their impact on human economies and societies: The potential of the Neolithic lake shore settlements in the Alpine foreland. *Environmental Archaeology*, *15*(2), 173–182. https://doi.org/10.1179/146141010X12640787648856

Schibler, J., Jacomet, S., Hüster-Plogmann, H., & Brombacher, C. (1997). Economic crash in the 37th and 36th centuries cal. BC in Neolithic lake shore sites in Switzerland. *Proc. 7th ICAZ Conference. Konstanz 26.9 - 1.10.1994. Anthropozoologica 25/26*, 553–570.

Schlichtherle, H. (1985). Samen und Früchte: Konzentrationsdiagramme pflanzlicher Grossreste aus einer neolithischen Seeuferstratigraphie. In C. Strahm & H. Uerpmann (Eds.), *Quantitative Untersuchungen an einem Profilsockel in Yverdon, Avenue des Sports* (pp. 7–43).

Schlichtherle, H., Hafner, A., & Borrello, M. A. (2013). Les villages préhistoriques des bord des lacs circumalpins entre le Ve et le IV millènaires av. J.-.C. In M. A. Borrello (Ed.), *Les Hommes préhistoriques et les Alpes* (pp. 69–84). BAR International Series 2476.

Schlichtherle, H., & Rau, S. (2016). *4.000 Jahre Pfahlbauten*. Jan Thorbecke Verlag.

Schoch, W. (1989). Les macrorestes végétaux de la station VIII. In P. Pétrequin (Ed.), *Les sites littoraux néolithiques de Clairvaux-les Lacs (Jura) - Tome II, Le Néolithique moyen.* (pp. 487–489). Editions de la Maison des sciences de l'homme.

Schulz Paulsson, B. (2019). Radiocarbon dates and Bayesian modeling support maritime diffusion model for megaliths in Europe. *Proceedings of the National Academy of Sciences*, *116*(9), 3460–3465. https://doi.org/10.1073/pnas.1813268116

Sendra, B., Gourlin, B., & Cockin, G. (2011). *ZAC Saint-Antoine 2. Saint-Aunès (Hérault), Languedoc-Roussillon. Rapport final d'opération*. Fouilles archéologiques préventives.

Siebke, I., Furtwängler, A., Steuri, N., Hafner, A., Ramstein, M., Krause, J., & Lösch, S. (2020). Crops vs. animals: regional differences in subsistence strategies of Swiss Neolithic farmers revealed by stable isotopes. *Archaeological and Anthropological Sciences*, *12*(10). https://doi.org/10.1007/s12520-020-01122-1

Smith, R. K., Stacey, R. J., Bergström, E., & Thomas-Oates, J. (2018). Detection of opium alkaloids in a Cypriot base-ring juglet. *Analyst*, *143*(21), 5127–5136. https://doi.org/10.1039/c8an01040d

Spangenberg, J. E., Ferrer, M., Jacomet, S., Bleicher, N., & Schibler, J. (2014). Molecular and isotopic characterization of lipids staining bone and antler tools in the Late Neolithic settlement, Zurich Opera Parking, Switzerland. *Organic Geochemistry*, *69*, 11–25. https://doi.org/10.1016/j.orggeochem.2014.01.015

Starnini, E., Biagi, P., & Mazzucco, N. (2018). The beginning of the Neolithic in the Po Plain (northern Italy): Problems and perspectives. *Quaternary International*, *470*, 301–317. https://doi.org/10.1016/j.quaint.2017.05.059

Starnini, E., Ghisotti, F., Girod, A., & Nisbet, R. (2000). Nuovi dati sul neolithico antico della Pianura Padana Centrale dal sito di Isorella (Brescia) / new data on the early neolithic of the central Po valley from the site of Isorella (Brescia). In A. Pessina & G. Muscio (Eds.), *La Neolitizzazione tra Oriente L' Occidente Convegnogno di Studi.Atti del Congegno die Studi Udine, 23-24 aprile 1999* (pp. 231–255). Edizioni del Museo

Friulano di Storia Naturale.

Steiner, B. L. (2018). *Aspects of archaeobotanical methodology applied to the sediments of archaeological wetland deposits. Doctoral Thesis*. Basel University.

Steiner, B. L., Akeret, Ö., Antolín, F., Brombacher, C., Vandorpe, P., & Jacomet, S. (2018). Layers rich in aquatic and wetland plants within complex anthropogenic stratigraphies and their contribution to disentangling taphonomic processes. *Vegetation History and Archaeobotany*, *27*(1), 45–64. https://doi.org/10.1007/s00334-017-0613-3

Steiner, B. L., Antolín, F., & Jacomet, S. (2015). Testing of the consistency of the sieving (wash-over) process of waterlogged sediments by multiple operators. *Journal of Archaeological Science: Reports*, *2*, 310–320. https://doi.org/10.1016/j.jasrep.2015.02.012

Steiner, B. L., Antolín, F., Soteras, R., Rottoli, M., & Banchieri, D. G. (n.d.). New archaeobotanical research at the earliest pile-dwelling of the Circumalpine area. In W. Ballmer, A., Hafner, A. & Tinner (Ed.), *Prehistoric Wetland Sites of Southern Europe. Archaeology, Chronology, Palaeoecology and Bioarchaeology*. Springer International Publishing.

Steiner, B. L., Antolín, F., Vach, W., & Jacomet, S. (2017). Subsampling of large-volume samples in waterlogged sediments . A time-saving strategy or a source of error ? *Review of Palaeobotany and Palynology*, *245*, 10–27. https://doi.org/10.1016/j.revpalbo.2017.05.013

Stika, H.-P. (2005). Early Neolithic agriculture in Ambrona, Provincia Soria, central Spain. *Vegetation History and Archaeobotany*, *14*, 189–197. https://doi.org/10.1007/s00334-005-0085-8

Stöckli, W. E. (2009). *Chronologie und Regionalität des jüngeren Neolithikums (4300-2400 v. Chr.) im Schweizer Mittelland, in Süddeutschland und in Ostfrankreich : aufgrund der Keramik und der absoluten Datierungen, ausgehend von den Forschungen in der Feuchtbodensiedlungen der*. Archäologie Schweiz.

Stöckli, W. E., Niffeler, U., & Gross-Klee, E. (1995). *Die Schweiz vom Paläolithikum bis zum frühen Mittelalter. Vom Neandertaler bis zu Karl dem Grossen.* Verlag Schweizerichte Gesellschaft für Ur- und Frühgeschichte.

Suter, P., Arnold, B., & Schlichtherle, H. (2009). Pfahlbauten : UNESCO Welterbe-Kandidatur “Prähistorische Pfahlbauten rund um die Alpen” = Palafittes : candidature au Patrimoine mondial de l’UNESCO “Sites palafittiques préhistoriques autour des Alpes” = Palafitte : candidatura a patrimonio mondiale dell. In *Candidatura a patrimonio mondiale dell’UNESCO “Siti palafitticoli preistorici dell’arco alpino.”* Palafittes - Verein zur Unterstützung der UNESCO Welterbe-Kandidatur “Prähistorische Pfahlbauten rund um die Alpen” c/o Archäologischer Dienst des Kantons Bern.

Suter, P., & Jacomet, S. (1987). *Zürich “Kleiner Hafner” : Tauchgrabungen 1981-1984*. Orell Füssli.

Tafuri, M. A., Rottoli, M., Cupitò, M., Pulcini, M. L., Tasca, G., Carrara, N., Bonfanti, F., Salzani, L., & Canci, A. (2018). Estimating C4 plant consumption in Bronze Age Northeastern Italy through stable carbon and nitrogen isotopes in bone collagen. *International Journal of Osteoarchaeology*, *28*(2), 131–142. https://doi.org/10.1002/oa.2639

Teall, E. K. (2014). Medicine and Doctoring in Ancient Mesopotamia. *Grand Valley Journal of History*, *3*(1), 1–8. https://doi.org/10.4103/0973-7847.95849

Tecchiati, U., Castiglioni, E., & Rottoli, M. (2013). Economia di sussistenza nell'età del rame dell'Italia settentrionale. Il contributo di archeozoologia e archeobotanica. In R. de Marinis (Ed.), *L'età del Rame. La Pianura padana e le Alpi al tempo di Ötzi* (pp. 87–100). La compagnia della stampa Massetti Rodella.

Tegel, W., Elburg, R., Hakelberg, D., Stäuble, H., Büntgen, U., & Petraglia, M. (2012). Early Neolithic Water Wells Reveal the World's Oldest Wood Architecture. *PLoS ONE*, *7*(12), e51374. https://doi.org/10.1371/journal.pone.0051374

Teixidó, M. P., Benlliure, A. P., Antolín, F., Alonso, N., Hernán, E. C., Garcia, X. C., Bao, J. F. G., Seguí, M. S., & Fernàndez, J. G. (2008). El Collet de Puiggròs. Un assentament a l'aire lliure de l'època neolítica. *Trobades d'estudiosos de Les Garrigues*, 23–48. https://raco.cat/index.php/TrobadesGarrigues/article/view/365066

Tereso, J. P. (2012). *Environmenttal change, agricultural development and social trends in NW Iberia from the Late Prehistory to the Late Antiquity. Doctoral Thesis*. Universidade do Porto.

Terral, J.-F., Alonso, N., Buxó, R., Chatti, N., Fabre, L., Fiorentino, G., Marinval, P., Jordá, G. P., Pradat, B., Rovira, N., & Alibert, P. (2004). Historical biogeography of olive domestication (Olea europaea L.) as revealed by geometrical morphometry applied to biological and archaeological material. *Journal of Biogeography*, *31*(1), 63–77. https://doi.org/10.1046/j.0305-0270.2003.01019.x

Terral, J.-F., Newton, C., Ivorra, S., Gros-Balthazard, M., de Morais, C. T., Picq, S., Tengberg, M., & Pintaud, J.-C. (2012). Insights into the historical biogeography of the date palm (Phoenix dactylifera L.) using geometric morphometry of modern and ancient seeds. *Journal of Biogeography*, *39*(5), 929–941. https://doi.org/10.1111/j.1365-2699.2011.02649.x

Terral, J.-F., Tabard, E., Bouby, L., Ivorra, S., Pastor, T., Figueiral, I., Picq, S., Chevance, J. B., Jung, C., Fabre, L., Tardy, C., Compan, M., Bacilieri, R., Lacombe, T., & This, P. (2010). Evolution and history of grapevine (Vitis vinifera) under domestication: new morphometric perspectives to understand seed domestication syndrome and reveal origins of ancient European cultivars. *Annals of Botany*, *105*(3), 443–455. https://doi.org/10.1093/aob/mcp298

Tetenyi, P. (1997). Opium poppy (Papaver somniferum) Botany and Horticulture. *Horticultural Reviews*, *19*, 373–408.

Thirault, É. (Ed.). (2011). *Les occupations chasséennes de Cazan l'Héritière, à Vernègues, Rapport Final d'opération* (Vol. 1). Paléotime.

Thirault, É., & Remicourt, M. (2014). Les puits à eau néolithiques dans le Sud de la France : une question à creuser ... In I. Sénépart, C. Billard, F. Bostyn, I. Praud, & É. Thirault (Eds.), *Méthodologie des recherches de terrain sur la Préhistoire récente en France. Nouveaux acquis, nouveaux outils, 1987-2012.* (pp. 231–250).

Tibi, S. (2006). Al-Razi and Islamic medicine in the 9th century. In *Journal of the Royal Society of Medicine* (Vol. 99, Issue 4, pp. 206–207). Royal Society of Medicine Press. https://doi.org/10.1258/jrsm.99.4.206

Tinner, W., Nielsen, E. H., & Lotter, A. F. (2007). Mesolithic agriculture in Switzerland? A critical review of the evidence. *Quaternary Science Reviews*, *26*(9–10), 1416–1431. https://doi.org/10.1016/j.quascirev.2007.02.012

Tison, J.-M., & Foucault, B. de. (2014). *Flora gallica : flore de France*. Biotope Éditions.

Tobler, C. M.-. (2010). Stansstad-Kehrsiten – Neolithische Seeufersiedlungen hart am Alpenrand. In I. Matuschik, C. Strahm, B. Eberschweiler, G. Fingerlin, A. Hafner, M. Kinsky, M. Mainberger, & G. Schöbel (Eds.), *Vernetzungen. Aspekte siedlungsarchäologischer Forschungen. Festschrift für Helmut Schlichtherle zum 60. Geburtstag* (pp. 287–296). Lavori.

Tolar, T., Vovk, I., & Jug, U. (2020). The use of Cornus sanguinea L. (dogwood) fruits in the Late Neolithic. *Vegetation History and Archaeobotany*, *Table 1*. https://doi.org/10.1007/s00334-020-00788-w

Toulemonde, F., Durand, F., Berrio, L., Bonnaire, E., Daoulas, G., & Wiethold, J. (2015). Records of “new” glume wheat in France: a review. *Vegetation History and Archaeobotany*, *24*(1), 197–206. https://doi.org/10.1007/s00334-014-0479-6

UNODC. (2020). *World Drug Report 2020* (Vol. 3). United Nations. https://wdr.unodc.org/wdr2020/field/WDR20_Booklet_3.pdf

Van de Velde, P. (2007). On chronology: pot sherds, house ghosts, and carbonized seeds. *Analecta Praehistorica Leidensia*, *39*(Excavations at Geleen-Janskamperveld 1990/1991), 205–222. https://www.researchgate.net/publication/268741425

van der Veen, M. (2007). Formation processes of desiccated and carbonized plant remains - the identification of routine practice. *Journal of Archaeological Science*, *34*(6), 968–990. https://doi.org/10.1016/j.jas.2006.09.007

van der Veen, M., & Fieller, N. (1982). Sampling seeds. *Journal of Archaeological Science*, *9*(3), 287–298. https://doi.org/10.1016/0305-4403(82)90024-3

van der Veen, M., Hill, A., & Livarda, A. (2013). The archaeobotany of medieval britain (C AD 450-1500): Identifying research priorities for the 21st century. *Medieval Archaeology*, *57*(1), 151–182. https://doi.org/10.1179/0076609713Z.00000000018

van der Veen, M., Livarda, A., & Hill, A. (2007). The Archaeobotany of Roman Britain: Current State and Identification of Research Priorities. *Britannia*, *38*, 181–210. https://doi.org/10.3815/000000007784016557

van Willigen, S. (2020). Le Néolithique moyen méditerranéen : état des connaissances et problématiques du projet. In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 15–36). Presses Universitaires de Provence.

van Willigen, S., André, G., Antolín, F., Bader, M., Follmann, F., Jacomet, S., Jesus, A., Quesnel, Y., & Denaire, A. (2020). Déroulement des opérations et moyens mis en œuvre. In S. van Willigen, M. Bailly, B. Röder, J. Schibler, & A. Schmitt (Eds.), *Les Bagnoles à L'Isle-sur-la-Sorgue (Vaucluse) – le Néolithique moyen et les occupations postérieures (âge du Bronze, âge du Fer et Antiquité)* (pp. 87–100). Presses Universitaires de Provence.

van Willigen, S., Bailly, M., Röder, B., Schibler, J., Schmitt, A., André, G., Antolín, F., Bader, M., Brochier, J. E., D'anna, A., Willigen, S. van, & André, G. (Eds.). (2020). *Les*

Bagnoles à L'Isle-sur-la-Sorgue : un site majeur du Néolithique moyen en Vaucluse. Presses universitaires de Provence.

Vandorpe, P., & Jacomet, S. (2007). Comparing different pre-treatment methods for strongly compacted organic sediments prior to wet-sieving: a case study on Roman waterlogged deposits. *Environmental Archaeology*, *12*(2), 207–214. https://doi.org/10.1179/174963107x226462

Vaquer, J. (2014). Les pratiques funéraires au Néolithique moyen dans le Midi de la France. *Rivista Di Scienze Preistoriche*, *64*, 5–24.

Vaquer, J., & Ruas, M.-P. (2009). La grotte de l'Abeurador Félines-Minervois (Hérault): occupations humaines et environnement du Tardiglaciaire à l'Holocène. In D. Fabre (Ed.), *De Méditerranée et d'ailleurs…, Mélanges offerts a Jean Guilaine* (pp. 761–792). Archives d'Écologie Préhistorique.

Venturino Gambari, M., & Arobba, D. (2017). Arquata Scrivia, località Moriassi Tracce di frequentazione preistorica dell'età del Rame. *Quaderni Di Archeologia Del Piemonte 1*, 200–204.

Venturino Gambari, M., Cavalieri, S., Chiarenza, N., Cestari, M., Ribero, M., & Arobba, D. (2018). Novi Ligure , località Pieve . Paleosuolo e strutture del Neolitico antico. *Quaderno Soprintendenza Archeologia Del Piemonte 3*, 172–184.

Venturino Gambari, M., De Carlo, N., Giomi, F., Chiarenza, N., & Arobba, D. (2016). Novi Ligure, località Pieve. Strutture a fossa del Neolitico antico e dell'età del Bronzo. *Quaderni Della Soprintendenza Archeologica Del Piemonte 31*, 176–181.

Veselovskaia, M. A. (1976). *The Poppy: its classification and importance as oleiferous crop*. Agricultural Research Service.

Vial, J. (Ed.). (2013). *Aéropole Gap-Tallard (Hautes-Alpes), Habitat chasséen et emsemble monumental de l'Age du Fer en Moyenne Durance - Rapport final d'opération archéologique* (Vol. 2). Fouilles archéologiques préventives HADES.

Vignaud, A. (Ed.). (2010). *Pyrénées-Orientales, Perpignan, route de Canohès Lotissement « Le Petit Prince » Silos et sépultures du Néolithique moyen - Rapport final d'opération*. Fouilles archéologiques préventives INRAP Méditerranéeap.

Villaret-von Rochow, M. (1967). Frucht- und Samenreste aus der neolithischen Station Seeberg, Burgäschisee-Süd. In *Seeberg Burgäschisee Süd, Teil 4: Chronologie und Umwelt* (pp. 21–63). Verlag Stämpfli & Cie.

Villaret-von Rochow, M. (1971). Samenanalysen aus der spätneolithischen Grabung Auvernier (Neuenburger See). In I. Wellmann (Ed.), *IIIème congrès international des musées d'agriculture: Résumées des communications présentées* (pp. 206–208). Magyar Mezögazdasagi Muzeum.

Visentini, P., Avigliano, R., Castiglioni, E., Fontana, A., Lemorini, C., Mazzoli, C., Petrucci, G., & Tasca, G. (2014). Il sito fortificato di Meduno sach di sotto (Pordenone) nel quadro dell'eneolitico dell'Italia nord-orientale. *Gortiana, 36*, 69–124.

Vital, J., Bouby, L., Jallet, F., & Rey, P.-J. (2007). Un autre regard sur le gisement du boulevard périphérique nord de Lyon (Rhône) au Néolithique et à l'âge du Bronze Secteurs 94.1 et 94.8. *Gallia Préhistoire*, *49*, 1–126.

Wallace, M., Bonhomme, V., Russell, J., Stillman, E., George, T. S., Ramsay, L., Wishart, J., Timpany, S., Bull, H., Booth, A., & Martin, P. (2019). Searching for the Origins of Bere Barley: a Geometric Morphometric Approach to Cereal Landrace Recognition in Archaeology. *Journal of Archaeological Method and Theory*, *26*(3), 1125–1142. https://doi.org/10.1007/s10816-018-9402-2

Warinner, C., & Guedes, J. D. A. (2014). Digitizing the archaeobotanical record. In J. M. Marston, J. D. A. Guedes, & C. Warinner (Eds.), *Method and Theory in Paleoethnobotany* (pp. 147–160). University Press of Colorado. https://doi.org/10.5876/9781607323167.c008

Waterbolk, H. T., & Zeist, W. Van. (1967). Preliminary Report on the Neolithic Bog Settlement of Niederwil. *Palaeohistoria*, *12*, 559–580.

Welk, E., de Rigo, D., & Caudullo, G. (2016). Prunus avium in Europe: distribution, habitat, usage and threats. In J. San-Miguel-Ayanz, D. de Rigo, G. Caudullo, T. Houston Durrant, & A. Mauri (Eds.), *European Atlas of Forest Tree Species* (Vol. 50, Issue March, pp. 140–141).

Wey, O. (2012). *Die Cortaillod-Kultur am Burgäschisee : Materialvorlage und Synthese zu den neolithischen Fundkomplexen von Burgäschisee-Ost, -Südwest, -Süd und -Nord* (S. Ulrich-Bochsler (Ed.)). Stämpfli Verlag.

Widmer, A. B., Affolter, J., & Jacquat, C. (2012). Die Siedlungsreste aus dem jüngeren Neolithikum von Zug-Vorstadt. *Jahrbuch Archäologie Schweiz 95*, 35–76.

Wiethold, J. (2009). Didenheim (Haut-Rhin) « Kahlberg ». Tests carpologiques et anthracologiques de deustructures à combustion : les structures 43 (sondage 96) et 44 (sondage 103). In F. Boisseau, A. Colecchia-Latron, & J. Wiethold (Eds.), *Didenheim « Kalhlberg » (Bas-Rhin)* (pp. 26–29). Fouilles archéologiques préventives INRAP.

Wilkinson, K., & Stevens, C. J. (2003). *Environmental Archaeology: Approaches, Techniques and Applications*. Tempus.

Willems, W., & van de Dries, M. (2007). The origins and development of quality assurance in archaeology. In W. J. H. Willems & M. van de Dries (Eds.), *Quality Management in Archaeology* (pp. 1–12). Oxbow Books.

Willigen, S. van, D'Anna, A., Renault, S., & Sargiano, J.-P. (2011). Le Sud-Est de la France entre 4400 et 3400 avant notre ère. Sériation céramique et outillage lithique. *Sériation Céramique et Outillage Lithique », Préhistoires Méditerranéennes [En Ligne]*, *2*. http://journals.openedition.org/pm/601

Wright, E. (2021). Investigating cattle husbandry in the Swiss Late Neolithic using different scales of temporal precision: potential early evidence for deliberate livestock "improvement" in Europe. *Archaeological and Anthropological Sciences*, *13*(2), 36. https://doi.org/10.1007/s12520-020-01252-6

Wright, P. (2003). Preservation or destruction of plant remains by carbonization? *Journal of Archaeological Science*, *30*(5), 577–583. https://doi.org/10.1016/S0305-4403(02)00203-0

Yazıcı, L., & Yılmaz, G. (2017). Determination of alkaloids and oil rates of some poppy (papaver somniferum L.) varieties cultivated as winter and summer. *International Journal of Secondary Metabolite*, *4*(2), 359–362. https://doi.org/10.21448/ijsm.373906

Zapata, L., Baldellou, V., & Utrilla, P. (2008). Bellotas de cronología neolítica para consumo humano en la cueva de Chaves (Bastarás, Huesca). *IV Congreso Del Neolico Peninsular: 27-30 de Noviembre de 2006*, *1*(January 2008), 402–410. http://dialnet.unirioja.es/servlet/extart?codigo=2865579

Zeist, W. Van, & Helsdingen, A. M. B. (1991). V. Samen und Früchte aus Niederwil. In H. T. Waterbolk & W. A. van Zeist (Eds.), *Niederwil, eine Siedlung der Pfyner Kultur. III: Naturwissenschaftliche Untersuchungen: Vol. III Naturw* (pp. 49–113). Verlag Paul Haupt.

Zhao, Z. (2011). New Archaeobotanic Data for the Study of the Origins of Agriculture in China. *Current Anthropology*, *52*(S4), S295–S306. https://doi.org/10.1086/659308

Zibulski, P. (2010). Botanik. In U. Eberli (Ed.), *Die horgenzeitliche Siedlung Pfäffikon-Burg* (pp. 236–255). Monographien der Kantonsarchäologie Zürich 40.

Zierzinski, E. (2019a). Annexe 19. In Hénon H (Ed.), *Saint-Priest, Rhône, Auvergne-Rhône-Alpes ZAC des Feuilly* (Vol. 3, p. 593). Rapport de Fouille Inrap Auvergne-Rhône-Alpes.

Zierzinski, E. (2019b). La carpologie. In H. Hénon (Ed.), *Saint-Priest, Rhône, Auvergne-Rhône-Alpes ZAC des Feuilly* (Vol. 1, pp. 104–105). Rapport de Fouille Inrap Auvergne-Rhône-Alpes.

Zohary, D., Hopf, M., & Weiss, E. (2012). *Domestication of Plants in the Old World: The origin and spread of domesticated plants in Southwest Asia, Europe, and the Mediterranean Basin* (4th ed.). Oxford University Press. https://doi.org/10.1093/acprof:osobl/9780199549061.003.0010

Appendix A: List of all sites with archaeobotanical data

Table A1 Table with bibliography and explanation of exclusion and highlighted on dark grey (unpublished, not within the study area, archaeobotanical study without carpology; not analysed carpology) and light grey for sites that are mainly coming from national/internal/companies archaeobotanical reports

ID	Site Name	Country	Region	Removed	Bibliography
1	Rocca di rivoli	IT	Veneto		(Mottes et al., 2009)
2	Este - località Meggiaro	IT	Veneto		(Castiglioni & Rottoli, 2015)
3	Monselice - via Valli	IT	Veneto		(Castiglioni & Rottoli, 2015)
4	Maserà	IT	Veneto		(Castiglioni & Rottoli, 2015)
5	Lugo di Grezzana	IT	Veneto		(Rottoli et al., 2015)
6	Fimon-Molino Casarotto	IT	Veneto		(Mottes et al., 2009)
7	Fimon Le Fratte	IT	Veneto		(Pini et al., 2016)
8	Saint Martin de Corléans	IT	Aosta		(Castellano & Perego, 2018; Perego, 2016)
9	Bannia	IT	Friuli-Venezia Giulia		(Cottini et al., 1997)
10	Arquata Scrivia, Località Moriassi	IT	Piemonte		(Venturino Gambari & Arobba, 2017)
11	Fagnigola	IT	Friuli-Venezia Giulia		(Pessina, 2001)
12	Canedole di Roverbella	IT	Lombardia		(Carra, 2019)
13	Sammardenchia	IT	Friuli-Venezia Giulia		(Pessina, 2001)
14	Palù di Livenza	IT	Friuli-Venezia Giulia		(Rottoli & Castiglioni, 2009)
15	Pavia de Udine	IT	Friuli-Venezia Giulia		(Rottoli & Castiglioni, 2009)
16	Valler	IT	Friuli-Venezia Giulia		(Carugati, 1993)
17	Meduno	IT	Friuli-Venezia Giulia		(Visentini et al., 2014)
18	Riparo Biarzo	IT	Friuli-Venezia Giulia	Y	No seeds
19	Revine Lago	IT	Veneto	Y	No seeds
20	Piancada	IT	Friuli-Venezia Giulia		(Rottoli & Castiglioni, 2009)
21	Latsch	IT	Trentino-Alto Adige		(Festi et al., 2011)
22	Villandro/Villanders	IT	Trentino-Alto Adige		(Nisbet, 2008)
23	Riva del Garda	IT	Trentino-Alto Adige		(Mottes, 2013, p. 106)
24	Isera peat bog	IT	Trentino-Alto Adige		(Cristiani et al., 2009, p. 195)
25	La Vella set II and III	IT	Trentino-Alto Adige		(Mottes & Rottoli, 2006)
26	La Vela di Trento vIII	IT	Trentino-Alto Adige		(Degasper et al., 2006)
27	Otzi	IT	Trentino-Alto Adige		(Heiss & Oeggl, 2009)
28	Bressanone- Millan	IT	Trentino-Alto Adige		(Rottoli & Castiglioni, 2009)
29	Velturno-Tanzgasse	IT	Trentino-Alto Adige		(Castelletti & Maspero, 1992)
30	Balm Chanto	IT	Piemonte		(Rottoli & Castiglioni, 2009)
31	Casalnoceto	IT	Piemonte		(Castelletti & Motella de Carlo, 1998)
32	Alba Corso Laghe 43	IT	Piemonte		(Motella de Carlo & Venturino Gambari, 2004)
33	Alba- Corso Europa	IT	Piemonte		(Motella de Carlo & Venturino Gambari, 2004)
34	Castello d ' Annone	IT	Piemonte		(Motella de Carlo, 2014)

35	Valgrana -Tetto Chiappello	IT	Piemonte		(Motella de Carlo & Venturino Gambari, 2004)
36	Alba-Cooperativa dei Lavoratori	IT	Piemonte	Y	No seeds
37	Caverna delle Arene Candide	IT	Liguria		(Arobba et al., 2017; Nisbet et al., n.d.)
38	San Sebastiano di Perti	IT	Liguria		(Arobba & Vicino, 2003)
39	Arma dell ' Aquila	IT	Liguria		(Arobba & Caramiello, 2006b)
40	Riparo sotto Roccia di Pian del Ciliegio	IT	Liguria		(Arobba & Caramiello, 2009)
41	Grotta del Sanguineto o della Matta	IT	Liguria		(Arobba & Vicino, 2002)
42	Grotta marina di Bergeggi	IT	Liguria		(Arobba & Caramiello, 2006a)
43	Riparo di Rocca Due Teste all'Alpicella	IT	Liguria		(Arobba & Caramiello, 2014)
44	Core BH1, Piazza della Vittoria	IT	Liguria		(Arobba et al., 2018)
45	Piazza Brignole - Foce del Torrente Bisagno	IT	Liguria		(Arobba et al., 2014)
46	Novi Ligure, località Pieve	IT	Piemonte		(Venturino Gambari et al., 2016, 2018)
47	Albisola	IT	Liguria	Y	No seeds
48	Castellare di Uscio	IT	Liguria		(Arobba & Caramiello, 2006a)
49	Albinea	IT	Emilia Romagna		(Rottoli & Castiglioni, 2009)
50	Fiorano	IT	Emilia Romagna		(Rottoli & Castiglioni, 2009)
51	Lugo di Romagna	IT	Emilia Romagna		(Rottoli, 2019)
52	Ponte Ghiara	IT	Emilia Romagna		(Carra, 2012)
53	Ponte Molino	IT	Lombardia		(Carra, 2012)
54	Rivaltella- Ca Romensini	IT	Emilia Romagna		(Carra, 2012)
55	Savignano	IT	Emilia Romagna		(Rottoli & Castiglioni, 2009)
56	Forlì via Navicella	IT	Emilia Romagna		(Gobbo, 2010)
57	Bazzarola	IT	Emilia Romagna		(Carra, 2012)
58	Chiozza di Scandiano	IT	Emilia Romagna		(Rottoli & Castiglioni, 2009)
59	Levata di Curtatone	IT	Emilia Romagna		(Carra, 2012)
60	Parma via Guidorossi	IT	Emilia Romagna		(Gobbo, 2010; Marchesini et al., 2016; Rottoli & Regola, 2011)
61	Spilamberto - Cava via Macchioni	IT	Emilia Romagna		(Gobbo, 2010)
62	Provezza	IT	Emilia Romagna		(Gobbo, 2010)
63	Forlimpopoli - via Canalazzo	IT	Emilia Romagna		(Gobbo, 2010)
64	S. Andrea de Travo	IT	Emilia Romagna		(Gobbo, 2010)
65	Cecima	IT	Lombardia		(Rottoli & Castiglioni, 2009)
66	Isorella	IT	Lombardia		(Starnini et al., 2000)
67	Dugali Alti	IT	Lombardia		(Nisbet, 1995)
68	Pizzo di Bodio	IT	Lombardia		(Banchieri et al., 2015)
69	Vho di Piadena	IT	Lombardia		(Castelletti & Maspero, 1992)
70	Acquanegra sul Mosio	IT	Lombardia		(Nisbet, 1985)
71	Casatico di Marcaria	IT	Lombardia		(Nisbet, 1985)
72	Isolino di Varese	IT	Lombardia		(Antolín et al., 2022; Banchieri et al., 2015; Banchieri & Rottoli, 2009; Steiner et al., n.d.)
73	Rivarolo Mantovano	IT	Lombardia		(Castelletti & Maspero, 1992)
74	Lovere-Via Deccio Celeri	IT	Lombardia		(Rottoli & Castiglioni, 2009)

75	Monte Covolo	IT	Lombardia		(Pals & Voorrips, 1979)
76	Lagozza di Besnate	IT	Lombardia		(Rottoli & Castiglioni, 2009)
77	Cueva de Chaves	ES	Aragon	Y	Not in the study area
78	Coro Trasito	ES	Aragon	Y	Not in the study area
79	Can Sadurní	ES	Catalonia		(Antolín, 2016; Antolín & Schäfer, 2020) Antolín, unpublished
80	La Draga	ES	Catalonia		(Antolín, 2016) Antolín, unpublished
81	Caserna de Sant Pau	ES	Catalonia		(Ramón & Canal, 2008)
82	Font del Ros	ES	Catalonia		(Pallarés et al., 1997)
83	Cova de Sant Llorenç	ES	Catalonia		(Antolín, 2016)
84	Los Cascajos	ES	Navarra	Y	Not in the study area
85	Carrer Reina Amàlia, 31-33	ES	Catalonia		(Antolín, 2016)
86	Plansallosa	ES	Catalonia		(Antolín, 2016)
87	Cova del Sardo	ES	Catalonia		(Antolín, 2016)
88	La Dou	ES	Catalonia		(Antolín, 2016)
89	Codella	ES	Catalonia		(Antolín, 2016)
90	Camp del Colomer	ES	Andorra		(Antolín, 2016)
91	Serra del Mas Bonet	ES	Catalonia		(Antolín, 2016)
92	120 Cave	ES	Catalonia		(Antolín, 2016)
93	Bòbila Madurell	ES	Catalonia		(Antolín, 2016)
94	Mines of Gavà	ES	Catalonia		(Antolín, 2016; Buxó et al., 1991; Juan-Tresserras & Villalba, 1999)
95	Espina C	ES	Catalonia		(Antolín, 2016)
96	Pla del Gardelo	ES	Catalonia		(Antolín, 2016)
97	Puig del Collet / El Collet/Collet Puiggròs	ES	Catalonia		(Teixidó et al., 2008)
98	CIM "El Camp"	ES	Catalonia		(Antolín, 2016; Antolín et al., 2010)
99	Pesseta Cave	ES	Catalonia		(Antolín, 2008a)
100	Camí dels Banys de la Mercè	ES	Catalonia		(Antolín et al., 2010)
101	Cingle del Mas Nou	ES	Valencian	Y	Not in the study area
102	Can Revella (Can Roqueta)	ES	Catalonia		(Antolín, 2008b)
103	Castelnuovo di Teolo	IT	Veneto		(Agrostelli et al., 2015)
104	Auvelles	ES	Catalonia		(Antolín, n.d.)
105	Cova del Toll	ES	Catalonia		(Antolín, 2020; Hopf, 1971)
106	Cova Bonica	ES	Catalonia		unpublished
107	Cova Freda	ES	Catalonia		unpublished
108	Cova Gran	ES	Catalonia		unpublished
109	Guixeres de Vilobí	ES	Catalonia		unpublished
110	Pou Nou 2	ES	Catalonia		(Antolín, López, et al., 2018)
111	Coves del Fem	ES	Catalonia		unpublished
112	L' escola Especial Meritxell	ES	Andorra		(Antolín et al., 2013)
113	Rivoli Veronese	IT	Veneto		(Biagi & Nisbet, 1987)
114	Barbiano	IT	Trentino-Alto Adige		(Nisbet, 1985)
115	Aica di Fiè / Völs am Schlern/Volseraicha	IT	Trentino-Alto Adige		(Biagi & Nisbet, 1987)
116	Brescia S. Polo	IT	Lombardia		(Castiglioni et al., 2008)
117	Tolerait	IT	Trentino-Alto Adige		(Biagi & Nisbet, 1987)

118	Abri Buholoup	FR	Occitanie	Y	Not in the study area
119	Abri de Roquemissou	FR	Occitanie	Y	Not in the study area
120	Abri Roc Troué	FR	Occitanie	Y	Not in the study area
122	Aspre del Paradís	FR	Occitanie		(Manen et al., 2001)
123	Aulp du Seuil	FR	Auvergne-Rhône-Alpes		(Martin, 2010; Martin et al., 2012)
124	Auriac	FR	Occitanie		(Marinval, 2003)
125	Auriac-Golf	FR	Occitanie		(Martin et al., 2016)
126	Balma de l'Abeurador	FR	Occitanie		(Vaquer & Ruas, 2009)
127	Balma Margineda	AD	Andorra		(Marinval, 2007a)
128	Barreau de la Devèze Sud	FR	Occitanie		(Figueiral, 2012)
129	Baume Bourbon	FR	Occitanie		(Bouby, Marinval, Durand, et al., 2020; Coste et al., 1987)
130	Baume d'Oullins	FR	Occitanie		(Bouby, Marinval, Durand, et al., 2020)
131	Baume Fontbrégoua	FR	Provence-Alpes-Côte d'Azur		(Savard, 2000)
132	Boulevard périphéerique Nord de Lyon	FR	Auvergne-Rhône-Alpes		(Vital et al., 2007, pp. 101–107)
132	Campasses et Labro	FR	Occitanie	Y	Not in the study area
134	Caucade	FR	Provence-Alpes-Côte d'Azur		(Martin et al., 2016)
134	Centre des Impôs	FR	Occitanie	Y	Not in the study area
136	Claparouse	FR	Provence-Alpes-Côte d'Azur		(Bouby & Léa, 2006; Martin et al., 2016)
137	Clos de Roque	FR	Provence-Alpes-Côte d'Azur		(Martin, 2012, pp. 242–246)
137	Côtes de Roquefort	FR	Occitanie	Y	Not in the study area
139	Cova de l'Esperit	FR	Occitanie		(Bouby, Marinval, Durand, et al., 2020; Marinval, 1988a)
140	Encombres	FR	Occitanie		(Bouby, 1996)
141	Font Juvénal	FR	Occitanie		(Marinval, 1988a)
142	Gardon	FR	Auvergne-Rhône-Alpes		(Bouby, 2009)
143	Grotte de l' Aigle	FR	Occitanie		(Bouby, Marinval, Durand, et al., 2020)
144	Grotte de Montou Montbolo	FR	Occitanie		(Buxó, 2006)
145	Grotte du Taï	FR	Occitanie		(Bouby et al., 2019)
145	Grotte Foissac	FR	Occitanie	Y	Not in the study area
147	Grotte G	FR	Provence-Alpes-Côte d'Azur		(Courtin & Erroux, 1974, p. 329)
148	Grotte Gazel	FR	Occitanie		(Bouby, Marinval, Durand, et al., 2020)
149	Grotte Murée	FR	Provence-Alpes-Côte d'Azur		(Courtin & Erroux, 1974, p. 329)
150	Grotte St Marcel	FR	Auvergne-Rhône-Alpes		(Erroux, 1988)
151	Jardins de Vert Parc	FR	Occitanie		(Bouby, 1999)
152	La Grande Rivoire	FR	Auvergne-Rhône-Alpes		(Martin, 2010, pp. 59–90)
153	Clairvaux - La Motte aux Magnins V	FR	Bourgogne-Franche-Comté		(Lundström-Baudais, 1989; Schaal & Pétrequin, 2016)
153	La Pla de Peyre	FR	Occitanie	Y	Not in the study area
154	La Poujade	FR	Occitanie	Y	Not in the study area

156	La Resclauze	FR	Occitanie		(Bouby, Marinval, Durand, et al., 2020)
157	La Roberte	FR	Auvergne-Rhône-Alpes		(Martin et al., 2016)
158	La Salle	FR	Occitanie		(Marinval, 2003)
159	Le Bousquetas	FR	Occitanie		(Carozza et al., 1999)
160	Le Champ du Poste	FR	Occitanie		(Figueiral, 2018)
161	Le Chenet des Pierres	FR	Auvergne-Rhône-Alpes		(Martin, 2010; Martin et al., 2008)
162	Le Crès	FR	Occitanie		(Bouby, 2004)
163	Le Font aux Pigeons	FR	Provence-Alpes-Côte d'Azur		(Marinval, 1988a)
164	Le Lagarel	FR	Occitanie		(Bouby et al., 2010)
165	Le Logis de Berre	FR	Auvergne-Rhône-Alpes		(Martin et al., 2016)
166	Le Moulin	FR	Auvergne-Rhône-Alpes		(Martin et al., 2016)
167	Le Pirou	FR	Occitanie		(Figueiral & Rousselet, 2015)
168	Le Puech Haut	FR	Occitanie		(Bouby, 2005)
169	Le Rochas	FR	Auvergne-Rhône-Alpes		(Marinval, 1988a)
170	Le Serre de Boidon	FR	Auvergne-Rhône-Alpes		(Marinval, 1988a)
171	Le Valladas	FR	Auvergne-Rhône-Alpes		(Lundström-Baudais, 2015)
172	Les Jas del Biau	FR	Occitanie	Y	Not in the study area
172	Les Coudoumines	FR	Occitanie	Y	Not in the study area
174	Les Lauzières	FR	Provence-Alpes-Côte d'Azur		(Marinval, 1988a)
175	Les Moulins	FR	Auvergne-Rhône-Alpes		(Lundström-Baudais, 2015)
176	Les Plots	FR	Occitanie		(Marinval, 2003)
177	Mas de Vignoles IX	FR	Occitanie		(Figueiral & Séjalon, 2014)
178	Mas de Vignoles X	FR	Occitanie		(Bouby & Figueiral, 2014)
179	Mas Neuf	FR	Occitanie		(Bouby & Figueiral, 2014)
180	Montbeyre-La Cadoule	FR	Occitanie		(Marinval, 1988a)
181	Moulin de la Garonne	FR	Auvergne-Rhône-Alpes		(Marinval, 1988a)
182	Mourre de la Barque	FR	Provence-Alpes-Côte d'Azur		unpublished
183	Peiro Signado	FR	Occitanie		(Bouby, Marinval, Durand, et al., 2020)
184	Pendimoun	FR	Provence-Alpes-Côte d'Azur		(Binder et al., 2020)
185	Plateau Raverre	FR	Auvergne-Rhône-Alpes		(Martin et al., 2016)
186	Pont de Roque Haute	FR	Occitanie		(Marinval, 2007b)
187	Roc de Dourgne	FR	Occitanie		(Marinval, 1993)
188	Roquemaure	FR	Occitanie		(Marinval, 1988a)
189	Sargel	FR	Occitanie	Y	Not in the study area
189	Roquemengarde	FR	Occitanie	Y	Not in the study area
191	St. Martin d'Azirou	FR	Occitanie		(Marinval, 1988a)
192	Clairvaux XIV	FR	Bourgogne-Franche-Comté		(Schaal, 2007; Schaal & Pétrequin, 2016)
193	Toronde	FR	Occitanie		(Marinval, 1988a)
194	Aven des Corneilles	FR	Occitanie	Y	Not in the study area
195	Vieux-Mounoï	FR	Provence-Alpes-Côte d'Azur		(Martin et al., 2016)
196	Villa Giribaldi	FR	Provence-Alpes-Côte d'Azur		(Binder et al., 2004)

197	ZAC Feuilly Saint-Priest	FR	Auvergne-Rhône-Alpes		(Zierzinski, 2019b, 2019a)
198	ZAC Saint-Antoine II	FR	Occitanie		(Rousselet, 2011)
199	Zürich - AKAD-Seehofstrasse	CH	Zürich		(Brombacher & Jacomet, 1997; Jacomet, 1981; Jacomet et al., 1989)
200	Zürich - Pressehaus	CH	Zürich		(Brombacher & Jacomet, 1997; Jacomet, 1986b)
201	Arbon - Bleiche 3	CH	Thurgau		(Hosch, 2004)
202	Binningen-Friedhofstrasse	CH	Basel-Country		(Akeret & Zibulski, 2010)
203	Seeberg - Burgäschisee SW	CH	Bern		(Wey, 2012); unpublished
204	Cham -St. Andreas	CH	Zug		(Jacomet, 1986a)
205	Egolzwil 3	CH	Luzern		(Bollinger, 1994)
206	Frasses - Praz au Doux	CH	Fribourg		(Mauvilly et al., 1997)
207	Herznach - Unterdorf	CH	Aargau		unpublished
208	Horgen-Scheller	CH	Zürich		(Favre, 2002)
209	Zurich-Kleiner Hafner	CH	Zürich		(Brombacher & Jacomet, 1997; Jacomet, 1987; Jacomet et al., 1989)
210	Lattringen - Haupstation (site VII)	CH	Bern		(Brombacher, 1997)
211	Lüscherz - Klein Station, inerdorf	CH	Bern		(Brombacher, 1997)
212	Lattringen -Riedstation (site VI)	CH	Bern		(Brombacher, 1997)
212	Schallstadt-Wolfenweiler, Mengen-Abtsbreite	DE	Baden- Württemberg	Y	Not in the study area
213	Zürich - Mozartstrasse	CH	Zürich		(Brombacher & Dick, 1987; Brombacher & Jacomet, 1997)
214	Mythenschloss	CH	Zürich		(Brombacher & Dick, 1987; Brombacher & Jacomet, 1997)
215	Neftenbach	CH	Zürich		(Jacomet, 1996)
216	Nidau BKW or Nidau 'Schlossmatte/ BKW	CH	Bern		(Brombacher, 2000)
217	Cham -Eslen	CH	Zug		(Martinoli & Jacomet, 2002) unpublished
218	Risch, Oberrisch - Aabach	CH	Zug		(Jacomet & Steiner, n.d.) unpublished
219	Seedorf - Lobsigesee	CH	Uri		(Brombacher, 2020)
220	Zürich, Seefeld KanSan	CH	Zürich		(Brombacher & Jacomet, 1997)
221	Sevelen - Pfäfersbüel	CH	St. Gallen		(Rigert, Ebneter, et al., 2005)
222	Stansstad-Kehrsiten	CH	Nidwalden		(Tobler, 2010)
223	Port - Stüdeli	CH	Bern		(Brombacher & Jacomet, 2003)
224	Villeneuve-La Baume Abri 1	CH	Fribourg		(Mauvilly et al., 2010, p. 17)
225	Wetzikon, Kempten Tösstalerstr	CH	Zurich		(Rigert, Jacomet, et al., 2005)
226	Zizers- Friedau	CH	Graubünden		(Brombacher & Vandorpe, 2012)
227	Zug-Riedmatt	CH	Zug		(Steiner, 2018)
228	Delémont - En la Pran	CH	Jura		(Brombacher & Klee, 2009)
229	Bennwil - Ötschberg	CH	Basel-Country		unpublished
230	Bauma del Serrat del Pont	ES	Catalonia		Could not find the publication used
231	Cova de les Portes	ES	Catalonia		(Alonso, 1995)
232	El Cavet	ES	Catalonia		(Martins et al., 2015)

233	Les Vautes	FR	Occitanie		(Buxó, 2003)
234	Grotte d' engorner	FR	Occitanie		(Erroux, 1985)
235	Boussargues	FR	Occitanie		(Marinval, 2008)
236	Roquessols	FR	Occitanie		(Figueiral, 2010)
237	Sion - La Planta	CH	Valais		(Martin, 2015)
238	Sion - Tourbillon	CH	Valais		(Martin, 2015)
239	Sion- La Gillière 2	CH	Valais		(Martin, 2015)
240	Sion - Ritz 33	CH	Valais		(Martin, 2015)
241	Savièse - La Soie	CH	Valais		(Martin, 2015)
242	Petit-Chasseur IV	CH	Valais		(Lundström-Baudais, 2000; Lundström-Baudais & Martin, 2011)
244	Saint-Aubin/Derrière la Croix	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2003)
245	Concise- Sous Colachoz	CH	Vaud		(Karg, 2002; Märkle, 2000)
246	Zürich - Parkhaus Opera	CH	Zurich		(Antolín, Brombacher, et al., 2017)
247	Gachnang, Niederwil	CH	Thurgau		(W. Van Zeist & Helsdingen, 1991)
248	Yverdon- Avenue des Sports	CH	Vaud		(Schlichtherle, 1985)
249	Auvernier	CH	Neuchâtel		(Villaret-von Rochow, 1971)
250	Saint-Blaise/Bains des Dames 4	CH	Neuchâtel		(Mermod, 2000, 2007)
251	Twann	CH	Bern		(Piening, 1980, 1981)
252	Les Bagnoles	FR	Provence-Alpes-Côte d'Azur		(Antolín, Delefosse, et al., 2020; Antolín, Schimitt, et al., 2020; Jesus, Prats, et al., 2021)
253	Trou Arnaud	FR	auvergne-Rhône-Alpes		(Marinval, 1988b, p. 100)
254	La Cavalade	FR	Occitanie		(Bouby, 2016)
255	Balmes	FR	Auvergne-Rhône-Alpes		(Martin, 2010)
256	Clairvaux VII	FR	Bourgogne-Franche-Comté		(Neveu & Zech-Matterne, 2016)
257	Chalain 19	FR	Bourgogne-Franche-Comté		(Schaal, 2000)
258	Clairvaux III	FR	Bourgogne-Franche-Comté		(Lundström-Baudais, 1986)
259	Clairvaux II	FR	Bourgogne-Franche-Comté		(Lundström-Baudais, 1995)
260	L'Héritière Cazan	FR	Provence-Alpes-Côte d'Azur		(Thirault, 2011) could not find the carpology list, not present in the scan book
261	Naters, Altersheim	CH	Valais		Unpublished
262	Sion, Médiathèque	CH	Valais		Unpublished
263	Sion, Bramois Pranóe	CH	Valais		Unpublished
264	Sion, Saint-Guérin	CH	Valais		Unpublished
265	Carbonara Scrivia, Loc. Cascina Maghisello	IT	Piemont	Y	Unpublished
266	Spilamberto S. Cesario Sito VIII, Sito I_	IT	Emilia Romagna		(Castelletti et al., 1998)
267	ZAC Les Chalus II Lot 1-	FR	Provence-Alpes-Côte d'Azur		(Prat, 2013)
268	Route de Canohès Lotissement « Le Petit Prince »	FR	Occitanie		(Vignaud, 2010, p. 119) there are seeds but not analysed

269	Schwindratzheim « Terrasses de la Zorn »	FR	Grand Est	Y	Sampled but not study
270	Lotissement Schlossgarten	FR	Grand Est	Y	no seeds in the report
271	La Fare-les-Oliviers – Jonquière I	FR	Provence-Alpes-Côte d'Azur		(Figueiral, 2016)
272	L' aéropole Tallard	FR	Provence-Alpes-Côte d'Azur		(Hallavant, 2013; Vial, 2013, fig. 126)
273	Cepie	FR	Occitanie		(Ros, 2018)
274	509 avenue des Noyers	FR	Provence-Alpes-Côte d'Azur		(Figueiral, 2019)
275	Trets ZAC la Burlière	FR	Provence-Alpes-Côtes d'Azur		(Figueiral & Ivorra, 2017)
276	Quincieux Grange Rouge	FR	Auvergne-Rhône-Alpes		(Cabanis, 2018; Ramponi, 2018, pp. 74–79)
277	Lattes Port-Ariane III	FR	Occitanie		(Alonso et al., 2004)
278	Chens-sur-Léman Pré d'Ancy	FR	Auvergne-Rhône-Alpes		(Cabanis, 2014; Néré, 2014, fig. 264)
279	Clos Roque Route de Barjols,	FR	Provence-Alpes-Côte d'Azur		(Martin, 2018)
280	Gap Lachaup	FR	Provence-Alpes-Côte d'Azur		(Dubesset et al., 2018, p. 45,80,191)
281	A8 Rousset/ Le plan	FR	Provence-Alpes-Côte d'Azur		(Rousselet, 2009)
282	Velaux, La Bastide Neuve III ·	FR	Provence-Alpes-Côte d'Azur		(Bouchette, 2012)
283	Le site néolithique final de Ponteau	FR	Provence-Alpes-Côte d'Azur		(Rousselet, 2012)
284	Charavines - Les Baigneurs	FR	Auvergne-Rhône-Alpes		(Lundström-Baudais, 2010)
285	Brise-Lames	CH	Neuchâtel		(Lundström-Baudais, 1977)
286	Pfyn-Breitenloo	CH	Thurgau		(Haas et al., 2007)
287	Clairvaux VIII	FR	Bourgogne-Franche-Comté		(Schoch, 1989)
288	Cova de la Colomera	ES	Catalonia		(Oms Arias et al., 2013)
289	La serreta	ES	Catalonia		(López, 2013b)
290	Xammar in Maresme	ES	Catalonia		Unpublished/no seeds
291	Chalain 3 (layer VIII)	FR	Bourgogne-Franche-Comté		(Baudais et al. 1997)
292	12, rue de la Flambère	FR	Occitanie	Y	Not in the study area
293	Quartier Sainte-Anne	FR	Provence-Alpes-Côte d'Azur		(Bouby, 2020)
294	20 rue Fodéré, Villa Lympia	FR	Provence-Alpes-Côte d'Azur		(Figueiral, 2015)
295	ZAC de la Farigoule	FR	Occitanie		(Bouby & Durand, 2016)
296	Mittelhoetzleinfeld	FR	Alsace		(Bonnaire, 2019)
297	Florival	FR	Alsace		(Schaal, 2012)
298	Baldersheim	FR	Alsace	Y	Could not find the publication
299	Reichstett	FR	Alsace	Y	Could not find the publication
300	Wettolsheim	FR	Alsace	Y	Could not find the publication
301	Bergheim, Haut-Rhin, « Saulager » , zone d'activité du Muehlbach	FR	Alsace	Y	(Schaal, 2011)
302	Didenheim-Kahlberg	FR	Alsace		(Wiethold, 2009)
303	Burgäschisee Süd	CH	Bern		(Villaret-von Rochow, 1967)

304	Puyascada Cave	ES	Aragon	Y	Not in the study area
305	Els Trocs Cave	ES	Aragon	Y	Not in the study area
306	Sutz- Rütte V	CH	Bern		(Brombacher & Schlumbaum, 2017)
307	Biel-Vingelz	CH	Bern		(Brombacher & Schlumbaum, 2017)
308	Pfäffikon- Burg	CH	Schwyz		(Zibulski, 2010)
309	Auvernier/La Saunerie	CH	Neuchâtel		(Roguin-Dubochet 1982 in Mermod 2007)
310	Strandboden, Agglolac, Nidau	CH	Bern		unpublished
311	Burgäschisee Nord	CH	Bern		(Wey, 2012); unpublished
312	Le Chevenières	CH	Vaud		Unpublished
313	Petit Ruz	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2010)
314	Sur les Rochettes Est	CH	Fribourg		(Akeret, 2005)
315	Les Tilles	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2010)
316	Treytel	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2003)
317	Entzheim	FR	Alsace	Y	(Hopf, 1975)
318	Entzheim « Les Terres de la Chapelle » (Bas-Rhin)	FR	Alsace	Y	(Lefranc et al., 2017)
319	Grotte Antonnaire	FR	Auvergne-Rhône-Alpes		(Beeching et al., 2000; Erroux, 1971)
320	Teuleria dels Àlbers-1	ES	Catalonia		(López & Cantero, 2009)
321	Vinya d'en Pau	ES	Catalonia		unpublished
322	Zal del Port de Tarragona	ES	Catalonia		(López, 2018)
323	Cinc Ponts	ES	Catalonia		(López, 2013b)
324	Mas Pujó	ES	Catalonia		(López, 2013b)
325	Mas d'en Boixos	ES	Catalonia		(López, 2007, 2013a)
326	Thayngen Weier	CH	Schaffhausen		(Fredskild, 1978; Jørgensen, 1975; Robinson & Rasmussen, 1989)
327	Zurich Oberrieden	CH	Zurich		(Hügin & Michel-Tobler, 2004, pp. 22–23)
328	Zug Vorstadt	CH	Zug		(Widmer et al., 2012)
329	Grand Pré	CH	Neuchâtel		(Leducq et al., 2009), carpology is only mention sporadically on the CD (Catalogue)
330	Les Maladières	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2003)
331	Les Pâquiers	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2006b, 2006a)
332	Place d'Armes	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2010)
333	Champs Devant	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2003)
334	Steckborn, Schanz	CH	Thurgau		(Martinoli & Brombacher, 2006)
335	Reinach Mausacker	CH	Basel-Country	Y	Unpublished
336	Oberbipp Steingasse	CH	Bern		(Ramstein et al., 2020)
337	Frenkendorf Rheinstrasse	CH	Basel-Country	Y	Unpublished

338	Oberriet Abri Unterkobel	CH	St. Gallen	Y	Unpublished
339	Reinach Fleischbachstrasse	CH	Basel-Country		(Kühn & Schlumbaum, 2015)
340	Grandson Corcelettes Les Pins	CH		Y	Unpublished
341	Düdingen	CH		Y	Unpublished
342	Aux Courbes Rayes	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2010)
343	Bataillard	CH	Neuchâtel		(Leducq et al., 2009) carpology is only mention sporadically on the CD (Catalogue)
344	Chézard-Littorail	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2016)
345	Les Buchilles	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2010)
346	Aux Buchilles	CH	Neuchâtel		(Akeret & Geith-Chauvière, 2010)
347	Müstair_ Sondierbohrung Joos	CH	Graubünden		(Brombacher, 2007)
348	Baar Früebergstrasse	CH	Zug		(Gnepf Horisberger et al., 2005)
349	Zug Vorstadt	CH	Zug		(Jacomet & Wagner, 1987)
350	Quatre Pilans I	ES	Lleida		Bronze age
351	Minferri	ES	Lleida		Unpublished not added
352	Cantorella	ES	Lleida		Unpublished not added
353	Clos de Roque - Chemin de Barjols	FR	Provence-Alpes-Côte d'Azur		(Cockin & Furestier, 2009)

Appendix B: Archaeobotanical metadata

This appendix contains the archaeobotanical results.

Table 1. Archaeobotanical metadata and Table 2. Plants presence.

Archaeobotanical metadata: information on the country, phase, the total remains, taxa, the possible number of samples, total Vol., type of site and culture.

Appendix B Table 1. Archaeobotanical metadata

ID	Record name	Country	Phase	Latitude	Longitude	Total of remains	Taxa	Samples	Total vol (L)	Type of site	Culture
1	Rocca di rivoli	Northern Italy	Phase 2	45.571806	10.811826	unknown	1	N/A	no info	open air - dry	VBQ II
2	Este - località Meggiaro	Northern Italy	Phase 3	45.233016	11.667384	27	2	2	2.75	open air - dry	eneolitico
3	Monselice - via Valli	Northern Italy	Phase 2	45.244868	11.738325	~100	10	3	5.5	open air - dry	VBQ
4	Masera	Northern Italy	Phase 2	46.134345	8.326142	891	16	3	25	open air - dry	VBQ
5	Lugo di Grezzana	Northern Italy	Phase 1	45.519537	11.016505	1111	16	9	unclear	open air - dry	Fiorano
6	Fimon-Molino Casarotto	Northern Italy	Phase 2	45.472595	11.50875	unk wl	7	no info	no info	open air - wet	VBQ
7	Fimon Le Fratte	Northern Italy	Phase 3	45.466716	11.536208	774	19	15?	6150	open air - wet	
8	Saint Martin de Corléans	Northern Italy	Phase 2	45.735318	7.296976	1003	13	10?	?	open air - dry	VBQ III
9	Bannia	Northern Italy	Phase 2	45.918564	12.757229	44	4	5	37.5	open air - dry	VBQ III
10	Arquata Scrivia, Località Moriassi	Northern Italy	Phase 3	44.692836	8.872436	300	17	4	unclear	open air - dry	
11	Fagnigola	Northern Italy	Phase 1	45.852616	12.685108	10200	5	6?	unclear	open air - dry	Friuli
12	Canedole di Roverbella	Northern Italy	Phase 3	45.235386	10.844445	no info	8	no info	no info	open air - dry	
13	Sammardenchia	Northern Italy	Phase 1	45.98381	13.227885	9193	26	35	unclear	open air - dry	Friuli; Fiorano and Danilo
14	Palù di Livenza	Northern Italy	Phase 2	45.713467	12.72986	3,274 wl	23	unclear	unclear	open air - wet	VBQ Lagozza
15	Pavia de Udine	Northern Italy	Phase 1	45.996282	13.302513	3681	13	unclear	unclear	open air - dry	Friuli
16	Valler	Northern Italy	Phase 1	45.869765	12.727458	53	6	unclear	unclear	open air - dry	Friuli
17	Meduno	Northern Italy	Phase 3	46.217051	12.788202	737	12	33	unclear	open air - dry	
20	Piancada	Northern Italy	Phase 1	45.781012	13.087123	1598	15	unclear	unclear	open air - dry	Friuli
21	Latsch_1	Northern Italy	Phase 2	46.617706	10.858964	104	8	5	39	open air - dry	Early &middle LN
21	Latsch_2	Northern Italy	Phase 3	46.617706	10.858964	593	15	16	162	open air - dry	Remedello
22	Villandro_1	Northern Italy	Phase 1	46.630518	11.53753	318	13	3	unclear	open air - dry	Gaban
22	Villandro_2	Northern Italy	Phase 2	46.630518	11.53753	150	11	6	unclear	open air - dry	VBQ
23	Riva del Garda	Northern Italy	Phase 2	45.883497	10.862613	6738	21	unclear	unclear	open air - dry	VBQ
24	Isera peat bog	Northern Italy	Phase 1	45.886734	11.009006	1	1	no info	N/A	undefined	EN
25	La Vella II	Northern Italy	Phase 1	46.082986	11.100794	180	14	no info	unclear	open air - dry	Gaban
26	La Vela di Trento vIII_1	Northern Italy	Phase 2	46.082986	11.100794	274	12	4	unclear	open air - dry	VBQ II
26	La Vela di Trento vIII_2	Northern Italy	Phase 2	46.082986	11.100794	497	17	4	unclear	open air - dry	VBQ II
27	Otzi	Northern Italy	Phase 3	46.756339	10.877064	40612	121	107	unclear	undefined	
28	Bressanone- Millan	Northern Italy	Phase 3	45.499127	9.129598	994	6	no info	no info	open air - dry	
29	Velturno-Tanzgasse	Northern Italy	Phase 3	46.669436	11.597903	97	12	5	uclear	open air - dry	Rame
30	Balm Chanto	Northern Italy	Phase 3	44.963687	7.19755	150	4	no info	no info	cave/shelter	
31	Casalnoceto	Northern Italy	Phase 3	44.913364	8.981829	unk.	3	no info	no info	open air - dry	
32	Alba Corso Laghe 43	Northern Italy	Phase 2	44.690593	8.034173	2467	8	23	unclear	open air - dry	
33	Alba- Corso Europa	Northern Italy	Phase 2	44.688779	8.013396	1356	11	20	unclear	open air - dry	
34	Castello d ' Annone	Northern Italy	Phase 2	44.878711	8.315075	unknown	15	6	unclear	open air - dry	
35	Valgrana -Tetto Chiappello	Northern Italy	Phase 2	44.412563	7.380766	4699	11	unclear	unclear	open air - dry	
37	Caverna delle Arene Candide_3	Northern Italy	Phase 1	44.162293	8.328223	206	10	unclear	1366	cave/shelter	Cardial
37	Caverna delle Arene Candide_1	Northern Italy	Phase 1	44.162293	8.328223	313	14	unclear	494	cave/shelter	Impressa
37	Caverna delle Arene Candide_2	Northern Italy	Phase 1	44.162293	8.328223	77	9	unclear	407	cave/shelter	Impressa
37	Caverna delle Arene Candide_4	Northern Italy	Phase 1	44.162293	8.328223	32	4	unclear	788	cave/shelter	post-cardiale
38	San Sebastiano di Perti	Northern Italy	Phase 1	44.168903	8.341621	112	14	unclear	68	open air - dry	Impressa
39	Arma dell ' Aquila	Northern Italy	Phase 2	44.180085	8.377329	N/A	1	imprint	N/A	cave/shelter	VBQ
40	Riparo sotto Roccia di Pian del Ciliegio_1	Northern Italy	Phase 2	44.170735	8.346629	338	19	9	400	cave/shelter	VBQ
40	Riparo sotto Roccia di Pian del Ciliegio_2	Northern Italy	Phase 2	44.170735	8.346629	214.5	15	3	190	cave/shelter	VBQ
40	Riparo sotto Roccia di Pian del Ciliegio_3	Northern Italy	Phase 2	44.170735	8.346629	126	14	3	230	cave/shelter	VBQ
41	Grotta del Sanguineto o della Matta	Northern Italy	Phase 2	44.298387	8.464533	N/A	1	imprint	N/A	cave/shelter	VBQ
42	Grotta marina di Bergeggi	Northern Italy	Phase 2	44.249107	8.43863	N/A	2	imprint	N/A	cave/shelter	VBQ
43	Riparo di Rocca Due Teste all'Alpicella_1	Northern Italy	Phase 2	44.403287	8.532263	15	4	3	8	cave/shelter	VBQ II
43	Riparo di Rocca Due Teste all'Alpicella_2	Northern Italy	Phase 2	44.403287	8.532263	3.5	1	only manual	only manual	cave/shelter	ProtoLagozza-Chassey
43	Riparo di Rocca Due Teste all'Alpicella_3	Northern Italy	Phase 3	44.403287	8.532263	2	1	3	grab sample?	cave/shelter	
44	Core BH1, Piazza della Vittoria	Northern Italy	Phase 1	44.402928	8.945532	1337	21	unclear	unclear	undefined	
45	Piazza Brignole - Foce del Torrente Bisagno	Northern Italy	Phase 2	44.408665	8.9442	16	3	1	0.527	undefined	
46	Novi Ligure, località Pieve	Northern Italy	Phase 1	44.768199	8.804517	7632	10	11 SU	unclear	open air - dry	
48	Castellare di Uscio	Northern Italy	Phase 3	44.41718	9.152408	no info	3	no info	no info	open air - dry	
49	Albinea	Northern Italy	Phase 1	44.619867	10.602587	unknown	1	unknown	unknown	open air - dry	Fiorano
50	Fiorano	Northern Italy	Phase 1	44.53197	10.828493	unknown	1	unknown	unknown	open air - dry	Fiorano
51	Lugo di Romagna	Northern Italy	Phase 1	44.480157	11.896385	11520	39	121	unclear	open air - dry	Fiorano
52	Ponte Ghiara	Northern Italy	Phase 1	44.840061	10.016175	7523	34	210	66	open air - dry	VBQ I
53	Ponte Molino	Northern Italy	Phase 2	45.411624	11.873797	2209	14	5	unclear	open air - dry	MN-LN
54	Rivaltella- Ca Romensini	Northern Italy	Phase 2	44.656038	10.589435	1074	17	5	unclear	open air - dry	
55	Savignano	Northern Italy	Phase 1	44.479599	11.037502	unknown	1	unknown	unknown	open air - dry	Fiorano

ID	Record name	Country	Phase	Latitude	Longitude	Total of remains	Taxa	Samples	Total vol (L)	Type of site	Culture
56	Forlì via Navicella	Northern Italy	Phase 1	44.257353	12.088737	367	12	4	20	open air - dry	
56	Forlì via Navicella_2	Northern Italy	Phase 2	44.257353	12.088737	164	6	5	25	open air - dry	
56	Forlì via Navicella_3	Northern Italy	Phase 2	44.257353	12.088737	1	1	1	5	open air - dry	Cultura Diana
57	Bazzarola_2	Northern Italy	Phase 1	44.677154	10.653673	7811	22	5?	48.4	open air - dry	Fiorano
57	Bazzarola_1	Northern Italy	Phase 1	44.677154	10.653673	773	13	1	16	open air - dry	Impressa
57	Bazzarola_3	Northern Italy	Phase 2	44.677154	10.653673	1387	22	2	8	open air - dry	VBQ
58	Chiozza di Scandiano	Northern Italy	Phase 2	44.002338	10.231952	unknown	1	unknown	unknow	undefined	VBQ
59	Levata di Curtatone	Northern Italy	Phase 2	45.153121	10.714878	14041	25?	22	unclear	open air - dry	VBQ
60	Parma via Guidorossi	Northern Italy	Phase 2	44.78291	10.29639	3435	23	17	44	open air - dry	VBQ
61	Spilamberto - Cava via Macchioni	Northern Italy	Phase 1	44.532521	11.016477	283	25	14	70	open air - dry	Fiorano
62	Provezza_3	Northern Italy	Phase 3	44.183263	12.182213	17	11	1	5	open air - dry	
62	Provezza_1	Northern Italy	Phase 3	44.183263	12.182213	8	1	2	10	open air - dry	
62	Provezza_2	Northern Italy	Phase 3	44.183263	12.182213	9	3	3	15	open air - dry	
63	Forlimpopoli - via Canalazzo	Northern Italy	Phase 3	44.183897	12.107943	25	10	1	5	open air - dry	
64	S. Andrea de Travo	Northern Italy	Phase 3	44.862512	9.546044	3	3	1	5	open air - dry	Chasséen culture-Lagozza
65	Cecima	Northern Italy	Phase 1	44.850259	9.080448	>44	1	unclear	unclear	open air - dry	Vho
66	Isorella	Northern Italy	Phase 1	45.309228	10.322083	11	5	3	unclear	open air - dry	Vho
67	Dugali Alti	Northern Italy	Phase 1	45.223886	10.253558	3	2	N/A	N/A	open air - dry	Vho
68	Pizzo di Bodio_1	Northern Italy	Phase 2	45.796039	8.754136	2	2	unclear	unclear	open air - wet	VBQ
68	Pizzo di Bodio_2	Northern Italy	Phase 2	45.796039	8.754136	unclear	6	unclear	unclear	open air - wet	VBQ
69	Vho di Piadena	Northern Italy	Phase 1	45.129257	10.385032	6	4	N/A	0.05	open air - dry	Vho
70	Acquanegra sul Mosio	Northern Italy	Phase 2	45.147377	10.485383	unclear	3	unclear	unclear	open air - dry	
71	Casatico di Marcaria	Northern Italy	Phase 2	45.278322	9.145495	ca 400	5	unclear	unclear	open air - dry	
72	Isolino di Varese	Northern Italy	Phase 2	45.812058	8.717889	858	30	5	1.8	open air - wet	
73	Rivarolo Mantovano	Northern Italy	Phase 2	45.074907	10.444393	unclear	5	unclear	unclear	open air - dry	
74	Lovere-Via Deccio Celeri	Northern Italy	Phase 3	45.817872	10.07433	39	6	3	no info	open air - dry	Bell Beaker
75	Monte Covolo_2	Northern Italy	Phase 3	45.61826	10.4724	157	13	25	50?	open air - dry	White ware phase
75	Monte Covolo_3	Northern Italy	Phase 3	45.61826	10.4724	271	13	50	50?	open air - dry	Bell Beaker
76	Lagozza di Besnate	Northern Italy	Phase 2	45.708119	8.749041	unk wl	18	unclear	unclear	open air - wet	
79	Can Sadurní_layer18	NE Iberia	Phase 1	41.345292	1.911656	54197	20	11	1.125	cave/shelter	EN
79	Can Sadurní_Layer11	NE Iberia	Phase 2	41.345292	1.911656	1814	21	14	unclear	cave/shelter	
79	Can Sadurní_Layer10	NE Iberia	Phase 2	41.345292	1.911656	429	25	25	217	cave/shelter	
80	La Draga_SA	NE Iberia	Phase 1	42.126841	2.758798	283888	5	31	ca.1150	open air - wet	EN
80	La Draga_SB_SD	NE Iberia	Phase 1	42.126841	2.758798	44866	79	47	679.27	open air - wet	EN
81	Caserna de Sant Pau_Cardial_	NE Iberia	Phase 1	41.376604	2.168768	148	7	8	unclear	open air - dry	Cardial
81	Caserna de Sant Pau_Cardial_epicardial/postcardial	NE Iberia	Phase 1	41.376604	2.168768	89	9	9	unclear	open air - dry	cardial and epicardial/postcardial
82	Font del Ros	NE Iberia	Phase 1	42.096933	1.844625	222	6	no info	unclear	open air - dry	
83	Cova de Sant Llorenç_EN	NE Iberia	Phase 1	41.252495	1.831822	6	3	7	35	cave/shelter	
83	Cova de Sant Llorenç_LEN	NE Iberia	Phase 1	41.252495	1.831822	44	9	25	196	cave/shelter	
83	Cova de Sant Llorenç_MN	NE Iberia	Phase 2	41.252495	1.831822	9	3	9	64	cave/shelter	
83	Cova de Sant Llorenç_LN	NE Iberia	Phase 3	41.252495	1.831822	4	2	3	19	cave/shelter	
85	Carrer Reina Amàlia, 31-33_ EN	NE Iberia	Phase 1	41.377111	2.166868	142	10	14	218.5	open air - dry	
85	Carrer Reina Amàlia, 31-33,MN	NE Iberia	Phase 2	41.377111	2.166868	447	9	16	188	open air - dry	
86	Plansallosa	NE Iberia	Phase 1	42.23537	2.63126	48	4	no info	unclear	open air - dry	
87	Cova del Sardo_LEN	NE Iberia	Phase 1	42.522494	0.834458	33	7	6	61	cave/shelter	
87	Cova del Sardo_MN	NE Iberia	Phase 2	42.522494	0.834458	36	6	9	107	cave/shelter	
87	Cova del Sardo_LMN	NE Iberia	Phase 2	42.522494	0.834458	20	9	6	61	cave/shelter	
87	Cova del Sardo_LN	NE Iberia	Phase 3	42.522494	0.834458	47	4	5	61	cave/shelter	
88	La Dou_LEN	NE Iberia	Phase 1	42.120003	2.469146	53	11	30	73	open air - dry	
88	La Dou_EMN	NE Iberia	Phase 2	42.120003	2.469146	121	16	13	163	open air - dry	
89	Codella	NE Iberia	Phase 1	42.125373	2.477817	27	8	7	unclear	open air - dry	
90	Camp del Colomer	NE Iberia	Phase 2	42.43885	1.491219	3447	43	61	615.6	open air - dry	
91	Serra del Mas Bonet_LEN	NE Iberia	Phase 1	42.252838	2.94256	95	4	6	45	open air - dry	
91	Serra del Mas Bonet_MN	NE Iberia	Phase 2	42.252838	2.94256	4	2	11	28.5	open air - dry	
91	Serra del Mas Bonet_LN	NE Iberia	Phase 3	42.252838	2.94256	128	5	53	122	open air - dry	
92	120 Cave_Neol2	NE Iberia	Phase 1	42.23768	2.65095	67	5	unclear	unclear	cave/shelter	
92	120 Cave_Neol3	NE Iberia	Phase 2	42.23768	2.65095	12	4	unclear	unclear	cave/shelter	
93	Bòbila Madurell_MN	NE Iberia	Phase 2	41.53469	2.0821	26446	10	239	950	open air - dry	
93	Bòbila Madurell_LN	NE Iberia	Phase 3	41.53469	2.0821	963	9	55	190	open air - dry	
94	Mines of Gavà_4200-3800 BC	NE Iberia	Phase 2	41.30712	2.00388	76	4	7	196	mines	
94	Mines of Gavà_3200-2800 BC	NE Iberia	Phase 3	41.30712	2.00388	350	13	38	unclear	mines	
95	Espina C	NE Iberia	Phase 3	41.648079	1.14094	13	2	13	28	open air - dry	
96	Pla del Gardelo	NE Iberia	Phase 2	41.547067	0.823449	44	3	13	530	open air - dry	
97	Puig del Collet / El Collet/Collet Puiggròs	NE Iberia	Phase 2	41.550956	0.888372	114	6	4	179	open air - dry	
98	CIM "El Camp"_LEN	NE Iberia	Phase 1	41.148258	1.168291	1	1	1	10	open air - dry	
98	CIM "El Camp"_EMN	NE Iberia	Phase 2	41.148258	1.168291	1	1	1	10	open air - dry	

ID	Record name	Country	Phase	Latitude	Longitude	Total of remains	Taxa	Samples	Total vol (L)	Type of site	Culture
99	Pesseta Cave	NE Iberia	Phase 3	41.38994	1.57065	no info	2	65	no info	cave/shelter	
100	Camí dels Banys de la Mercè	NE Iberia	Phase 1	42.366414	2.927584	37	5	37	93	open air - dry	
102	Can Revella (Can Roqueta)	NE Iberia	Phase 2	41.54732	2.11051	9	3	2	49	open air - dry	
103	Castelnuovo di Teolo	Northern Italy	Phase 2	45.331025	11.685516	302	9	unclear	no info	open air - dry	VBQ “Chassey-Lagozza”
104	Auvelles_Postcardial	NE Iberia	Phase 1	41.817416	0.726554	2714	16	3	3.64	open air - dry	
104	Auvelles_neo2	NE Iberia	Phase 2	41.817416	0.726554	19	4	9	no info	open air - dry	
105	Cova del Toll_MN	NE Iberia	Phase 2	41.81351	2.09804	149	6	21	unclear	cave/shelter	
105	Cova del Toll_LN	NE Iberia	Phase 3	41.81351	2.09804	9840	3	no info	no info	cave/shelter	
110	Pou Nou 2	NE Iberia	Phase 2	41.348653	1.738673	11689	14	14	unclear	open air - dry	
112	L' escola Especial Meritxell	NE Iberia	Phase 2	42.506317	1.521836	61	9	6	77	open air - dry	
113	Rivoli Veronese	Northern Italy	Phase 2	45.571806	10.811826	unclear	1	unclear	no info	open air - dry	VBQ III
114	Barbiano	Northern Italy	Phase 2	46.606483	11.516718	unclear	3	unclear	no info	open air - dry	VBQ
115	Aica di Fiè / Völs am Schlern/Volseraicha	Northern Italy	Phase 3	46.493294	11.48427	no info	1	no info	no info	open air - dry	VBQ
116	Brescia S. Polo	Northern Italy	Phase 3	45.22373	10.219	no info	1	no info	no info	open air - dry	Bell Beaker
117	Tolerait	Northern Italy	Phase 3	46.286842	11.211402	no info	5	no info	no info	open air - dry	Chalcolithic
122	Aspre del Paradís_EN	SE France	Phase 1	42.626196	2.948085	12	3	one?	50	open air - dry	Cardial/Epicardial II
122	Aspre del Paradís_LN	SE France	Phase 3	42.626196	2.948085	19	5	one?	50	open air - dry	vérazien
123	Aulp du Seuil	SE France	Phase 2	45.332045	5.905189	509	20	28	597	cave/shelter	
124	Auriac	SE France	Phase 2	43.191028	2.336323	246	5	unclear	no info	open air - dry	Chasséen culture
125	Auriac-Golf	SE France	Phase 2	43.186579	2.335671	3	1	unclear	no info	open air - dry	
126	Balma de l'Abeurador_epicardial	SE France	Phase 1	43.328957	2.600531	72	8	unclear	unclear	cave/shelter	epicardial
126	Balma de l'Abeurador_Chassenclassic	SE France	Phase 2	43.328957	2.600531	29	3	unclear	unclear	cave/shelter	classic Chasséen
126	Balma de l'Abeurador_Chassenancien	SE France	Phase 2	43.328957	2.600531	96	5	unclear	unclear	cave/shelter	Chasséen ancien
127	Balma Margineda_5472-4849	NE Iberia	Phase 1	42.478993	1.488585	80	19	3	unclear	cave/shelter	Cardial/Epicardial I
127	Balma Margineda_4793-4612	NE Iberia	Phase 1	42.478993	1.488585	5	4	1	unclear	cave/shelter	Cardial/Epicardial I
128	Barreau de la Devèze Sud_MN1	SE France	Phase 2	43.344225	3.215753	0	0	2	20	open air - dry	classic Chasséen
128	Barreau de la Devèze Sud_MN2	SE France	Phase 2	43.344225	3.215753	902	4	2	20	open air - dry	classic Chasséen
128	Barreau de la Devèze Sud_MN	SE France	Phase 2	43.344225	3.215753	39	1	1	10	open air - dry	classic Chasséen
129	Baume Bourbon	SE France	Phase 1	43.902974	4.468391	32	1	1	unclear	cave/shelter	Cardial < 5000 BC
130	Baume d'Oullins	SE France	Phase 1	44.341609	4.457664	221	4	2	unclear	cave/shelter	Cardial > 5000 BC
131	Baume Fontbrégoua_Cardialancien	SE France	Phase 1	43.563772	6.231338	1113	17	81	unclear	cave/shelter	Chasséen ancien
131	Baume Fontbrégoua_Cardial final	SE France	Phase 1	43.563772	6.231338	962	10	46	unclear	cave/shelter	Cardial final
131	Baume Fontbrégoua_Pre_Chassen	SE France	Phase 2	43.563772	6.231338	329	10	13	unclear	cave/shelter	Pre_Chasséen
131	Baume Fontbrégoua_Chassen ancien	SE France	Phase 2	43.563772	6.231338	1152	11	34	unclear	cave/shelter	Chasséen ancien
131	Baume Fontbrégoua_Chassee recent	SE France	Phase 2	43.563772	6.231338	67	10	10	unclear	cave/shelter	Cardial to Chassen
132	Boulevard périphérique Nord de Lyon_EN	SE France	Phase 1	45.791312	4.840968	1799	9	no info	161.5	open air - dry	Cardial/Epicardial
132	Boulevard périphérique Nord de Lyon_MN	SE France	Phase 2	45.791312	4.840968	172	6	no info	26.5	open air - dry	Neolitique Moyen Bourguignon
132	Boulevard périphérique Nord de Lyon_campaniforme	SE France	Phase 3	45.791312	4.840968	51	5	no info	24.5	open air - dry	Campaniforme
134	Caucade	SE France	Phase 2	43.680081	7.219443	3	2	no info	unclear	open air - dry	Chasséen
136	Claparouse	SE France	Phase 2	43.893979	5.114628	10660	5	no info	unclear	open air - dry	Chasséen
137	Clos de Roque	SE France	Phase 2	43.452497	5.864004	5330	53	unclear	unclear	open air - dry	LN?
139	Cova de l'Esperit	SE France	Phase 1	42.833829	2.919303	34	8	no info	unclear	cave/shelter	Cardial/Epicardial I
140	Encombres	SE France	Phase 2	43.344334	2.960542	186	6	no info	unclear	open air - dry	Chasséen ancien
141	Font Juvénal_EN	SE France	Phase 1	43.269681	2.401473	11	4	3	unclear	cave/shelter	epicardial
141	Font Juvénal_MN1	SE France	Phase 2	43.269681	2.401473	1674	14	13?	unclear	cave/shelter	classic Chasséen
141	Font Juvénal_MN2	SE France	Phase 2	43.269681	2.401473	19	5	6	unclear	cave/shelter	MN Chasséen evolue
141	Font Juvénal_LN	SE France	Phase 3	43.269681	2.401473	8	6	6	unclear	cave/shelter	Chalcolithic
142	Gardon_ENRhodanie	SE France	Phase 1	45.958432	5.359561	21	6	no info	unclear	cave/shelter	Neolithique ancien rhodanien
142	Gardon_MNSain-UZE	SE France	Phase 2	45.958432	5.359561	8	3	no info	unclear	cave/shelter	Saint-Uze
143	Grotte de l' Aigle	SE France	Phase 1	44.225227	4.348998	5	4	indet	unclear	cave/shelter	Cardial/Epicardial II
144	Grotte de Montou Montbolo_MN	SE France	Phase 2	42.652973	2.679827	6863	17	511	unclear	cave/shelter	
144	Grotte de Montou Montbolo_LN	SE France	Phase 3	42.652973	2.679827	51	511	15	unclear	cave/shelter	
145	Grotte du Taï_Early Neo 1	SE France	Phase 1	43.939495	4.564221	2622	49	58	993	cave/shelter	EN
145	Grotte du Taï_Early Neo 2	SE France	Phase 1	43.939495	4.564221	505	26	27	227	cave/shelter	EN
145	Grotte du Taï_Middle Neolithic	SE France	Phase 2	43.939495	4.564221	265	85	13	1220	cave/shelter	MN
145	Grotte du Taï_Ferriéres	SE France	Phase 3	43.939495	4.564221	1298	23	18	249.5	cave/shelter	Ferrières (LN1)
145	Grotte du Taï_Fontbouisse	SE France	Phase 3	43.939495	4.564221	46	6	6	55.5	cave/shelter	Fontbouisse (LN2)
147	Grotte G	SE France	Phase 2	43.716163	6.134433	229	7	no info	unclear	cave/shelter	
148	Grotte Gazel_5000	SE France	Phase 1	43.32417	2.419938	94	8	9	no info	cave/shelter	Cardial > 5000 BC
148	Grotte Gazel_after5000	SE France	Phase 1	43.32417	2.419938	2	2	2	no info	cave/shelter	Cardial < 5000 BC
149	Grotte Murée	SE France	Phase 2	43.771621	6.099698	41	2	no info	unclear	cave/shelter	
150	Grotte St Marcel_EN	SE France	Phase 1	44.331093	4.541511	15	3	no info	unclear	cave/shelter	Cardial/Epicardial II
150	Grotte St Marcel_MN	SE France	Phase 2	44.331093	4.541511	6	2	no info	unclear	cave/shelter	Neolitique moyen chasseen
150	Grotte St Marcel_LN	SE France	Phase 3	44.331093	4.541511	645	8	6	no info	cave/shelter	Cardial/Epicardial II
151	Jardins de Vert Parc_chass	SE France	Phase 2	43.632984	3.897506	510	10	10?	158	open air - dry	Chasséen

ID	Record name	Country	Phase	Latitude	Longitude	Total of remains	Taxa	Samples	Total vol (L)	Type of site	Culture
152	La Grande Rivoire_EN	SE France	Phase 1	45.209178	5.633108	107	8	2	24.5	cave/shelter	
152	La Grande Rivoire_MN1	SE France	Phase 2	45.209178	5.633108	1465	41	34	278.8	cave/shelter	
152	La Grande Rivoire_MN2	SE France	Phase 2	45.209178	5.633108	523	43	6	52	cave/shelter	
152	La Grande Rivoire_LN	SE France	Phase 3	45.209178	5.633108	8110	32	23	125	cave/shelter	
153	Clairvaux - La Motte aux Magnins V	SE France	Phase 2	46.576233	5.751053	114781	99	17	unclear	open air - wet	Neolitique Moyen Bourguignon
156	La Resclauze	SE France	Phase 1	43.513338	3.272799	58	3	indet	unclear	open air - dry	cardial/epicardial
157	La Roberte	SE France	Phase 2	44.524949	4.716932	488	4	no info	no info	open air - dry	MN?
158	La Salle	SE France	Phase 2	43.195465	2.334709	292	2	no info	no info	cave/shelter	Bizien
159	Le Bousquetas	SE France	Phase 3	43.539645	3.459371	4520	4	5	140	open air - dry	vérazien And fontboisse
160	Le Champ du Poste_Chassen ancien	SE France	Phase 2	43.212161	2.353663	363	4	11	110?	open air - dry	Chasséen
160	Le Champ du Poste_Verazien	SE France	Phase 3	43.212161	2.353663	7	2	3	30?	open air - dry	Chasséen verazien
161	Le Chenet des Pierres_MN1	SE France	Phase 2	45.443217	6.648055	3762	27	28	198	open air - dry	VBQ/St Uze/ChA
161	Le Chenet des Pierres_MN2	SE France	Phase 2	45.443217	6.648055	28	26	10	168	open air - dry	ChR/Lagozza
162	Le Crès	SE France	Phase 2	43.350455	3.196894	643	5	1	20	open air - dry	Chasséen ancien
163	Le Font aux Pigeons	SE France	Phase 1	43.38296	5.164636	43164	10	21	unclear	open air - dry	Cardial ancien/moyen/final
164	Le Lagarel	SE France	Phase 3	43.652984	3.508645	1199	3	1	2	open air - dry	
165	Le Logis de Berre	SE France	Phase 2	44.413686	4.74316	526	5	no info	no info	open air - dry	
166	Le Moulin	SE France	Phase 2	44.186795	5.475206	472	6	no info	no info	open air - dry	
167	Le Pirou	SE France	Phase 2	43.42096	3.358238	291	3	7	342		
168	Le Puech Haut_LN1	SE France	Phase 3	43.534099	3.458481	49	4	1	15	open air - dry	Ferrières et Fontbouisse
168	Le Puech Haut_LN2	SE France	Phase 3	43.534099	3.458481	205	9	3	40	open air - dry	Ferrières et Fontbouisse
168	Le Puech Haut_LN3	SE France	Phase 3	43.534099	3.458481	1490	9	8	160	open air - dry	Ferrières et Fontbouisse
169	Le Rochas	SE France	Phase 3	44.391688	4.501187	Unknown	1	no info	no info	open air - dry	Culture de Fontbouisse
170	Le Serre de Boidon	SE France	Phase 3	44.759629	4.562443	4608	9	1	no info	open air - dry	Culture de Fontbouisse
171	Le Valladas	SE France	Phase 1	44.348515	4.76827	72724	5	no info	unclear	open air - dry	Cardial
174	Les Lauzières	SE France	Phase 3	43.7667	5.36667	6680	4	no info	unclear	open air - dry	chalcolithique campaniforme
175	Les Moulins	SE France	Phase 2	44.34369	4.753042	4694.45	15	30?	unclear	open air - dry	Chasséen
176	Les Plots	SE France	Phase 2	43.218178	2.412707	75	5	no info	no info	open air - dry	Chasséen languedocien
177	Mas de Vignoles IX	SE France	Phase 2	43.807332	4.363319	115	13	2?	40-60	open air - dry	Chasséen
178	Mas de Vignoles X	SE France	Phase 1	43.807332	4.363319	13	5	7	90	open air - dry	Early Epicardial
179	Mas Neuf	SE France	Phase 1	43.806437	4.358295	> 47450	2	1	unclear	open air - dry	Cardial/Epicardial II
180	Montbeyre-La Cadoule	SE France	Phase 2	43.682725	3.925613	415	5	no info	no info	open air - dry	Chasséen
181	Moulin de la Garonne	SE France	Phase 2	44.0073	8.172717	7	1	no info	no info	open air - dry	Chasséen
182	Mourre de la Barque_Neo2	SE France	Phase 2	43.636646	5.639546	496	15	7	35.7	cave/shelter	type Mourre de la Barque
182	Mourre de la Barque_Neo3	SE France	Phase 2	43.636646	5.639546	35	7	8	unclear	cave/shelter	type Mourre de la Barque
183	Peiro Signado	SE France	Phase 1	43.308694	3.328162	374	15	27	unclear	cave/shelter	Impressa
184	Pendimoun_Impressa	SE France	Phase 1	43.863272	7.87493	2800	not possible to quantified	491	2946	cave/shelter	Impressa
184	Pendimoun_cardial	SE France	Phase 1	43.863272	7.87493	1470	not possible to quantified	443	844.8	cave/shelter	Cardial
184	Pendimoun_SMP	SE France	Phase 2	43.863272	7.87493	49	not possible to quantified	93	333.7	cave/shelter	VBQ
185	Plateau Raverre	SE France	Phase 2	45.189198	4.861578	97	8	no info	no info	open air - dry	Saint-Uze
186	Pont de Roque Haute	SE France	Phase 1	43.291008	3.361951	17; 44 frag	3	no info	unclear	open air - dry	Impressa
187	Roc de Dourgne	SE France	Phase 1	42.768701	2.082064	4	1	1	9	cave/shelter	couche 5 Epicardial; 5325-4856; couche 6 Pericardial 5560-5240
188	Roquemaure	SE France	Phase 3	44.051884	4.778861	203	9	2?	unclear	cave/shelter	vérazien
191	St. Martin d'Azirou	SE France	Phase 3	43.784791	3.49262	382	6	no info	unclear	cave/shelter	LN
192	Clairvaux XIV	SE France	Phase 2	46.567294	5.746356	2265.25	117	13	unclear	open air - wet	Neolitique Moyen
193	Toronde	SE France	Phase 2	43.168939	2.327266	1	1	no info	no info	open air - dry	Neo moye chassen
195	Vieux-Mounoï	SE France	Phase 2	43.273237	5.775848	4?	2	no info	no info	cave/shelter	
196	Villa Giribaldi	SE France	Phase 2	43.701384	7.280885	830	22	7	unclear	open air - dry	
197	ZAC Feuilly_ Cardial	SE France	Phase 1	45.698938	4.947071	671	3	1?	65	open air - dry	cardial
197	ZAC Feuilly_MNB	SE France	Phase 2	45.698938	4.947071	9212	12	18	19	open air - dry	Neolitique Moyen Bourguignon
198	ZAC Saint-Antoine II_preCha4300	SE France	Phase 2	43.636932	3.966221	2	0	unclear	40	open air - dry	Pre_Chasséen
198	ZAC Saint-Antoine II_chansancien	SE France	Phase 2	43.636932	3.966221	126	11	unclear	60	open air - dry	Chasséen ancien
198	ZAC Saint-Antoine II_chassen recent	SE France	Phase 2	43.636932	3.966221	2780	16	unclear	270	open air - dry	
198	ZAC Saint-Antoine II_MN	SE France	Phase 2	43.636932	3.966221	90	6	unclear	100	open air - dry	
199	Zürich - AKAD-Seehofstrasse	Switzerland	Phase 2	47.364521	8.548591	237550	126	128	209.75	open air - wet	Pfyn
200	Zürich - Pressehaus_1_Horgen	Switzerland	Phase 2	47.364521	8.548591	5496	56	17	1.7	open air - wet	
200	Zürich - Pressehaus_2_Schnur	Switzerland	Phase 3	47.364521	8.548591	7131	74	3	3.93	open air - wet	Schnurkeramik
201	Arbon - Bleiche 3	Switzerland	Phase 3	47.50589	9.436122	1309661	142	281	608.42	open air - wet	
202	Binningen-Friedhofstrasse	Switzerland	Phase 3	47.541828	7.580002	4187	22	12	632.2	open air - dry	Schnurkeramik
203	Seeberg - Burgäschisee SW	Switzerland	Phase 2	47.16719	7.666378	6037	40	15	58.7	open air - wet	Cortaillod-K.allg. 4500-3500 BC cal
204	Cham -St. Andreas	Switzerland	Phase 2	47.179634	8.466008	947	10	4	unclear	open air - wet	Pfyn (Cortaillod?)
205	Egolzwil 3	Switzerland	Phase 2	47.184717	8.00719	29794	102	100	81.47	open air - wet	Egolzwil 4400-4250 BC cal
206	Frasses - Praz au Doux	Switzerland	Phase 3	46.833749	6.867238	1164	47	7	58.3	open air - wet	
208	Horgen-Scheller_Schnur	Switzerland	Phase 3	47.268742	8.588183	4886	49	3	3	open air - wet	Schnurkeramik
208	Horgen-Scheller_ Horgen	Switzerland	Phase 3	47.268742	8.588183	494123	181	62	58.9	open air - wet	Horgen

ID	Record name	Country	Phase	Latitude	Longitude	Total of remains	Taxa	Samples	Total vol (L)	Type of site	Culture
209	Kleiner Hafner_Ego	Switzerland	Phase 2	47.36599	8.544157	16090	74	16	6.03	open air - wet	Cortaillod
209	Kleiner Hafner_Cort	Switzerland	Phase 2	47.36599	8.544157	95759	123	76	13.25	open air - wet	Egolzwil
210	Lattringen - Haupstation (site VII)_Cord	Switzerland	Phase 3	47.099653	7.21597	10871	85	25	5	open air - wet	Cortaillod tardif 3700-3500 BC cal
210	Lattringen - Haupstation (site VII)_Horg	Switzerland	Phase 3	47.099653	7.21597	53013	127	71	30.48	open air - wet	Horgen Occidental vor 3000/2900 BC cal
211	Lüscherz - Klein Station, inerdorf_1	Switzerland	Phase 2	47.046686	7.151586	10591	62	11	8.34	open air - wet	Jungneolithikum 4 3750-3500 (-3300) BC cal
211	Lüscherz - Klein Station, inerdorf_2	Switzerland	Phase 3	47.046686	7.151586	4788	2	5	0.05	open air - wet	Spätneolithikum 1 allg. 3500-3250 BC cal
212	Lattringen -Riedstation (site VI)	Switzerland	Phase 2	47.099653	7.21597	115	2	4	0.002	open air - wet	Spätneolithikum 1 allg. 3500-3250 BC cal
213	Zürich - Mozartstrasse_Pyy2	Switzerland	Phase 2	47.365049	8.546656	104458	142	98	48.425	open air - wet	Pfyn
213	Zürich - Mozartstrasse_Cort	Switzerland	Phase 2	47.365049	8.546656	1282	60	4	2.5	open air - wet	Cortaillod klass;
213	Zürich - Mozartstrasse_FruheszentralCortaill	Switzerland	Phase 2	47.365049	8.546656	48793	156	93	31.273	open air - wet	FruheszentralCortaill
213	Zürich - Mozartstrasse_Pyy1	Switzerland	Phase 2	47.365049	8.546656	5238	71	14	9.82	open air - wet	Pfyn
213	Zürich - Mozartstrasse_Horgen	Switzerland	Phase 3	47.365049	8.546656	280204	160	163	82.314	open air - wet	Horgen
214	Mythenschloss_Schnur1	Switzerland	Phase 3	47.361004	8.534579	58034	111	51	28.79	open air - wet	Schnurkeramik1
214	Mythenschloss_Horgen	Switzerland	Phase 3	47.361004	8.534579	13501	48	25	1.39	open air - wet	Horgen
215	Neftenbach_Aspach	Switzerland	Phase 3	47.526642	8.66883	32	7	1	unknow	open air - dry	Horgen K. allg. 3400-2800 BC cal
216	Nidau BKWi or Nidau 'Schlossmatte/ BKW	Switzerland	Phase 2	47.093447	7.232703	32292	106	30	24.53	open air - wet	Lattrigen
219	Seedorf - Lobsigesee	Switzerland	Phase 2	47.030079	7.298229	4353	24	20	34.53	open air - wet	
220	Zürich, Seefeld KanSan_Pfy	Switzerland	Phase 2	47.356492	8.553318	173933	148	56	25.95	open air - wet	Pfyn
220	Zürich, Seefeld KanSan_Schnur	Switzerland	Phase 3	47.356492	8.553318	191671	165	100	61.59	open air - wet	Schnurkeramik
220	Zürich, Seefeld KanSan_Horg	Switzerland	Phase 3	47.356492	8.553318	820558	197	148	84.57	open air - wet	Horgen
221	Sevelen - Pfäfersbüel	Switzerland	Phase 1	47.121881	9.486933	821	17	2	26	open air - dry	Rössen allg. 4700-4400 BC cal
222	Stansstad-Kehrsiten_ 3750-3500_Pfyn	Switzerland	Phase 2	47.000019	8.366233	256172	84	4	156.01	open air - wet	Pfyn
222	Stansstad-Kehrsiten_ 4250-3750_Corta	Switzerland	Phase 2	47.000019	8.366233	82583	78	1	100.4	open air - wet	zentralschweizerisches Cortaillod allg. 4250-3750 BC cal;
223	Port - Stüdeli_US_41	Switzerland	Phase 2	47.116528	7.255142	51940	86	49	6.99	open air - wet	Cortaillod-K.allg. 4500-3500 BC cal
224	Villeneuve-La Baume Abri 1	Switzerland	Phase 3	46.730382	6.857404	182655	5	1	6	cave/shelter	Lüscherz 2900-2700 BC cal
225	Wetzikon, Kempten Tösstalerstr	Switzerland	Phase 3	47.326858	8.801019	1506	26	20	144.72	undefined	Glockenbecher 2400-2200 BC cal Bell Beaker
226	Zizers- Friedau	Switzerland	Phase 1	46.936525	9.565511	2542	28	74	399.5	open air - dry	Hinkelstein 5000-4800 BC cal
227	Zug-Riedmatt	Switzerland	Phase 3	47.179756	8.484631	2261679	159	219	147.09	open air - wet	
228	Delémont - En la Pran	Switzerland	Phase 3	47.365843	7.345239	117	8	10	unclear	open air - dry	
230	Bauma del Serrat del Pont_EN	NE Iberia	Phase 1	42.247474	2.605036	3	2	no info	unclear	cave/shelter	
230	Bauma del Serrat del Pont_LN	NE Iberia	Phase 3	42.247474	2.605036	32	7	no info	unclear	cave/shelter	
231	Cova de les Portes	NE Iberia	Phase 3	42.306047	1.443469	45	5	no info	unclear	cave/shelter	vérazien
232	El Cavet	NE Iberia	Phase 1	41.073819	1.085401	no info	1	?	unclear	open air - dry	
233	Les Vautes	SE France	Phase 3	43.671931	3.833155	3017	6	3	unclear	open air - dry	Fontbouisse
234	Grotte d' engorner	SE France	Phase 3	42.586754	2.366525	251	3	no info	unclear	cave/shelter	
235	Boussargues	SE France	Phase 3	44.141006	4.584432	46245?	11	74	unclear	open air - dry	chalcolithique Fontbouisse
236	Roquessols	SE France	Phase 3	43.42834	3.356568	1644	7	15	35	open air - dry	Complexe Saint-Pono-Verazien
237	Sion - La Planta	Switzerland	Phase 1	46.232831	7.358411	694	19	unknow	74	open air - dry	
238	Sion - Tourbillon_1	Switzerland	Phase 1	46.233453	7.377619	497	12	unknow	94	open air - dry	
238	Sion - Tourbillon_EN/MN	Switzerland	Phase 2	46.233453	7.377619	275	7	4	40	open air - dry	ceramic shows affinities with Isolino group
239	Sion- La Gillière 2	Switzerland	Phase 1	46.233122	7.360626	25709	17	unknow	118	open air - dry	
240	Sion - Ritz 33	Switzerland	Phase 2	46.235836	7.35988	11763	24	1?	8	open air - dry	
241	Savièse - La Soie	Switzerland	Phase 2	46.250078	7.343188	5968	39	unclear	504.5	open air - dry	
242	Petit-Chasseur IV_MNI 4500	Switzerland	Phase 2	46.231702	7.351246	14	1	3	9.24	open air - dry	
242	Petit-Chasseur IV_'Cortaillod type Petit-Chasseur (4000-3800)	Switzerland	Phase 2	46.231702	7.351246	8224.5	17	23	91.12	open air - dry	Cortaillod, type Petit-Chasseur
244	Saint-Aubin/Derrière la Croix_Cort	Switzerland	Phase 2	46.889736	6.980627	4852	22	21	1735.49	open air - dry	Cortaillod-K.allg. 4500-3500 BC cal
244	Saint-Aubin/Derrière la Croix_2800-2500	Switzerland	Phase 3	46.889736	6.980627	111	10	2	151.3	open air - dry	Endneolithikum 1 allg. 2800-2500 BC cal
245	Concise- Sous Colachoz_ Cortaillod-Moyen	Switzerland	Phase 3	46.854304	6.719125	141005	134	18	unclear	open air - wet	Cortaillod Tardif;Auvernier corde
246	Zürich - Parkhaus Opera_Horgen	Switzerland	Phase 3	47.365725	8.5461	7681279	174	615	1450.21	open air - wet	Horgen
247	Gachnang, Niederwil	Switzerland	Phase 2	47.3774	8.29526	232293	108	22	unclear	open air - wet	Pfyn
248	Yverdon- Avenue des Sports_Weber	Switzerland	Phase 3	46.781417	6.650345	1432	18	2	unclear	open air - wet	Luscherez recent; Auvernier corde
248	Yverdon- Avenue des Sports_Schilichtherle	Switzerland	Phase 3	46.781417	6.650345	43800	121	42	28.435?	open air - wet	Luscherez recent; Auvernier corde
249	Auvernier	Switzerland	Phase 3	46.979589	6.879015	unknow	24	unknow	unknow	open air - wet	
250	Saint-Blaise/Bains des Dames 4_Horgen	Switzerland	Phase 3	46.988348	6.920576	56	16	1	330	open air - wet	Lüscherz récent & Auvernier Cordé
250	Saint-Blaise/Bains des Dames 4_Auvernier-Cordé	Switzerland	Phase 3	46.988348	6.920576	3723	77	2	1995	open air - wet	Lüscherz récent & Auvernier Cordé
250	Saint-Blaise/Bains des Dames 4_Auvernier-Cordé ancien	Switzerland	Phase 3	46.988348	6.920576	9355	122	19	10275	open air - wet	Lüscherz récent & Auvernier Cordé
250	Saint-Blaise/Bains des Dames 4_Auvernier-Lüscherz	Switzerland	Phase 3	46.988348	6.920576	16482	127	1	16720	open air - wet	Lüscherz récent & Auvernier Cordé
250	Saint-Blaise/Bains des Dames 4_Auvernier-Cordé moyen	Switzerland	Phase 3	46.988348	6.920576	42372	153	33	15165	open air - wet	Lüscherz récent & Auvernier Cordé
251	Twann_Cortaillod	Switzerland	Phase 2	47.122203	7.1712	14530	12	16	unclear	open air - wet	Cortaillod
251	Twann_Middle Horgen	Switzerland	Phase 3	47.122203	7.1712	3128	7	7	unclear	open air - wet	
252	Les Bagnoles_MN2	SE France	Phase 2	43.91419	5.057106	23488	74	26	144.8	open air - dry	

ID	Record name	Country	Phase	Latitude	Longitude	Total of remains	Taxa	Samples	Total vol (L)	Type of site	Culture
252	Les Bagnoles_MN1	SE France	Phase 2	43.91419	5.057106	3659	72	23	213	open air - dry	
253	Trou Arnaud	SE France	Phase 2	44.5708	5.2767	~1000	3	no info	N/A	cave/shelter	Chasséen
254	La Cavalade_LN2	SE France	Phase 3	43.600762	3.912682	109	12	14	unclear	open air - dry	Ferrieres
254	La Cavalade_LN3	SE France	Phase 3	43.600762	3.912682	344	16	7	unclear	open air - dry	type Cavalade
255	Balmes_LN1	SE France	Phase 3	45.25682	6.803092	29088	13	1	520	cave/shelter	
256	Clairvaux VII	SE France	Phase 2	46.567294	5.746356	2234.4 sondage not all	several not counted	6	2.4	open air - wet	Neolitique Moyen Bourguignon
257	Chalain 19	SE France	Phase 3	46.677663	5.781905	29088	69	10	unclear	open air - wet	
258	Clairvaux III	SE France	Phase 3	46.567294	5.746356	18426	102	27	unclear	open air - wet	close relation with western CH
259	Clairvaux II	SE France	Phase 3	46.567294	5.746356	1184	32	3	0.693	open air - wet	
260	L'Héritière Cazan	SE France	Phase 2	43.68583	5.17139	unclear	not possible	not possible	unclear	open air - dry	Chasséen
266	Spilamberto S. Cesario Sito I	Northern Italy	Phase 3	44.532521	11.016477	99	9	3	unclear	open air - dry	Lagozza
266	Spilamberto S. Cesario Sito VIII	Northern Italy	Phase 3	44.532521	11.016477	98	7	10	unclear	open air - dry	VBQ Lagozza
267	ZAC Les Chalus II Lot 1-	SE France	Phase 2	43.959933	5.780712	unk	2	no info	unclear	open air - dry	
268	Route de Canohès Lotissement « Le Petit Prince »	SE France	Phase 2	42.668995	2.84998	60	no info	no info	un	open air - dry	montbolo-chasséen
271	Jonquiere I	SE France	Phase 3	43.550993	5.194541	48	3	3?	unclear	open air - dry	LN
272	L' aéropole Tallard	SE France	Phase 2	44.459642	6.033672	108	14	12	149	open air - dry	Chasséen
273	Cepie_MN	SE France	Phase 2	43.103762	2.245024	17	7	6	unclear	open air - dry	
273	Cepie_LN	SE France	Phase 3	43.103762	2.245024	0	0	1	unclear	open air - dry	
274	509 avenue des Noyers	SE France	Phase 3	43.433797	5.409083	1985	7	1	10	open air - dry	
275	Trets ZAC la Burlière_MN	SE France	Phase 2	43.456872	5.679971	20324	7	4	30	open air - dry	Néolithique moyen type Mourre de la Barque
276	Quincieux Grange Rouge_MN	SE France	Phase 2	45.909629	4.785722	56	7	7	70	open air - dry	
276	Quincieux Grange Rouge_LN	SE France	Phase 3	45.909629	4.785722	2	1	1	10	open air - dry	
277	Lattes Port-Ariane III_MN	SE France	Phase 2	43.574698	3.900977	6	1	3?	50	open air - dry	
277	Lattes Port-Ariane III_LN	SE France	Phase 3	43.574698	3.900977	36	3	1?	355	open air - dry	
278	Chens-sur-Léman Pré dAncy	SE France	Phase 2	46.325449	6.267459	no seeds at all	0	3	27	open air - dry	
279	Clos Roque Route de Barjols MN2	SE France	Phase 2	43.557156	6.00775	110	1	3	50	open air - dry	
279	Clos Roque Route de Barjols LN	SE France	Phase 3	43.557156	6.00775	19	3	6	230	open air - dry	Néolithique final de type Fraischamp
280	Gap Lachaup	SE France	Phase 3	44.597048	5.955001	77	8	11SU	unclear	open air - dry	Chasséen to LN
281	A8 Rousset_Le Plan	SE France	Phase 3	43.478961	5.623891	?1	1	no info	508 (sieved 120)	open air - dry	LN
282	Velaux, La Bastide Neuve III	SE France	Phase 2	43.534226	5.205146	no seeds for MN	0	1	10	open air - dry	
283	Le site néolithique final de Ponteau_PH2	SE France	Phase 3	43.356294	5.027296	718	5	7	123	open air - dry	Néolithique final méridional
283	Le site néolithique final de Ponteau_PH3	SE France	Phase 3	43.356294	5.027296	76932	6	48	642.4	open air - dry	Néolithique final méridional
283	Le site néolithique final de Ponteau_PH4	SE France	Phase 3	43.356294	5.027296	10803	6	6	102	open air - dry	Néolithique final méridional
284	Charavines - Les Baigneurs	SE France	Phase 3	45.422249	5.161388	9836 more	39	no info	unclear	open air - wet	Auvernier Cordé helvétique
285	Brise-Lames	Switzerland	Phase 2	46.977575	6.87692	10808	140	7	4.936	open air - wet	Lüscherz
286	Pfyn-Breitenloo	Switzerland	Phase 2	47.593962	8.956029	253			0.6	open air - wet	Pfyn
287	Clairvaux VIII	SE France	Phase 2	46.567294	5.746356	1018	33	unclear	0.1	open air - wet	Neolitique Moyen Bourguignon recent
288	Cova de la Colomera	NE Iberia	Phase 1	42.153075	0.982073	476	11	3?	unclear	cave/shelter	
289	La serreta_NAE_NACardial	NE Iberia	Phase 1	41.349134	1.709623	4	3	3	70	open air - dry	Neolitic antic evolucionat
289	La serreta_NAE	NE Iberia	Phase 1	41.349134	1.709623	55	3	4?	79	open air - dry	Neolitic antic evolucionat
289	La serreta_MN	NE Iberia	Phase 2	41.349134	1.709623	35	5	unclear	233	open air - dry	
289	La serreta_LN	NE Iberia	Phase 3	41.349134	1.709623	9	4	1	7	open air - dry	
291	Chalain 3 (layer VIII)	SE France	Phase 3	46.677663	5.781905	2031	71	50	unclear	open air - wet	LN and Horgen
293	Alleins Quartier Sainte-Anne	SE France	Phase 3	43.703712	5.161235	65	3	8	unknow vol.	open air - dry	style du Mourre du Tendre
294	20 rue Fodéré, Villa Lympia	SE France	Phase 2	43.707078	7.275895	21	2	13?	10	open air - dry	Chasséen méridional
295	ZAC de la Farigoule	SE France	Phase 3	43.761053	4.312254	339	5	12?	unclear	open air - dry	Néolithique final languedocien
296	Mittelhoetzleinfeld	SE France	Phase 1	47.787784	7.368746	5	2	unclear	23	open air - dry	Hinkelstein ou Grossgartach
297	Florival	SE France	Phase 1	47.897577	7.219694	375.4	10	12?	238	open air - dry	Rubane
301	Bergheim, Haut-Rhin, « Saulager » , zone d'activité du Muehlbach	SE France	Phase 1	48.303183	6.815928	1	1		24	open air - dry	Rubane moyen
303	Burgäschisee Süd	Switzerland	Phase 2	47.166677	7.669071	10529	54	125	unclear	open air - wet	Cortaillod-K.allg. 4500-3500 BC cal
306	Sutz- Rütte V	Switzerland	Phase 2	47.098659	7.216152	89442	72	47	5.45	open air - wet	
307	Biel-Vingelz	Switzerland	Phase 3	47.131495	7.221362	7042	70	5	2.35	open air - wet	
308	Pfäffikon- Burg	Switzerland	Phase 3	47.204628	8.774979	187401	53	3	14.9	open air - wet	Horgen K. allg. 3400-2800 BC cal
309	Auvernier/La Saunerie_Lüschers	Switzerland	Phase 3	46.977577	6.876927	not quantified	72	7	no info	open air - wet	Lüscherz ; Auvernier/Dorde
309	Auvernier/La Saunerie_Auvernier	Switzerland	Phase 3	46.977577	6.876927	not quantified	64	7	no info	open air - wet	Lüscherz ; Auvernier/Dorde
309	Auvernier/La Saunerie	Switzerland	Phase 3	46.977577	6.876927	not quantified	74	3	no info	open air - wet	Lüscherz ; Auvernier/Dorde
311	Burgäschisee Nord	Switzerland	Phase 2	47.172857	7.668663	715	48	4	30500	open air - wet	Cortaillod-K.allg. 4500-3500 BC cal
313	Petit Ruz_MN_Neol2	Switzerland	Phase 2	46.943127	6.846786	44	6	48	548	open air - dry	
313	Petit Ruz_LN_Neol5	Switzerland	Phase 3	46.943127	6.846786	35	5	64	358	open air - dry	
314	Sur les Rochettes Est_Glockenb	Switzerland	Phase 3	46.850711	6.844785	3436	34	75	734	open air - dry	Glockenbecher 2400-2200 BC cal Bell Beaker
315	Les Tilles_MN	Switzerland	Phase 2	46.949096	6.8354	39	9	3	542	open air - dry	
315	Les Tilles_2800-2500	Switzerland	Phase 3	46.949096	6.8354	147	4	unclear	241	open air - dry	
316	Treytel_4340 et 4040	Switzerland	Phase 2	46.917335	6.805569	65	7	unclear	164.7	open air - dry	Néolithique ancien
316	Treytel_MN	Switzerland	Phase 2	46.917335	6.805569	314	15	5	147.8	open air - dry	

ID	Record name	Country	Phase	Latitude	Longitude	Total of remains	Taxa	Samples	Total vol (L)	Type of site	Culture
316	Treytel_Cort_ancien	Switzerland	Phase 2	46.917335	6.805569	586	22	12	664.7	open air - dry	
316	Treytel_Cort_classi	Switzerland	Phase 2	46.917335	6.805569	745	25	7	454.4	open air - dry	
316	Treytel_LN	Switzerland	Phase 3	46.917335	6.805569	3343	32	3	1548.7	open air - dry	
317	Entzheim « Les Terres de la Chapelle » (Bas-Rhin)	SE France	Phase 1	48.539066	7.646036	0	0	N/A	N/A	open air - dry	Rubane ancien
318	Entzheim	SE France	Phase 1	48.539066	7.646036	26				open air - dry	Rubane ancien
319	Grotte Antonnaire	SE France	Phase 3	44.678092	5.362552	no info	no info	no info	no info	cave/shelter	
320	Teuleria dels Àlbers-1	NE Iberia	Phase 3	41.375832	1.722254	23	2	?	18	open air - dry	
322	Zal del Port de Tarragona_MN	NE Iberia	Phase 2	41.105818	1.240599	0	0	1?	15	open air - dry	
323	Cinc Ponts	NE Iberia	Phase 3	41.346126	1.69794	69	6	3?	53	open air - dry	
324	Mas Pujó	NE Iberia	Phase 1	41.325432	1.674578	5	2	4	147	open air - dry	
325	Mas d'en Boixos	NE Iberia	Phase 1	41.364191	1.661479	716	7	8	215	open air - dry	
326	Thayngen Weier_Profile III	Switzerland	Phase 3	47.747376	8.710243	3824	68	9	unclear	open air - wet	Pfyn
326	Thayngen Weier	Switzerland	Phase 3	47.747376	8.710243	2411.9	32	10	0.37	open air - wet	Pfyn
327	Zurich Oberrieden	Switzerland	Phase 3	47.273022	8.578681	total weight of 394 grams, which corresponds to almost 50,000 grains	1	13	N/A	open air - wet	Horgen
328	Zug Vorstadt 26	Switzerland	Phase 3	47.16936	8.514367	1835	12	2?	unclear	open air - wet	Horgen
329	Grand Pré_Neol2	Switzerland	Phase 2	46.936603	6.824008	13	4	1	5	open air - dry	
330	Les Maladières_Cort_ancien	Switzerland	Phase 2	46.926315	6.824251	1861	16	9	225	open air - dry	Cortaillod
330	Les Maladières_Cort_classic	Switzerland	Phase 2	46.926315	6.824251	4970	15	7	166.5	open air - dry	Cortaillod klass;
330	Les Maladières_MN	Switzerland	Phase 2	46.926315	6.824251	23	4	1	13.5	open air - dry	MN
330	Les Maladières_Horgen	Switzerland	Phase 3	46.926315	6.824251	2	2	1	6	open air - dry	Horgen
330	Les Maladières_camp	Switzerland	Phase 3	46.926315	6.824251	114	14	2	14.8	open air - dry	Bell beaker
331	Les Pâquiers_Cortaillod Classique	Switzerland	Phase 2	46.92229	6.812997	4	3	1	109.8	open air - dry	
331	Les Pâquiers_Cortaillod tardif/Port-Conty	Switzerland	Phase 3	46.92229	6.812997	83	12	12	355.9	open air - dry	
333	Champs Devant_MNI	Switzerland	Phase 2	46.934774	7.041298	148	13	2	108.1	open air - dry	
333	Champs Devant_MN2	Switzerland	Phase 2	46.934774	7.041298	884	27	2	124.7	open air - dry	
342	Aux Courbes Rayes	Switzerland	Phase 3	46.944069	6.850464	308	15	20	348	open air - dry	
343	Bataillard	Switzerland	Phase 2	46.930745	6.815189	44	10	9	170	open air - dry	
344	Chézard-Littorail_Cort	Switzerland	Phase 2	46.959695	6.869639	0	0	1	6.2	open air - dry	Cortaillod-K.allg. 4500-3500 BC cal
344	Chézard-Littorail_Lüs	Switzerland	Phase 3	46.959695	6.869639	91	11	1	135.1	open air - dry	Lüscherz
344	Chézard-Littorail_auver	Switzerland	Phase 3	46.959695	6.869639	1	1	1	13	open air - dry	Auvernier-Cordé
345	Les Buchilles	Switzerland	Phase 2	46.946361	6.82926	12	4	3	78	open air - dry	
346	Aux Buchilles	Switzerland	Phase 2	46.944832	6.823584	34	7	1	628.9	open air - dry	
348	Baar Früebergstrasse	Switzerland	Phase 3	47.204902	8.52467	679	17	3?	unclear	open air - dry	Schnurkeramik
349	Zug Vorstadt	Switzerland	Phase 3	47.16936	8.514367	2471	55	unclear	2.99	open air - wet	Pfyn
353	Clos de Roque - Chemin de Barjols_MN	SE France	Phase 2	43.452497	5.864004	1	1	1	50	open air - dry	
353	Clos de Roque - Chemin de Barjols_LN	SE France	Phase 3	43.452497	5.864004	33	9	11	390	open air - dry	
354	La Vella III	Northern Italy	Phase 2	46.082986	11.100794	181	14	no info	no info	open air - dry	

Appendix B Table 2 Archaeobotanical dataset, presence/absence data

ID	Site	Phase	*Hordeum vulgare*	*Triticum monococcum*	*T. dicoccum*	*T. aes/dur/turg*	*T. timopheevii*	*T. spelta*	*Secale cereale*	*Panicum miliaceum*	*Setaria italica*	*Triticum* sp.	Cerealia	*Cicer arietinum*	*Lathyrus cicera/sativus*	*Lens culinaris*	*Pisum sativum*	*Vicia ervilia*	*Vicia faba*	*Vicia sativa*	*Linum usitatissimum*	*Papaver setigerum/somniferum*	*Arbutus unedo*	*Cornus mas*	*Cornus sanguinea*	*Corylus avellana*	*Fagus sylvatica*	*Ficus carica*	*Fragaria vesca*	*Juglas regia*	*Juniperus communis/oxycedrus*	*Malus/Pyrus*	*Olea europaea oleaster*	*Physalis alkekengi*	*Pistacia lentiscus*	*Pistacia terebinthus*	*Prunus avium*	*Prunus mahaleb*	*Prunus spinosa*	*Quercus*	*Rosa*	*Rubus*	*Sambucus*	*Solanum nigrum*	*Sorbus domestica*	*Trapa natans*	*Vitis*	Amorphous matter
1	Rocca di rivoli	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Este	Phase 3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Monselice	Phase 2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0
4	Masera	Phase 2	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
5	Lugo di Grezzana	Phase 1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
6	Fimon-Molino Casarotto	Phase 2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0
7	Fimon Le Fratte	Phase 3	1	0	1	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
8	Saint Martin de Corléans	Phase 2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
9	Bannia	Phase 2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Arquata Scrivia	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
11	Fagnigola	Phase 1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Canedole di Roverbella	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0
13	Sammardenchia	Phase 1	1	1	1	1	0	1	0	0	0	1	1	0	1	1	1	1	1	0	1	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	1
14	Palù di Livenza	Phase 2	0	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	0	1	1	0	0	1	0	1	0	0	1	0	0	1	0	1	0	0	0	0	1	0
15	Pavia de Udine	Phase 1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
16	Valler	Phase 1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Meduno	Phase 3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
20	Piancada	Phase 1	1	1	1	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0
21	Latsch_1	Phase 2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Latsch_2	Phase 3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
22	Villandro_1	Phase 1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
22	Villandro_2	Phase 2	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
23	Riva del Garda	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	0
24	Isera peat bog	Phase 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	La Vella II	Phase 1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
26	La Vela di Trento vIII_1	Phase 2	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
26	La Vela di Trento vIII_2	Phase 2	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1
27	Otzi	Phase 3	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
28	Bressanone- Millan	Phase 3	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
29	Velturno-Tanzgasse	Phase 3	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Balm Chanto	Phase 3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Casalnoceto	Phase 3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
32	Alba Corso Laghe 43	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
33	Alba- Corso Europa	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
34	Castello d ' Annone	Phase 2	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
35	Valgrana -Tetto Chiappello	Phase 2	1	1	1	1	0	1	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
37	Arene Candide_3	Phase 1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
37	Arene Candide_1	Phase 1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
37	Arene Candide_2	Phase 1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
37	Arene Candide_4	Phase 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
38	San Sebastiano di Perti	Phase 1	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0
39	Arma dell ' Aquila	Phase 2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	Pian del Ciliegio_1	Phase 2	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0
40	Pian del Ciliegio_2	Phase 2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
40	Pian del Ciliegio_3	Phase 2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0
41	Grotta del Sanguineto o della Matta	Phase 2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	Grotta marina di Bergeggi	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
43	Due Teste all'Alpicella_1	Phase 2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
43	Due Teste all'Alpicella_2	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
43	Due Teste all'Alpicella_3	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
44	Core BH1, Piazza della Vittoria	Phase 1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0
45	Piazza Brignole - Foce del Torrente Bisagno	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

ID	Site	Phase	*Hordeum vulgare*	*Triticum monococcum*	*T. dicoccum*	*T. aes/dur/turg*	*T. timopheevii*	*T. spelta*	*Secale cereale*	*Panicum miliaceum*	*Setaria italica*	*Triticum* sp.	*Cerealia*	*Cicer arietinum*	*Lathyrus cicera/sativus*	*Lens culinaris*	*Pisum sativum*	*Vicia ervilia*	*Vicia faba*	*Vicia sativa*	*Linum usitatissimum*	*Papaver setigerum/somniferum*	*Arbutus unedo*	*Cornus mas*	*Cornus sanguinea*	*Corylus avellana*	*Fagus sylvatica*	*Ficus carica*	*Fragaria vesca*	*Juglas regia*	*Juniperus communis/oxycedrus*	*Malus/Pyrus*	*Olea europaea oleaster*	*Physalis alkekengi*	*Pistacia lentiscus*	*Pistacia terebinthus*	*Prunus avium*	*Prunus mahaleb*	*Prunus spinosa*	*Quercus*	*Rosa*	*Rubus*	*Sambucus*	*Solanum nigrum*	*Sorbus domestica*	*Trapa natans*	*Vitis*	Amorphous matter
46	Novi Ligure	Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
48	Castellare di Uscio	Phase 3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
49	Albinea	Phase 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	Fiorano	Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	Lugo di Romagna	Phase 1	1	1	1	1	0	1	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	1	1	0	1	1	0
52	Ponte Ghiara	Phase 1	1	0	1	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	1	0	0	0	1	0
53	Ponte Molino	Phase 2	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0
54	Rivaltella- Ca Romensini	Phase 2	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0
55	Savignano	Phase 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	Forlì via Navicella	Phase 1	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
56	Forlì via Navicella_2	Phase 2	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
56	Forlì via Navicella_3	Phase 2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	Bazzarola_2	Phase 1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0
57	Bazzarola_1	Phase 1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
57	Bazzarola_3	Phase 2	1	1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
58	Chiozza di Scandiano	Phase 2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	Levata di Curtatone	Phase 2	1	1	1	1	0	1	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	1	0	0	0	0	0	1	0	1	1	1	0	0	1	0
60	Parma via Guidorossi	Phase 2	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0
61	Spilamberto - Cava via Macchioni	Phase 1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
62	Provezza_3	Phase 3	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	Provezza_1	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	Provezza_2	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	Forlimpopoli - via Canalazzo	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	S. Andrea de Travo	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
65	Cecima	Phase 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	Isorella	Phase 1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	Dugali Alti	Phase 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	Pizzo di Bodio_1	Phase 2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	Pizzo di Bodio_2	Phase 2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
69	Vho di Piadena	Phase 1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	Acquanegra sul Mosio	Phase 2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	Casatico di Marcaria	Phase 2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	Isolino di Varese	Phase 2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	1	0	1	0	0	0	0	0	1	0	1	1	0	0	0	1	0
73	Rivarolo Mantovano	Phase 2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
74	Lovere-Via Deccio Celeri	Phase 3	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	Monte Covolo_3	Phase 3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	0	0	0	1	0
75	Monte Covolo_2	Phase 3	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0
76	Lagozza di Besnate	Phase 2	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	1	0	1	0	0	0	0	1	1	0	1	0	0	0	0	1	0
79	Can Sadurní_layer18	Phase 1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0
79	Can Sadurní_Layer11	Phase 2	1	1	1	1	1	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0
79	Can Sadurní_Layer10	Phase 2	1	1	1	1	1	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0
80	La Draga_SA	Phase 1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	La Draga_SB_SD	Phase 1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	1	1	0	0	0	1	0
81	Caserna de Sant Pau_Cardial_	Phase 1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81	Caserna de Sant Pau_Cardial_epicardial/postcardial	Phase 1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	Font del Ros	Phase 1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	Cova de Sant Llorenç_EN	Phase 1	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0
83	Cova de Sant Llorenç_LEN	Phase 1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	Cova de Sant Llorenç_MN	Phase 2	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
83	Cova de Sant Llorenç_LN	Phase 3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
85	Carrer Reina Amàlia, 31-33_ EN	Phase 1	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
85	Carrer Reina Amàlia, 31-33,MN	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
86	Plansallosa	Phase 1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
87	Cova del Sardo_LEN	Phase 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
87	Cova del Sardo_MN	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
87	Cova del Sardo_LMN	Phase 2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0

ID	Site	Phase	*Hordeum vulgare*	*Triticum monococcum*	*T. dicoccum*	*T. aes/dur/turg*	*T. timopheevii*	*T. spelta*	*Secale cereale*	*Panicum miliaceum*	*Setaria italica*	*Triticum* sp.	Cerealia	*Cicer arietinum*	*Lathyrus cicera/sativus*	*Lens culinaris*	*Pisum sativum*	*Vicia ervilia*	*Vicia faba*	*Vicia sativa*	*Linum usitatissimum*	*Papaver setigerum/somniferum*	*Arbutus unedo*	*Cornus mas*	*Cornus sanguinea*	*Corylus avellana*	*Fagus sylvatica*	*Ficus carica*	*Fragaria vesca*	*Juglas regia*	*Juniperus communis/oxycedrus*	*Malus/Pyrus*	*Olea europaea oleaster*	*Physalis alkekengi*	*Pistacia lentiscus*	*Pistacia terebinthus*	*Prunus avium*	*Prunus mahaleb*	*Prunus spinosa*	*Quercus*	*Rosa*	*Rubus*	*Sambucus*	*Solanum nigrum*	*Sorbus domestica*	*Trapa natans*	*Vitis*	Amorphous matter
87	Cova del Sardo_LN	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
88	La Dou_LEN	Phase 1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0
88	La Dou_EMN	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
89	Codella	Phase 1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
90	Camp del Colomer	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	1	1	1	0	0	0	0
91	Serra del Mas Bonet_LEN	Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91	Serra del Mas Bonet_MN	Phase 2	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
91	Serra del Mas Bonet_LN	Phase 3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
92	120 Cave_Neol2	Phase 1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
92	120 Cave_Neol3	Phase 2	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0
93	Bòbila Madurell_MN	Phase 2	1	1	1	1	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
93	Bòbila Madurell_LN	Phase 3	1	1	0	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94	Mines of Gavà_4200-3800 BC	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
94	Mines of Gavà_3200-2800 BC	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
95	Espina C	Phase 3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
96	Pla del Gardelo	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
97	Puig del Collet / El Collet/Collet Puiggròs	Phase 2	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
98	CIM "El Camp"_LEN	Phase 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	CIM "El Camp"_EMN	Phase 2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	Pesseta Cave	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	Camí dels Banys de la Mercè	Phase 1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0
102	Can Revella (Can Roqueta)	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103	Castelnuovo di Teolo	Phase 2	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
104	Auvelles_neo2	Phase 2	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
104	Auvelles_Postcardial	Phase 1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105	Cova del Toll_MN	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105	Cova del Toll_LN	Phase 3	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
110	Pou Nou 2	Phase 2	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
112	L' escola Especial Meritxell	Phase 2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
113	Rivoli Veronese	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
114	Barbiano	Phase 2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115	Aica di Fiè / Völs am Schlern/Volseraicha	Phase 3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
116	Brescia S. Polo	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
117	Tolerait	Phase 3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
122	Aspre del Paradís_EN	Phase 1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
122	Aspre del Paradís_LN	Phase 3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
123	Aulp du Seuil	Phase 2	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
124	Auriac	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125	Auriac-Golf	Phase 2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126	Balma de l'Abeurador_epicardial	Phase 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
126	Balma de l'Abeurador_Chassenclassic	Phase 2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
126	Balma de l'Abeurador_Chassenancien	Phase 2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
127	Balma Margineda_5472-4849	Phase 1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0
127	Balma Margineda_4793-4612	Phase 1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
128	Barreau de la Devèze Sud_MN1	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
128	Barreau de la Devèze Sud_MN2	Phase 2	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
128	Barreau de la Devèze Sud_MN	Phase 2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
129	Baume Bourbon	Phase 1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130	Baume d'Oullins	Phase 1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
131	Baume Fontbrégoua_Cardialancien	Phase 1	1	1	1	1	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
131	Baume Fontbrégoua_Cardial final	Phase 1	1	1	1	1	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
131	Baume Fontbrégoua_Pre_Chassen	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
131	Baume Fontbrégoua_Chassen ancien	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
131	Baume Fontbrégoua_Chassee recent	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
132	Boulevard périphéerique Nord de Lyon_EN	Phase 1	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
132	Boulevard périphérique Nord de Lyon_MN	Phase 2	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0

ID	Site	Phase	*Hordeum vulgare*	*Triticum monococcum*	*T. dicoccum*	*T. aes/dur/turg*	*T. timopheevii*	*T. spelta*	*Secale cereale*	*Panicum miliaceum*	*Setaria italica*	*Triticum* sp.	Cerealia	*Cicer arietinum*	*Lathyrus cicera/sativus*	*Lens culinaris*	*Pisum sativum*	*Vicia ervilia*	*Vicia faba*	*Vicia sativa*	*Linum usitatissimum*	*Papaver setigerum/somniferum*	*Arbutus unedo*	*Cornus mas*	*Cornus sanguinea*	*Corylus avellana*	*Fagus sylvatica*	*Ficus carica*	*Fragaria vesca*	*Juglas regia*	*Juniperus communis/oxycedrus*	*Malus/Pyrus*	*Olea europaea oleaster*	*Physalis alkekengi*	*Pistacia lentiscus*	*Pistacia terebinthus*	*Prunus avium*	*Prunus mahaleb*	*Prunus spinosa*	*Quercus*	*Rosa*	*Rubus*	*Sambucus*	*Solanum nigrum*	*Sorbus domestica*	*Trapa natans*	*Vitis*	Amorphous matter
132	Boulevard périphérique Nord de Lyon_campaniforme	Phase 3	1	0	1	0	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
134	Caucade	Phase 2	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
136	Claparouse	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137	Clos de Roque	Phase 2	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	1	1	0	0	0	1	0
139	Cova de l'Esperit	Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0
140	Encombres	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
141	Font Juvénal_EN	Phase 1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
141	Font Juvénal_MN1	Phase 2	1	0	1	1	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0
141	Font Juvénal_MN2	Phase 2	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
141	Font Juvénal_LN	Phase 3	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
142	Gardon_ENRhodanie	Phase 1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
142	Gardon_MNSain-UZE	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
143	Grotte de l' Aigle	Phase 1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
144	Grotte de Montou Montbolo_MN	Phase 2	1	0	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0
144	Grotte de Montou Montbolo_LN	Phase 3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
145	Grotte du Taï_Early Neo 2	Phase 1	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	0
145	Grotte du Taï_Middle Neolithic	Phase 2	1	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
145	Grotte du Taï_Ferriéres	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	1
145	Grotte du Taï_Fontbouisse	Phase 3	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
145	Grotte du Taï_Early Neo 1	Phase 1	1	1	1	1	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0	1	1	0	0	0	0	1	1	0	0	0	1	0	0	1	1	0	1	1	1	0	0	1	0
147	Grotte G	Phase 2	1	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
148	Grotte Gazel_5000	Phase 1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
148	Grotte Gazel_after5000	Phase 1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
149	Grotte Murée	Phase 2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	Grotte St Marcel_EN	Phase 1	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	Grotte St Marcel_MN	Phase 2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
150	Grotte St Marcel_LN	Phase 3	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
151	Jardins de Vert Parc_chass	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
152	La Grande Rivoire_EN	Phase 1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
152	La Grande Rivoire_MN1	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	0
152	La Grande Rivoire_MN2	Phase 2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	0
152	La Grande Rivoire_LN	Phase 3	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0
153	Clairvaux - La Motte aux Magnins V	Phase 2	1	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
156	La Resclauze	Phase 1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
157	La Roberte	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
158	La Salle	Phase 2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
159	Le Bousquetas	Phase 3	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160	Le Champ du Poste_Chassen ancien	Phase 2	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
160	Le Champ du Poste_Verazien	Phase 3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
161	Le Chenet des Pierres_MN2	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0
161	Le Chenet des Pierres_MN1	Phase 2	1	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0
162	Le Crès	Phase 2	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
163	Le Font aux Pigeons	Phase 1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
164	Le Lagarel	Phase 3	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165	Le Logis de Berre	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
166	Le Moulin	Phase 2	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
167	Le Pirou	Phase 2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
168	Le Puech Haut_LN1	Phase 3	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
168	Le Puech Haut_LN2	Phase 3	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
168	Le Puech Haut_LN3	Phase 3	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
169	Le Rochas	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
170	Le Serre de Boidon	Phase 3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
171	Le Valladas	Phase 1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
174	Les Lauzières	Phase 3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
175	Les Moulins	Phase 2	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
176	Les Plots	Phase 2	1	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ID	Site	Phase	*Hordeum vulgare*	*Triticum monococcum*	*T. dicoccum*	*T. aes/dur/turg*	*T. timopheevii*	*T. spelta*	*Secale cereale*	*Panicum miliaceum*	*Setaria italica*	*Triticum* sp.	Cerealia	*Cicer arietinum*	*Lathyrus cicera/sativus*	*Lens culinaris*	*Pisum sativum*	*Vicia ervilia*	*Vicia faba*	*Vicia sativa*	*Linum usitatissimum*	*Papaver setigerum/somniferum*	*Arbutus unedo*	*Cornus mas*	*Cornus sanguinea*	*Corylus avellana*	*Fagus sylvatica*	*Ficus carica*	*Fragaria vesca*	*Juglas regia*	*Juniperus communis/oxycedrus*	*Malus/Pyrus*	*Olea europaea oleaster*	*Physalis alkekengi*	*Pistacia lentiscus*	*Pistacia terebinthus*	*Prunus avium*	*Prunus mahaleb*	*Prunus spinosa*	*Quercus*	*Rosa*	*Rubus*	*Sambucus*	*Solanum nigrum*	*Sorbus domestica*	*Trapa natans*	*Vitis*	Amorphous matter
177	Mas de Vignoles IX	Phase 2	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
178	Mas de Vignoles X	Phase 1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
179	Mas Neuf	Phase 1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	Montbeyre-La Cadoule	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
181	Moulin de la Garonne	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
182	Mourre de la Barque_Neo2	Phase 2	1	0	1	1	0	0	0	0	0	1	1	0	1	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0
182	Mourre de la Barque_Neo3	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
183	Peiro Signado	Phase 1	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
184	Pendimoun_Impressa	Phase 1	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
184	Pendimoun_cardial	Phase 1	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
184	Pendimoun_SMP	Phase 2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
185	Plateau Raverre	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
186	Pont de Roque Haute	Phase 1	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
187	Roc de Dourgne	Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
188	Roquemaure	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
191	St. Martin d'Azirou	Phase 3	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
192	Clairvaux XIV	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
193	Toronde	Phase 2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
195	Vieux-Mounoï	Phase 2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
196	Villa Giribaldi	Phase 2	1	1	1	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	1	0
197	ZAC Feuilly_ Cardial	Phase 1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
197	ZAC Feuilly_MNB	Phase 2	1	1	1	1	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
198	ZAC Saint-Antoine II_preCha4300	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
198	ZAC Saint-Antoine II_chassen recent	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
198	ZAC Saint-Antoine II_MN	Phase 2	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
198	ZAC Saint-Antoine II_chansancien	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
199	Zürich - AKAD-Seehofstrasse	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	0	1	1	1	0	0	0	0
200	Zürich - Pressehaus_1_Horgen	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0
200	Zürich - Pressehaus_2_Schnur	Phase 3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0
201	Arbon - Bleiche 3	Phase 3	1	0	1	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	0	0	1	0	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0
202	Binningen-Friedhofstrasse	Phase 3	0	1	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
203	Seeberg - Burgäschisee SW	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0
204	Cham -St. Andreas	Phase 2	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
205	Egolzwil 3	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0
206	Frasses - Praz au Doux	Phase 3	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0
208	Horgen-Scheller_Schnur	Phase 3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0
208	Horgen-Scheller_ Horgen	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
209	Kleiner Hafner_Ego	Phase 2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0
209	Kleiner Hafner_Cort	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
210	Lattringen - Haupstation (site VII)_Cord	Phase 3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
210	Lattringen - Haupstation (site VII)_Horg	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
211	Lüscherz - Klein Station, inerdorf_2	Phase 3	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
211	Lüscherz - Klein Station, inerdorf_1	Phase 2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0
212	Lattringen -Riedstation (site VI)	Phase 2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
213	Zürich - Mozartstrasse_Pyy2	Phase 2	1	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
213	Zürich - Mozartstrasse_Cort	Phase 2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0
213	Zürich - Mozartstrasse_FruheszentralCortaill	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	1	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	1	1	1	0	0	0	0
213	Zürich - Mozartstrasse_Pyy1	Phase 2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0
213	Zürich - Mozartstrasse_Horgen	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
214	Mythenschloss_Schnur1	Phase 3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
214	Mythenschloss_Horgen	Phase 3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	0	1	0	0	0	0
215	Neftenbach_Aspach	Phase 3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
216	Nidau BKW1 or Nidau Schlossmatte/ BKW	Phase 2	1	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
219	Seedorf - Lobsigesee	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
220	Zürich, Seefeld KanSan_Pfy	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
220	Zürich, Seefeld KanSan_Schnur	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0

ID	Site	Phase	*Hordeum vulgare*	*Triticum monococcum*	*T. dicoccum*	*T. aes/dur/turg*	*T. timopheevii*	*T. spelta*	*Secale cereale*	*Panicum miliaceum*	*Setaria italica*	*Triticum* sp.	Cerealia	*Cicer arietinum*	*Lathyrus cicera/sativus*	*Lens culinaris*	*Pisum sativum*	*Vicia ervilia*	*Vicia faba*	*Vicia sativa*	*Linum usitatissimum*	*Papaver setigerum/somniferum*	*Arbutus unedo*	*Cornus mas*	*Cornus sanguinea*	*Corylus avellana*	*Fagus sylvatica*	*Ficus carica*	*Fragaria vesca*	*Juglas regia*	*Juniperus communis/oxycedrus*	*Malus/Pyrus*	*Olea europaea oleaster*	*Physalis alkekengi*	*Pistacia lentiscus*	*Pistacia terebinthus*	*Prunus avium*	*Prunus mahaleb*	*Prunus spinosa*	*Quercus*	*Rosa*	*Rubus*	*Sambucus*	*Solanum nigrum*	*Sorbus domestica*	*Trapa natans*	*Vitis*	Amorphous matter
220	Zürich, Seefeld KanSan_Horg	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
221	Sevelen - Pfäfersbüel	Phase 1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
222	Stansstad-Kehrsiten_ 3750-3500_Pfyn	Phase 2	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
222	Stansstad-Kehrsiten_ 4250-3750_Corta	Phase 2	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
223	Port - Stüdeli_US_41	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0
224	Villeneuve-La Baume Abri 1	Phase 3	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
225	Wetzikon, Kempten Tösstalerstr	Phase 3	1	1	1	1	0	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
226	Zizers- Friedau	Phase 1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
227	Zug-Riedmatt	Phase 3	1	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	1	0	0
228	Delémont - En la Pran	Phase 3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
230	Bauma del Serrat del Pont_EN	Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
230	Bauma del Serrat del Pont_LN	Phase 3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
231	Cova de les Portes	Phase 3	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
232	El Cavet	Phase 1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
233	Les Vautes	Phase 3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
234	Grotte d' engorner	Phase 3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
235	Boussargues	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1
236	Roquessols	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
237	Sion - La Planta	Phase 1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
238	Sion - Tourbillon_1	Phase 1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
238	Sion - Tourbillon_EN/MN	Phase 2	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
239	Sion- La Gillière 2	Phase 1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
240	Sion - Ritz 33	Phase 2	1	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
241	Savièse - La Soie	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
242	Petit-Chasseur IV_MNI 4500	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
242	Petit-Chasseur IV_'Cortaillod type Petit-Chasseur (4000-3800)	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0
244	Saint-Aubin/Derrière la Croix_Cort	Phase 2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0
244	Saint-Aubin/Derrière la Croix_2800-2500	Phase 3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
245	Concise- Sous Colachoz_ Cortaillod-Moyen	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
246	Zürich - Parkhaus Opera_Horgen	Phase 3	1	1	1	1	0	1	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	0	1	1	0	1	0	0	1	0	1	0	0	1	0	1	1	1	1	1	1	0	1	0	0
247	Gachnang, Niederwil	Phase 2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0
248	Yverdon- Avenue des Sports_Weber	Phase 3	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0
248	Yverdon- Avenue des Sports_Schilichtherle	Phase 3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	1	0
249	Auvernier	Phase 3	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0
250	Saint-Blaise/Bains des Dames 4_Horgen	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
250	Saint-Blaise/Bains des Dames 4_Auvernier-Cordé	Phase 3	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
250	Saint-Blaise/Bains des Dames 4_Auvernier-Cordé ancien	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
250	Saint-Blaise/Bains des Dames 4_Auvernier-Lüscherz	Phase 3	1	0	1	1	0	1	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	1	0
250	Saint-Blaise/Bains des Dames 4_Auvernier-Cordé moyen	Phase 3	1	1	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
251	Twann_Cortaillod	Phase 2	1	1	1	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
251	Twann_Middle Horgen	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
252	Les Bagnoles_MN2	Phase 2	1	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	1	1	0	1	1	1	0	0	1	0
252	Les Bagnoles_MN1	Phase 2	1	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	1	1	0	0	0	1	0
253	Trou Arnaud	Phase 2	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
254	La Cavalade_LN2	Phase 3	1	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
254	La Cavalade_LN3	Phase 3	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1
255	Balmes_LN1	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
256	Clairvaux VII	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	1	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0
257	Chalain 19	Phase 3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	0	1	1	1	0	0	0	0	0
258	Clairvaux III	Phase 3	1	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
259	Clairvaux II	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0
260	L'Héritière Cazan	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
266	Spilamberto S. Cesario Sito I	Phase 3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
266	Spilamberto S. Cesario Sito VIII	Phase 3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
267	ZAC Les Chalus II Lot 1-	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
268	Route de Canohès Lotissement « Le Petit Prince »	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ID	Site	Phase	*Hordeum vulgare*	*Triticum monococcum*	*T. dicoccum*	*T. aes/dur/turg*	*T. timopheevii*	*T. spelta*	*Secale cereale*	*Panicum miliaceum*	*Setaria italica*	*Triticum* sp.	Cerealia	*Cicer arietinum*	*Lathyrus cicera/sativus*	*Lens culinaris*	*Pisum sativum*	*Vicia ervilia*	*Vicia faba*	*Vicia sativa*	*Linum usitatissimum*	*Papaver setigerum/somniferum*	*Arbutus unedo*	*Cornus mas*	*Cornus sanguinea*	*Corylus avellana*	*Fagus sylvatica*	*Ficus carica*	*Fragaria vesca*	*Juglas regia*	*Juniperus communis/oxycedrus*	*Malus/Pyrus*	*Olea europaea oleaster*	*Physalis alkekengi*	*Pistacia lentiscus*	*Pistacia terebinthus*	*Prunus avium*	*Prunus mahaleb*	*Prunus spinosa*	*Quercus*	*Rosa*	*Rubus*	*Sambucus*	*Solanum nigrum*	*Sorbus domestica*	*Trapa natans*	*Vitis*	Amorphous matter
271	Jonquiere I	Phase 3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
272	L' aéropole Tallard	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
273	Cepie_MN	Phase 2	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
273	Cepie_LN	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
274	509 avenue des Noyers	Phase 3	1	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
275	Trets ZAC la Burlière_MN	Phase 2	1	1	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
276	Quincieux Grange Rouge_MN	Phase 2	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
276	Quincieux Grange Rouge_LN	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
277	Lattes Port-Ariane III_MN	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
277	Lattes Port-Ariane III_LN	Phase 3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
278	Chens-sur-Léman Pré dAncy	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
279	Clos Roque Route de Barjols MN2	Phase 2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
279	Clos Roque Route de Barjols LN	Phase 3	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
280	Gap Lachaup	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
281	A8 Rousset_Le Plan	Phase 3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
282	Velaux, La Bastide Neuve III	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
283	Le site néolithique final de Ponteau_PH2	Phase 3	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
283	Le site néolithique final de Ponteau_PH3	Phase 3	1	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
283	Le site néolithique final de Ponteau_PH4	Phase 3	1	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
284	Charavines - Les Baigneurs	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0
285	Brise-Lames	Phase 2	1	1	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
286	Pfyn-Breitenloo	Phase 2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
287	Clairvaux VIII	Phase 2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
288	Cova de la Colomera	Phase 1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
289	La serreta_NAE_NACardial	Phase 1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
289	La serreta_NAE	Phase 1	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
289	La serreta_MN	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
289	La serreta_LN	Phase 3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
291	Chalain 3 (layer VIII)	Phase 3	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	0	0	0	0	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0
293	Alleins Quartier Sainte-Anne	Phase 3	1	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
294	20 rue Fodéré, Villa Lympia	Phase 2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
295	ZAC de la Farigoule	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
296	Mittelhoetzleinfeld	Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
297	Florival	Phase 1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
301	Bergheim, Haut-Rhin, « Saulager » , zone d'activité du Muehlbach	Phase 1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
303	Burgäschisee Süd	Phase 2	1	1	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0
306	Sutz- Rütte V	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	1	1	1	1	1	1	1	0	0	0	0
307	Biel-Vingelz	Phase 3	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
308	Pfäffikon- Burg	Phase 3	1	1	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0
309	Auvernier/La Saunerie	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
309	Auvernier/La Saunerie_Lüschers	Phase 3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	0	0
309	Auvernier/La Saunerie_Auvernier	Phase 3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0
311	Burgäschisee Nord	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	1	0	1	1	0	0
313	Petit Ruz_MN_Neol2	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
313	Petit Ruz_LN_Neol5	Phase 3	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
314	Sur les Rochettes Est_Glockenb	Phase 3	1	1	1	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0
315	Les Tilles_MN	Phase 2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0
315	Les Tilles_2800-2500	Phase 3	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
316	Treytel_4340 et 4040	Phase 2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
316	Treytel_MN	Phase 2	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
316	Treytel_Cort_ancien	Phase 2	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
316	Treytel_Cort_classi	Phase 2	1	1	1	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
316	Treytel_LN	Phase 3	1	1	1	1	0	0	0	1	0	1	1	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0
317	Entzheim « Les Terres de la Chapelle » (Bas-Rhin)	Phase 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
318	Entzheim	Phase 1	1	1	1												1																															
319	Grotte Antonnaire	Phase 3	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ID	Site	Phase	*Hordeum vulgare*	*Triticum monococcum*	*T. dicoccum*	*T. aes/dur/turg*	*T. timopheevii*	*T. spelta*	*Secale cereale*	*Panicum miliaceum*	*Setaria italica*	*Triticum* sp.	Cerealia	*Cicer arietinum*	*Lathyrus cicera/sativus*	*Lens culinaris*	*Pisum sativum*	*Vicia ervilia*	*Vicia faba*	*Vicia sativa*	*Linum usitatissimum*
320	Teuleria dels Àlbers-1	Phase 3	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
322	Zal del Port de Tarragona_MN	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
323	Cinc Ponts	Phase 3	1	0	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0
324	Mas Pujó	Phase 1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
325	Mas d'en Boixos	Phase 1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
326	Thayngen Weier_Profile III	Phase 3	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
326	Thayngen Weier	Phase 3	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
327	Zurich Oberrieden	Phase 3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
328	Zug Vorstadt 26	Phase 3	1	1	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
329	Grand Pré_Neol2	Phase 2	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
330	Les Maladières_Cort_ancien	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
330	Les Maladières_Cort_classic	Phase 2	1	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
330	Les Maladières_MN	Phase 2	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
330	Les Maladières_Horgen	Phase 3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
330	Les Maladières_camp	Phase 3	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
331	Les Pâquiers_Cortaillod Classique	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
331	Les Pâquiers_Cortaillod tardif/Port-Conty	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
333	Champs Devant_MNI	Phase 2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
333	Champs Devant_MN2	Phase 2	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
342	Aux Courbes Rayes	Phase 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
343	Bataillard	Phase 2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
344	Chézard-Littorail_Cort	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
344	Chézard-Littorail_Lüs	Phase 3	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
344	Chézard-Littorail_auver	Phase 3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
345	Les Buchilles	Phase 2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
346	Aux Buchilles	Phase 2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
348	Baar Früebergstrasse	Phase 3	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
349	Zug Vorstadt	Phase 3	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
353	Clos de Roque - Chemin de Barjols_MN	Phase 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
353	Clos de Roque - Chemin de Barjols_LN	Phase 3	1	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
354	La Vella III	Phase 2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ID	Site	*Papaver setigerum/somniferum*	*Arbutus unedo*	*Cornus mas*	*Cornus sanguinea*	*Corylus avellana*	*Fagus sylvatica*	*Ficus carica*	*Fragaria vesca*	*Juglas regia*	*Juniperus communis/oxycedrus*	*Malus/Pyrus*	*Olea europaea oleaster*	*Physalis alkekengi*	*Pistacia lentiscus*	*Pistacia terebinthus*	*Prunus avium*	*Prunus mahaleb*	*Prunus spinosa*	*Quercus*	*Rosa*	*Rubus*	*Sambucus*	*Solanum nigrum*	*Sorbus domestica*	*Trapa natans*	*Vitis*	Amorphous matter
320	Teuleria dels Àlbers-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
322	Zal del Port de Tarragona_MN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
323	Cinc Ponts	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
324	Mas Pujó	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
325	Mas d'en Boixos	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
326	Thayngen Weier_Profile III	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0
326	Thayngen Weier	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
327	Zurich Oberrieden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
328	Zug Vorstadt 26	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0
329	Grand Pré_Neol2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
330	Les Maladières_Cort_ancien	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
330	Les Maladières_Cort_classic	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
330	Les Maladières_MN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
330	Les Maladières_Horgen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
330	Les Maladières_camp	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
331	Les Pâquiers_Cortaillod Classique	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
331	Les Pâquiers_Cortaillod tardif/Port-Conty	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
333	Champs Devant_MNI	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
333	Champs Devant_MN2	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0
342	Aux Courbes Rayes	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
343	Bataillard	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
344	Chézard-Littorail_Cort	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
344	Chézard-Littorail_Lüs	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
344	Chézard-Littorail_auver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
345	Les Buchilles	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
346	Aux Buchilles	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
348	Baar Früebergstrasse	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
349	Zug Vorstadt	1	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0
353	Clos de Roque - Chemin de Barjols_MN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
353	Clos de Roque - Chemin de Barjols_LN	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
354	La Vella III	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1

Appendix C: Data quality

This Appendix shows the quality results based on the different parameters such as the date of excavation, recovery method, processing method, mesh size, type of record, type of publication and type of preservation. It is colour coded in agreement with the three types of classification: good, satisfactory and poor.

Appendix C: Table 1 - Data quality, metadata

Site name	ID	Country	Type of site	Phase	Date of excavation	Recovery method	Recovery method	Recovery method	Processing method	Processing method
Rocca di rivoli	1	Italy	open air - dry	Phase 2	1960	n.d.			Unknown	
Este - località Meggiaro	2	Italy	open air - dry	Phase 3	n.d.	systematic ?			Unknown	
Monselice - via Valli	3	Italy	open air - dry	Phase 2	n.d.	systematic ?			Unknown	
Masera	4	Italy	open air - dry	Phase 2	n.d.	systematic ?			Unknown	
Lugo di Grezzana	5	Italy	open air - dry	Phase 1	1990	probabilistic?			wet-sieving	
Fimon-Molino Casarotto	6	Italy	open air - wet	Phase 2	1970	n.d.			Unknown	
Fimon Le Fratte	7	Italy	open air - wet	Phase 3	2010	Judgmental sampling			semi-flotation	
Saint Martin de Corléans	8	Italy	open air - dry	Phase 2	2010	Manual			wet-sieving	
Bannia	9	Italy	open air - dry	Phase 2	1990	Manual			dry-sieving	
Arquata Scrivia, Località Moriassi	10	Italy	open air - dry	Phase 3	2010	Manual ?			flotation	
Fagnigola	11	Italy	open air - dry	Phase 1	1990	n.d.			flotation	
Canedole di Roverbella	12	Italy	open air - dry	Phase 3	2010	systematic?			flotation	
Sammardenchia	13	Italy	open air - dry	Phase 1	2000	systematic			flotation	
Palù di Livenza	14	Italy	open air - wet	Phase 2	1990	Core?			Unknown	
Pavia de Udine	15	Italy	open air - dry	Phase 1	1990	systematic?			unknown	
Valler	16	Italy	open air - dry	Phase 1	1990	n.d.			flotation	
Meduno	17	Italy	open air - dry	Phase 3	2000	systematic-probabilistic?			wet-sieving	
Piancada	20	Italy	open air - dry	Phase 1	2000	systematic?			unknown	
Latsch_2	21	Italy	open air - dry	Phase 2	2000	Judgmental sampling			flotation	
Latsch_1	21	Italy	open air - dry	Phase 3	2000	Judgmental sampling			flotation	
Villandro_3	22	Italy	open air - dry	Neo	2000	n.d.			flotation	
Villandro_2	22	Italy	open air - dry	Phase 2	2000	n.d.			flotation	
Villandro_1	22	Italy	open air - dry	Phase 1	2000	n.d.			flotation	
Riva del Garda	23	Italy	open air - dry	Phase 2	n.d.	n.d.			Unknown	
Isera peat bog	24	Italy	undefined	Phase 1	2000	pollen core			unknown	
La Vella II	25	Italy	open air - dry	Phase 1	1970	Judgmental sampling ?			wet-sieving	
La Vela di Trento vIII_1	26	Italy	open air - dry	Phase 2	2000	n.d.			Unknown	
La Vela di Trento vIII_2	26	Italy	open air - dry	Phase 2	2000	n.d.			Unknown	
Otzi	27	Italy	undefined	Phase 3	1990		hand picked		flotation	wet-sieving
Bressanone- Millan	28	Italy	open air - dry	Phase 3	2000	n.d.			Unknown	
Velturno-Tanzgasse	29	Italy	open air - dry	Phase 3	1980	n.d.			wet-sieving	
Balm Chanto	30	Italy	cave/shelter	Phase 3	1980	n.d.			Unknown	
Casalnoceto	31	Italy	open air - dry	Phase 3	1990	n.d.			Unknown	
Alba Corso Laghe 43	32	Italy	open air - dry	Phase 2	1980	n.d.			Unknown	
Alba- Corso Europa	33	Italy	open air - dry	Phase 2	1990	n.d.			Unknown	
Castello d ' Annone	34	Italy	open air - dry	Phase 2	1990	systematic?			Unknown	
Valgrana -Tetto Chiappello	35	Italy	open air - dry	Phase 2	1990	n.d.			Unknown	
Caverna delle Arene Candide_3	37	Italy	cave/shelter	Phase 1	2010	systematic?			flotation	
Caverna delle Arene Candide_1	37	Italy	cave/shelter	Phase 1	2010	systematic?			flotation	
Caverna delle Arene Candide_2	37	Italy	cave/shelter	Phase 1	2010	systematic?			flotation	
Caverna delle Arene Candide_4	37	Italy	cave/shelter	Phase 1	2010	systematic?			flotation	
San Sebastiano di Perti	38	Italy	open air - dry	Phase 1	1980	n.d.			flotation?	
Arma dell ' Aquila	39	Italy	cave/shelter	Phase 2	1940	Manual?			Unknown	
Riparo sotto Roccia di Pian del Ciliegio_1	40	Italy	cave/shelter	Phase 2	1990	probabilistic?			flotation	
Riparo sotto Roccia di Pian del Ciliegio_2	40	Italy	cave/shelter	Phase 2	1990	probabilistic?			flotation	
Riparo sotto Roccia di Pian del Ciliegio_3	40	Italy	cave/shelter	Phase 2	1990	probabilistic?			flotation	
Grotta del Sanguineto o della Matta	41	Italy	cave/shelter	Phase 2	1980	n.d.			Unknown	
Grotta marina di Bergeggi	42	Italy	cave/shelter	Phase 2	1970	n.d.			Unknown	
Riparo di Rocca Due Teste all'Alpicella_1	43	Italy	cave/shelter	Phase 2	1980	Manual some samples			flotation	
Riparo di Rocca Due Teste all'Alpicella_2	43	Italy	cave/shelter	Phase 2	1980	Manual some samples			flotation	
Riparo di Rocca Due Teste all'Alpicella_3	43	Italy	cave/shelter	Phase 3	1980	Manual some samples			flotation	
Core BH1, Piazza della Vittoria	44	Italy	undefined	Phase 1	2000	Core			unclear	
Piazza Brignole - Foce del Torrente Bisagno	45	Italy	undefined	Phase 2	2000	n.d.			wet-sieving	
Novi Ligure, località Pieve	46	Italy	open air - dry	Phase 1	2010	n.d.			flotation	
Castellare di Uscio	48	Italy	open air - dry	Phase 3	1980	n.d.			unknown	
Albinea	49	Italy	open air - dry	Phase 1	1870	n.d.			unknown	
Fiorano	50	Italy	open air - dry	Phase 1	1940	n.d.			unknown	
Lugo di Romagna	51	Italy	open air - dry	Phase 1	1990	some contexts	Grab sampling		flotation	
Ponte Ghiara	52	Italy	open air - dry	Phase 1	1990	17str			flotation	

Site name	ID	Country	Type of site	Phase	Date of excavation	Recovery method	Recovery method	Recovery method	Processing method	Processing method
Ponte Molino	53	Italy	open air - dry	Phase 2	2000	well			flotation	
Rivaltella- Ca Romensini	54	Italy	open air - dry	Phase 2	1980	n.d.			unclear	
Savignano	55	Italy	open air - dry	Phase 1	1980	n.d.			unknown	
Forlì via Navicella_2	56	Italy	open air - dry	Phase 2	2000	particulary cases(structures) 5 litres of all SU?			flotation	
Forlì via Navicella_3	56	Italy	open air - dry	Phase 2	2000	particulary cases(structures) 5 litres of all SU?			flotation	
Forlì via Navicella_1	56	Italy	open air - dry	Phase 1	2000	particulary cases(structures) 5 litres of all SU?			flotation	
Bazzarola_3	57	Italy	open air - dry	Phase 2	2000	mix stratigraohic method and structure wise			dry-sieving	flotation
Bazzarola_2	57	Italy	open air - dry	Phase 1	2000	mix stratigraohic method and structure wise			dry-sieving	flotation
Bazzarola_1	57	Italy	open air - dry	Phase 1	2000	mix stratigraohic method and structure wise			dry-sieving	flotation
Chiozza di Scandiano	58	Italy	undefined	Phase 2	1940	n.d.			Unknown	
Levata di Curtatone	59	Italy	open air - dry	Phase 2	2000	n.d.			unclear	
Parma via Guidorossi	60	Italy	open air - dry	Phase 2	2000	n.d.			Unknown	
Spilamberto - Cava via Macchioni	61	Italy	open air - dry	Phase 1	2000	5 litres of all SU?			flotation	wet-sieving
Provezza_1	62	Italy	open air - dry	Phase 3	2000	5 litres of all SU?			flotation	wet-sieving
Provezza_2	62	Italy	open air - dry	Phase 3	2000	5 litres of all SU?			flotation	wet-sieving
Provezza_3	62	Italy	open air - dry	Phase 3	2000	5 litres of all SU?			flotation	wet-sieving
Forlimpopoli - via Canalazzo	63	Italy	open air - dry	Phase 3	2000	5 litres of all SU?			flotation	wet-sieving
S. Andrea de Travo	64	Italy	open air - dry	Phase 3	1980	5 litres of all SU?			flotation	wet-sieving
Cecima	65	Italy	open air - dry	Phase 1	1980	n.d.			unknown	
Isorella	66	Italy	open air - dry	Phase 1	1970	all sediment of a pit			wet-sieving	
Dugali Alti	67	Italy	open air - dry	Phase 1	1980	sediment to charcoal			flotation	
Pizzo di Bodio_1	68	Italy	open air - wet	Phase 2	1980	n.d.			unknown	
Pizzo di Bodio_2	68	Italy	open air - wet	Phase 2	1980	n.d.			unknown	
Vho di Piadena	69	Italy	open air - dry	Phase 1	1970	n.d.			unknown	
Acquanegra sul Mosio	70	Italy	open air - dry	Phase 2	1980	n.d.			Unknown	
Casatico di Marcaria	71	Italy	open air - dry	Phase 2	1980	n.d.			Unknown	
Isolino di Varese_MN	72	Italy	open air - wet	Phase 2	2010	n.d.			Unknown	
Rivarolo Mantovano	73	Italy	open air - dry	Phase 2	1980	n.d.			Unknown	
Lovere-Via Deccio Celeri	74	Italy	open air - dry	Neo	1990	n.d.			Unknown	
Lovere-Via Deccio Celeri	74	Italy	open air - dry	Phase 3	1990	n.d.			Unknown	
Monte Covolo_1	75	Italy	open air - dry	Neo	1990	soil sample			flotation	
Monte Covolo_2	75	Italy	open air - dry	Phase 3	1990	soil sample			flotation	
Monte Covolo_3	75	Italy	open air - dry	Phase 3	1990	soil sample			flotation	
Lagozza di Besnate	76	Italy	open air - wet	Phase 2	1950	n.d.			Unknown	
Can Sadurní_Layer11	79	Spain	cave/shelter	Phase 2	2010	100% sediment			flotation	wash-over
Can Sadurní_Layer10	79	Spain	cave/shelter	Phase 2	2010	systematic fix volume (interval sampling Layer 10)			flotation	wash-over
Can Sadurní_layer18	79	Spain	cave/shelter	Phase 1	2010	100% sediment			flotation	wash-over
La Draga_SA	80	Spain	open air - wet	Phase 1	2010	systematic surface sampling 0.5-1 litre sediment sub-square and per square 7-10 L; judgement			wash-over	water-screening
La Draga_SB_SD	80	Spain	open air - wet	Phase 1	2010	systematic surface sampling 0.5-1 litre sediment sub-square and per square 7-10 L; judgement			wash-over	water-screening
Caserna de Sant Pau_Cardial	81	Spain	open air - dry	Phase 1	1990	judgement-syst			flotation	
Caserna de Sant Pau_epicardial/postcardial	81	Spain	open air - dry	Phase 1	1990	judgement-syst			flotation	
Font del Ros	82	Spain	open air - dry	Phase 1	1990	judgement-syst			flotation	
Cova de Sant Llorenç_MN	83	Spain	cave/shelter	Phase 2	2010	systematic 100%	interval		flotation	
Cova de Sant Llorenç_LN	83	Spain	cave/shelter	Phase 3	2010	systematic 100%	interval		flotation	
Cova de Sant Llorenç_EN	83	Spain	cave/shelter	Phase 1	2010	systematic 100%	interval		flotation	
Cova de Sant Llorenç_LEN	83	Spain	cave/shelter	Phase 1	2010	systematic 100%	interval		flotation	
Carrer Reina Amàlia, 31-33_MN	85	Spain	open air - dry	Phase 2	2000	judgement sampling variable; syst			flotation	
Carrer Reina Amàlia, 31-33_ EN	85	Spain	open air - dry	Phase 1	2000	judgement sampling variable; syst			flotation	
Plansallosa	86	Spain	open air - dry	Phase 1	1990	no info but probably judgment			no info	
Cova del Sardo_MN	87	Spain	cave/shelter	Phase 2	2000	probabilist			water-screening	
Cova del Sardo_LMN	87	Spain	cave/shelter	Phase 2	2000	probabilist			water-screening	
Cova del Sardo_LN	87	Spain	cave/shelter	Phase 3	2000	probabilist			water-screening	
Cova del Sardo_LEN	87	Spain	cave/shelter	Phase 1	2000	probabilist			water-screening	
La Dou_EMN	88	Spain	open air - dry	Phase 2	2000	judgement sampling variable			flotation	
La Dou_LEN	88	Spain	open air - dry	Phase 1	2000	judgement sampling variable			flotation	
Codella	89	Spain	open air - dry	Phase 1	2000	judgement sampling variable; interval			flotation	
Camp del Colomer	90	Spain	open air - dry	Phase 2	2000	judgement sampling variable; judg-sys			flotation	
Serra del Mas Bonet_MN	91	Spain	open air - dry	Phase 2	2000	judgement sampling variable judg-sys			flotation	
Serra del Mas Bonet_LN	91	Spain	open air - dry	Phase 3	2000	judgement sampling variable judg-sys			flotation	
Serra del Mas Bonet_LEN	91	Spain	open air - dry	Phase 1	2000	judgement sampling variable judg-sys			flotation	
120 Cave_Neol3	92	Spain	cave/shelter	Phase 2	1980	100% sediment; judg			dry-sieving	flotation
120 Cave_Neol2	92	Spain	cave/shelter	Phase 1	1980	100% sediment; judg			dry-sieving	flotation
Bòbila Madurell_MN/LN	93	Spain	open air - dry	Neo	1990	interval sampling:fixed vol systematic taken			water-screening	flotation
Bòbila Madurell_MN	93	Spain	open air - dry	Phase 2	1990	interval sampling:fixed vol systematic taken			water-screening	flotation
Bòbila Madurell_LN	93	Spain	open air - dry	Phase 3	1990	interval sampling:fixed vol systematic taken			water-screening	flotation
Mines of Gavà_4200-3800 BC	94	Spain	mines	Phase 2	1980	judgement sampling variable			flotation	wash-over
Mines of Gavà_3200-2800 BC	94	Spain	mines	Phase 3	1980	judgement sampling variable			flotation	wash-over
Espina C	95	Spain	open air - dry	Phase 3	2000	judgement sampling variable; judj sys			flotation	wash-over
Pla del Gardelo	96	Spain	open air - dry	Phase 2	2000	judgement sampling variable (judd-syst)			flotation	water-screening
Puig del Collet / El Collet/Collet Puiggròs	97	Spain	open air - dry	Phase 2	2000	judgement sampling variable			flotation	wash-over
CIM "El Camp"_unknow	98	Spain	open air - dry	Neo	2010	judgement sampling variable; judge-syst			water-screening	
CIM "El Camp"_EMN	98	Spain	open air - dry	Phase 2	2010	judgement sampling variable; judge-syst			water-screening	
CIM "El Camp"_LEN	98	Spain	open air - dry	Phase 1	2010	judgement sampling variable; judge-syst			water-screening	
Pesseta Cave	99	Spain	cave/shelter	Phase 3	2000	systematic			flotation	
Camí dels Banys de la Mercè	100	Spain	open air - dry	Phase 1	2000	systematic			flotation	
Can Revella (Can Roqueta)	102	Spain	open air - dry	Neo	2000	systematic			flotation	

Site name	ID	Country	Type of site	Phase	Date of excavation	Recovery method	Recovery method	Recovery method	Processing method	Processing method
Castelnuovo di Teolo	103	Italy	open air - dry	Phase 2	2010	systematic			flotation	
Auvelles_neo2	104	Spain	open air - dry	Phase 2	2000	Judgmental sampling			wash-over	
Auvelles_Postcardial	104	Spain	open air - dry	Phase 1	2000	Judgmental sampling			wash-over	
Cova del Toll_MN	105	Spain	cave/shelter	Phase 2	1990	Judgmental sampling			unknown	
Cova del Toll_LN	105	Spain	cave/shelter	Phase 3	1990	Judgmental sampling			unknown	
Pou Nou 2	110	Spain	open air - dry	Phase 2	2010	systematic			flotation	wash-over
L' escola Especial Meritxell	112	Spain	open air - dry	Phase 2	2000	systematic			flotation	
Rivoli Veronese	113	Italy	open air - dry	Phase 2	n.d.	none?			none?	
Barbiano	114	Italy	open air - dry	Phase 2	2000	none?			none?	
Aica di Fiè / Völs am Schlern/Volseraicha	115	Italy	open air - dry	Phase 3	1990	none?			none?	
Brescia S. Polo	116	Italy	open air - dry	Phase 3	1990	n.d.			Unknown	
Tolerait	117	Italy	open air - dry	Phase 3	n.d.	n.d.			Unknown	
Aspre del Paradís_EN	122	France	open air - dry	Phase 1	1990	n.d.			flotation	
Aspre del Paradís_LN	122	France	open air - dry	Phase 3	1990	n.d.			flotation	
Aulp du Seuil	123	France	cave/shelter	Phase 2	2000	all sediment			dry-sieving	flotation
Auriac	124	France	open air - dry	Phase 2	1980	n.d.			no info	
Auriac-Golf	125	France	open air - dry	Phase 2	1990	n.d.			no info	
Balma de l'Abeurador_epicardial	126	France	cave/shelter	Phase 1	1990	all sediment			dry-sieving	wet-sieving
Balma de l'Abeurador_Chassenclassic	126	France	cave/shelter	Phase 2	1990	all sediment			dry-sieving	wet-sieving
Balma de l'Abeurador_Chassenancien	126	France	cave/shelter	Phase 2	1990	all sediment			dry-sieving	wet-sieving
Balma Margineda_5472-4849	127	Andorra	cave/shelter	Phase 1	1990	for all layers?			dry-sieving	flotation
Balma Margineda_4793-4612	127	Andorra	cave/shelter	Phase 1	1990	for all layers?			dry-sieving	flotation
Barreau de la Devèze Sud_MN1	128	France	open air - dry	Phase 2	2000	systematic 10 l			wet-sieving	
Barreau de la Devèze Sud_MN2	128	France	open air - dry	Phase 2	2000	systematic 10 l			wet-sieving	
Barreau de la Devèze Sud_MN	128	France	open air - dry	Phase 2	2000	systematic 10 l			wet-sieving	
Baume Bourbon	129	France	cave/shelter	Phase 1	1970	n.d.			wet-sieving	
Baume d'Oullins	130	France	cave/shelter	Phase 1	1970	n.d.			no info	
Baume Fontbrégoua_Cardial final	131	France	cave/shelter	Phase 1	1990	sieve everything			dry-sieving	
Baume Fontbrégoua_Cardialancien	131	France	cave/shelter	Phase 1	1990	sieve everything			dry-sieving	
Baume Fontbrégoua_Chassee recent	131	France	cave/shelter	Phase 2	1990	sieve everything			dry-sieving	
Baume Fontbrégoua_Chassen ancien	131	France	cave/shelter	Phase 2	1990	sieve everything			dry-sieving	
Baume Fontbrégoua_Pre_Chassen	131	France	cave/shelter	Phase 2	1990	sieve everything			dry-sieving	
Boulevard périphéerique Nord de Lyon_EN	132	France	open air - dry	Phase 1	1990	judgement?			wet-sieving	
Boulevard périphérique Nord de Lyon_MN	132	France	open air - dry	Phase 2	1990	judgement?			wet-sieving	
Boulevard périphérique Nord de Lyon_campaniforme	132	France	open air - dry	Phase 3	1990	judgement?			wet-sieving	
Caucade	134	France	open air - dry	Phase 2	1990	no info only martin 2016			no info	
Claparouse	136	France	open air - dry	Phase 2	1970	all the bottom of the pit			wet-sieving	
Clos de Roque	137	France	open air - dry	Phase 2	2010	systematic			sieved	
Cova de l'Esperit	139	France	cave/shelter	Phase 1	1990	no info			no info	
Encombres	140	France	open air - dry	Phase 2	1990	judgement?			wet-sieving	flotation
Font Juvénal_EN	141	France	cave/shelter	Phase 1	1970	n.d.			no info	
Font Juvénal_MN1	141	France	cave/shelter	Phase 2	1970	n.d.			no info	
Font Juvénal_MN2	141	France	cave/shelter	Phase 2	1970	n.d.			no info	
Font Juvénal_LN	141	France	cave/shelter	Phase 3	1970	n.d.			no info	
Gardon_ENRhodanie	142	France	cave/shelter	Phase 1	2000	unclear systematic?			sieved	flotation
Gardon_MNSain-UZE	142	France	cave/shelter	Phase 2	2000	unclear systematic?			sieved	flotation
Grotte de l' Aigle	143	France	cave/shelter	Phase 1	1900	n.d.			no info	
Grotte de Montou Montbolo_MN	144	France	cave/shelter	Phase 2	1990	judgement?			wet-sieving	wet-sieving
Grotte de Montou Montbolo_LN	144	France	cave/shelter	Phase 3	1990	judgement?			wet-sieving	wet-sieving
Grotte du Taï_Early Neo 1	145	France	cave/shelter	Phase 1	2000	systematic and integral			flotation	
Grotte du Taï_Early Neo 2	145	France	cave/shelter	Phase 1	2000	systematic and integral			flotation	
Grotte du Taï_Middle Neolithic	145	France	cave/shelter	Phase 2	2000	systematic and integral			flotation	
Grotte du Taï_Ferriéres	145	France	cave/shelter	Phase 3	2000	systematic and integral			flotation	
Grotte du Taï_Fontbouisse	145	France	cave/shelter	Phase 3	2000	systematic and integral			flotation	
Grotte G	147	France	cave/shelter	Phase 2	1960	n.d.			no info	
Grotte Gazel_5000	148	France	cave/shelter	Phase 1	1970	n.d.			no info	
Grotte Gazel_after5000	148	France	cave/shelter	Phase 1	1970	n.d.			no info	
Grotte Murée	149	France	cave/shelter	Phase 2	1960	n.d.			no info	
Grotte St Marcel_EN	150	France	cave/shelter	Phase 1	1980	n.d.			no info	
Grotte St Marcel_MN	150	France	cave/shelter	Phase 2	1980	n.d.			no info	
Grotte St Marcel_LN	150	France	cave/shelter	Phase 3	1980	n.d.			no info	
Jardins de Vert Parc_chass	151	France	open air - dry	Phase 2	1990	judgement?			flotation	
La Grande Rivoire_EN	152	France	cave/shelter	Phase 1	2000	systematic			wet-sieving	flotation

Site name	ID	Country	Type of site	Phase	Date of excavation	Recovery method	Recovery method	Recovery method	Processing method	Processing method
La Grande Rivoire_MN1	152	France	cave/shelter	Phase 2	2000	systematic			wet-sieving	flotation
La Grande Rivoire_MN2	152	France	cave/shelter	Phase 2	2000	systematic			wet-sieving	flotation
La Grande Rivoire_LN	152	France	cave/shelter	Phase 3	2000	systematic			wet-sieving	flotation
Clairvaux - La Motte aux Magnins V	153	France	open air - wet	Phase 2	2000	4 stratigraphic columns			wet-sieving	
La Resclauze	156	France	open air - dry	Phase 1	1980	no info			no info	
La Roberte	157	France	open air - dry	Phase 2	1990	?			no info	
La Salle	158	France	cave/shelter	Phase 2	1990	all the filling was sieve by water (F4)			wet-sieving	
Le Bousquetas	159	France	open air - dry	Phase 3	1990	based on the structure?			sieved	
Le Champ du Poste_Chassen ancien	160	France	open air - dry	Phase 2	2000	unclear structures			flotation	
Le Champ du Poste_Verazien	160	France	open air - dry	Phase 3	2000	unclear structures			flotation	
Le Chenet des Pierres_MN1	161	France	open air - dry	Phase 2	1990	sytematic?			wet-sieving	
Le Chenet des Pierres_MN2	161	France	open air - dry	Phase 2	1990	sytematic?			wet-sieving	
Le Crès	162	France	open air - dry	Phase 2	2000	judgement?			flotation	
Le Font aux Pigeons	163	France	open air - dry	Phase 1	1950	? Concentration on the pits			?	
Le Lagarel	164	France	open air - dry	Phase 3	2000	n.d.			flotation	
Le Logis de Berre	165	France	open air - dry	Phase 2	1980	Martin inedit 2016				
Le Moulin	166	France	open air - dry	Phase 2	1980	Martin inedit 2016				
Le Pirou	167	France	open air - dry	Phase 2	2000	judgement?			dry-sieving	flotation
Le Puech Haut_LN1	168	France	open air - dry	Phase 3	1990	450 l			wet-sieving	
Le Puech Haut_LN2	168	France	open air - dry	Phase 3	1990	450 l			wet-sieving	
Le Puech Haut_LN3	168	France	open air - dry	Phase 3	1990	450 l			wet-sieving	
Le Rochas	169	France	open air - dry	Phase 3	1980	n.d.			no info	
Le Serre de Boidon	170	France	open air - dry	Phase 3	1970	n.d.			no info	
Le Valladas	171	France	open air - dry	Phase 1	1980	n.d.			no info	
Les Lauzières	174	France	open air - dry	Phase 3	1980	n.d.			no info	
Les Moulins	175	France	open air - dry	Phase 2	2000	n.d.			no info	
Les Plots	176	France	open air - dry	Phase 2	1990	n.d.			no info	
Mas de Vignoles IX	177	France	open air - dry	Phase 2	2000	only specific organic layers			sieved	
Mas de Vignoles X	178	France	open air - dry	Phase 1	2000	systematic			wet-sieving	
Mas Neuf	179	France	open air - dry	Phase 1	2000	one place with seeds			wet-sieving	
Montbeyre-La Cadoule	180	France	open air - dry	Phase 2	1950	n.d.			no info	
Moulin de la Garonne	181	France	open air - dry	Phase 2	n.d.	n.d.			no info	
Mourre de la Barque_Neo2	182	France	cave/shelter	Phase 2	2000	pontual ? Systematic?			dry-sieving	wet-sieving
Mourre de la Barque_Neo3	182	France	cave/shelter	Phase 2	2000	pontual ? Systematic?			dry-sieving	wet-sieving
Peiro Signado	183	France	cave/shelter	Phase 1	1990	not clear publish			unclear	
Pendimoun_Impressa	184	France	cave/shelter	Phase 1	2000	100% sediment?			sieved	
Pendimoun_Cardial	184	France	cave/shelter	Phase 1	2000	100% sediment?			sieved	
Pendimoun_SMP	184	France	cave/shelter	Phase 2	2000	100% sediment?			sieved	
Plateau Raverre	185	France	open air - dry	Phase 2	1980	n.d.			no info	
Pont de Roque Haute	186	France	open air - dry	Phase 1	1990	all sediment sieved 1mm but also some specific judgement			flotation	
Roc de Dourgne	187	France	cave/shelter	Phase 1	1980	n.d.			flotation	
Roquemaure	188	France	cave/shelter	Phase 3	n.d.	n.d.			no info	
St. Martin d'Azirou	191	France	cave/shelter	Phase 3	n.d.	n.d.			no info	
Clairvaux XIV	192	France	open air - wet	Phase 2	2000	tubes en PVC; fumiers			wet-sieving	
Toronde	193	France	open air - dry	Phase 2	1980	not applicable			not applicable	
Vieux-Mounoï	195	France	cave/shelter	Phase 2	1950	n.d.			?	
Villa Giribaldi	196	France	open air - dry	Phase 2	1980	n.d.			flotation	
ZAC Feuilly_Cardial	197	France	open air - dry	Phase 1	2000	judjement and systematic for charcoal			wet-sieving	
ZAC Feuilly_MNB	197	France	open air - dry	Phase 2	2000	judjement and systematic for charcoal			wet-sieving	
ZAC Saint-Antoine II_preCha4300	198	France	open air - dry	Phase 2	2000	systematic?			wet-sieving	flotation
ZAC Saint-Antoine II_4330-4050	198	France	open air - dry	Phase 2	2000	systematic?			wet-sieving	flotation
ZAC Saint-Antoine II_4100-3800	198	France	open air - dry	Phase 2	2000	systematic?			wet-sieving	flotation
ZAC Saint-Antoine II_MN	198	France	open air - dry	Phase 2	2000	systematic?			wet-sieving	flotation
Zürich - AKAD-Seehofstrasse	199	Switzerland	open air - wet	Phase 2	1970	Systematic sampling			wet-sieving	
Zürich - Pressehaus_1_Horgen	200	Switzerland	open air - wet	Phase 2	1970	Systematic sampling			wet-sieving	
Zürich - Pressehaus_2_Schnur	200	Switzerland	open air - wet	Phase 3	1970	Systematic sampling			wet-sieving	
Arbon - Bleiche 3	201	Switzerland	open air - wet	Phase 3	1990	Systematic sampling	Judgement sampling		wet-sieving	half flotation
Binningen-Friedhofstrasse	202	Switzerland	open air - dry	Phase 3	2000	unclear			half flotation	
Seeberg - Burgäschisee SW	203	Switzerland	open air - wet	Phase 2	1950	n.d.			dry-sieving	wet-sieving
Cham -St. Andreas	204	Switzerland	open air - wet	Phase 2	1980	Judgement sampling			wet-sieving	
Egolzwil 3	205	Switzerland	open air - wet	Phase 2	1980	Systematic sampling	Judgement sampling		wet-sieving	
Frasses - Praz au Doux	206	Switzerland	open air - wet	Phase 3	1990	n.d.			wet-sieving	
Horgen-Scheller_ Horgen	208	Switzerland	open air - wet	Phase 3	1990	Systematic sampling	Judgement sampling		wet-sieving	
Horgen-Scheller_Schnur	208	Switzerland	open air - wet	Phase 3	1990	Systematic sampling	Judgement sampling		wet-sieving	
Kleiner Hafner_Ego	209	Switzerland	open air - wet	Phase 2	1980	Systematic sampling	Judgement sampling		wet-sieving	
Kleiner Hafner_Cort	209	Switzerland	open air - wet	Phase 2	1980	Systematic sampling	Judgement sampling		wet-sieving	
Lattringen - Haupstation (site VII)_Cord	210	Switzerland	open air - wet	Phase 3	1990	Systematic sampling	Judgement sampling	Interval sampling	wet-sieving	
Lattringen - Haupstation (site VII)_Horg	210	Switzerland	open air - wet	Phase 3	1990	Systematic sampling	Judgement sampling	Interval sampling	wet-sieving	
Lüscherz - Klein Station, inerdorf_1	211	Switzerland	open air - wet	Phase 2	1980	Judgement sampling			wet-sieving	
Lüscherz - Klein Station, inerdorf_2	211	Switzerland	open air - wet	Phase 3	1980	Judgement sampling			wet-sieving	
Lattringen -Riedstation (site VI)	212	Switzerland	open air - wet	Phase 3	1990	Judgement sampling			wet-sieving	
Zürich - Mozartstrasse_Cort	213	Switzerland	open air - wet	Phase 2	1980	Judgement sampling			wet-sieving	
Zürich - Mozartstrasse_Pyy1	213	Switzerland	open air - wet	Phase 2	1980	Judgement sampling			wet-sieving	
Zürich - Mozartstrasse_Pyy2	213	Switzerland	open air - wet	Phase 2	1980	Judgement sampling			wet-sieving	
Zürich - Mozartstrasse_FruheszentralCortaill	213	Switzerland	open air - wet	Phase 2	1980	Judgement sampling			wet-sieving	
Zürich - Mozartstrasse_Schnur	213	Switzerland	open air - wet	Phase 3	1980	Judgement sampling			wet-sieving	
Zürich - Mozartstrasse_Horgen	213	Switzerland	open air - wet	Phase 3	1980	Judgement sampling			wet-sieving	

Site name	ID	Country	Type of site	Phase	Date of excavation	Recovery method	Recovery method	Recovery method	Processing method	Processing method
Mythenschloss_Horgen	214	Switzerland	open air - wet	Phase 3	1980	Judgement sampling			wet-sieving	
Mythenschloss_Schnur1	214	Switzerland	open air - wet	Phase 3	1980	Judgement sampling			wet-sieving	
Neftenbach_Aspach	215	Switzerland	open air - dry	Phase 3	1990	n.d.			unknown	
Nidau BKWi or Nidau 'Schlossmatte/ BKW	216	Switzerland	open air - wet	Phase 3	1990	Systematic sampling	Judgement sampling	Interval sampling	wet-sieving	
Seedorf - Lobsigesee	219	Switzerland	open air - wet	Phase 2	2000	n.d.			half flotation	
Zürich, Seefeld KanSan_Horg	220	Switzerland	open air - wet	Phase 2	1980	Judgement sampling			half flotation	
Zürich, Seefeld KanSan_Schnur	220	Switzerland	open air - wet	Phase 3	1980	Judgement sampling			half flotation	
Zürich, Seefeld KanSan_Pfy	220	Switzerland	open air - wet	Phase 3	1980	Judgement sampling			half flotation	
Sevelen - Pfäfersbüel	221	Switzerland	open air - dry	Phase 1	2000	n.d.			half flotation	
Stansstad-Kehrsiten_ 4250-3750_Corta	222	Switzerland	open air - wet	Phase 2	2000	n.d.			half flotation	
Stansstad-Kehrsiten_ 3750-3500_Pfyn	222	Switzerland	open air - wet	Phase 2	2000	n.d.			half flotation	
Port - Stüdeli_US_41	223	Switzerland	open air - wet	Phase 2	1980	Judgement sampling	Grab sampling		wet-sieving	
Villeneuve-La Baume Abri 1	224	Switzerland	cave/shelter	Phase 3	2000	Systematic sampling			wet-sieving	dry-sieving
Wetzikon, Kempten Tösstalerstr	225	Switzerland	undefined	Phase 3	2000	n.d.			half flotation	
Zizers- Friedau	226	Switzerland	open air - dry	Phase 1	2000	n.d.			wet-sieving	
Zug-Riedmatt	227	Switzerland	open air - wet	Phase 3	2000	Systematic sampling			wash-over	
Delémont - En la Pran	228	Switzerland	open air - dry	Phase 3	1990	n.d.			sieved	
Bauma del Serrat del Pont_LN	230	Spain	cave/shelter	Phase 3	1990	judgement			flotation	
Bauma del Serrat del Pont_EN	230	Spain	cave/shelter	Phase 1	1990	judgement			flotation	
Cova de les Portes	231	Spain	cave/shelter	Phase 3	1990	systematic all layers and squares (1990-91)			wet-sieving	flotation
El Cavet	232	Spain	open air - dry	Phase 1	2000	n.d.			flotation	
Les Vautes	233	France	open air - dry	Phase 3	1990	n.d.			unclear	
Grotte d' engorner	234	France	cave/shelter	Phase 3	1970	manual?			not applicable	
Boussargues	235	France	open air - dry	Phase 3	1990	systematic?			wet-sieving	
Roquessols	236	France	open air - dry	Phase 3	2000	n.d.			wet-sieving	
Sion - La Planta	237	Switzerland	open air - dry	Phase 1	1980	Judgement sampling			wet-sieving	
Sion - Tourbillon_2	238	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	
Sion - Tourbillon_1	238	Switzerland	open air - dry	Phase 1	1990	Judgement sampling			wet-sieving	
Sion- La Gillière 2	239	Switzerland	open air - dry	Phase 1	1990	Judgement sampling			wet-sieving	
Sion - Ritz 33	240	Switzerland	open air - dry	Phase 2	1980	Judgement sampling			wet-sieving	
Savièse - La Soie	241	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	
Petit-Chasseur IV_MNI 4500	242	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			flotation	
Petit-Chasseur IV_'Cortaillod type Petit-Chasseur (4000-3800)	242	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			flotation	
Saint-Aubin/Derrière la Croix_Cort	244	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			flotation	
Saint-Aubin/Derrière la Croix_2800-2500	244	Switzerland	open air - dry	Phase 3	1990	Judgement sampling			flotation	
Concise- Sous Colachoz_ Cortaillod-Moyen	245	Switzerland	open air - wet	Phase 3	2000	Systematic sampling			wet-sieving	goldwascher
Zürich - Parkhaus Opera_Horgen	246	Switzerland	open air - wet	Phase 3	2010	n.d.			wash-over	
Gachnang, Niederwil	247	Switzerland	open air - wet	Phase 2	1960	Systematic sampling	Judgement sampling		wet-sieving	
Yverdon- Avenue des Sports_Weber	248	Switzerland	open air - wet	Phase 3	1980	n.d.			no info	
Yverdon- Avenue des Sports_Schilichtherle	248	Switzerland	open air - wet	Phase 3	1980	n.d.			wet-sieving	
Auvernier	249	Switzerland	open air - wet	Phase 3	n.d.	n.d.			no info	
Saint-Blaise/Bains des Dames 4_Horgen	250	Switzerland	open air - wet	Phase 3	1980	Systematic sampling			wet-sieving	goldwascher
Saint-Blaise/Bains des Dames 4_Auvernier-Cordé ancien	250	Switzerland	open air - wet	Phase 3	1980	Systematic sampling			wet-sieving	goldwascher
Saint-Blaise/Bains des Dames 4_Auvernier-Cordé	250	Switzerland	open air - wet	Phase 3	1980	Systematic sampling			wet-sieving	goldwascher
Saint-Blaise/Bains des Dames 4_Auvernier-Cordé moyen	250	Switzerland	open air - wet	Phase 3	1980	Systematic sampling			wet-sieving	goldwascher
Saint-Blaise/Bains des Dames 4_Auvernier-Lüscherz	250	Switzerland	open air - wet	Phase 3	1980	Systematic sampling			wet-sieving	goldwascher
Twann_Cortaillod	251	Switzerland	open air - wet	Phase 2	1970	Systematic sampling	Judgement sampling		wet-sieving	
Twann_Middle Horgen	251	Switzerland	open air - wet	Phase 3	1970	Systematic sampling	Judgement sampling		wet-sieving	
Les Bagnoles_MN1	252	France	open air - dry	Phase 2	2010	judgement ?			wash-over	
Les Bagnoles_MN2	252	France	open air - dry	Phase 2	2010	judgement ?			wash-over	
Trou Arnaud	253	France	cave/shelter	Phase 2	1950	n.d.			no info	
La Cavalade_LN2	254	France	open air - dry	Phase 3	2010	systematic			wet-sieving	

Site name	ID	Country	Type of site	Phase	Date of excavation	Recovery method	Recovery method	Recovery method	Processing method	Processing method
La Cavalade_LN3	254	France	open air - dry	Phase 3	2010	systematic			wet-sieving	
Balmes_LN1	255	France	cave/shelter	Phase 3	1990	mix			dry-sieving	wet-sieving
Balmes_MN2/LN1	255	France	cave/shelter	Neo	1990	mix			dry-sieving	wet-sieving
Clairvaux VII	256	France	open air - wet	Phase 2	2000	pontual ?	manual		wet-sieving	
Chalain 19	257	France	open air - wet	Phase 3	2000	spatial square meter horizontal and vertical			wet-sieving	
Clairvaux III	258	France	open air - wet	Phase 3	1980	systematic cores?			wet-sieving	
Clairvaux II	259	France	open air - wet	Phase 3	1970	1 sample and excavation triangles (erosion)			sieved	
L'Héritière Cazan	260	France	open air - dry	Phase 2	2000	judgement only specific structure			wet-sieving	
Spilamberto S. Cesario Sito I	266	Italy	open air - dry	Phase 3	1980	profile?			wet-sieving	
Spilamberto S. Cesario Sito VIII	266	Italy	open air - dry	Phase 3	1980	profile?			wet-sieving	
ZAC Les Chalus II Lot 1	267	France	open air - dry	Phase 2	2010	judgement ?			flotation	
Route de Canohès Lotissement « Le Petit Prince »	268	France	open air - dry	Phase 2	2000	judgement			wet-sieving	
Jonquiere I	271	France	open air - dry	Phase 3	2010	judgement ?			wet-sieving	
L' aéropole Tallard	272	France	open air - dry	Phase 2	2010	judgement ?			flotation	
Cepie_MN	273	France	open air - dry	Phase 2	2010	judgement ?			flotation	
Cepie_LN	273	France	open air - dry	Phase 3	2010	judgement ?			flotation	
509 avenue des Noyers	274	France	open air - dry	Phase 3	2010	systematic			flotation	
Trets ZAC la Burlière	275	France	open air - dry	Phase 2	2010	systematic			flotation	
Quincieux Grange Rouge_MN	276	France	open air - dry	Phase 2	2010	systematic			flotation	
Quincieux Grange Rouge_LN	276	France	open air - dry	Phase 3	2010	systematic			flotation	
Lattes Port-Ariane III_MN	277	France	open air - dry	Phase 2	1990	systematic			wet-sieving	
Lattes Port-Ariane III_LN	277	France	open air - dry	Phase 3	1990	systematic			wet-sieving	
Chens-sur-Léman Pré dAncy	278	France	open air - dry	Phase 2	2010	systematic			flotation	
Clos Roque Route de Barjols MN2	279	France	open air - dry	Phase 2	2010	judgement ?			wet-sieving	
Clos Roque Route de Barjols LN	279	France	open air - dry	Phase 3	2010	judgement ?			wet-sieving	
Clos Roque Route de Barjols MN2/LN	279	France	open air - dry	Neo	2010	judgement ?			wet-sieving	
Gap Lachaup	280	France	open air - dry	Phase 3	2010	systematic and pontual			wet-sieving	
A8 Rousset_Le Plan	281	France	open air - dry	Phase 3	2000	unclear			wet-sieving	flotation
Velaux, La Bastide Neuve III	282	France	open air - dry	Phase 2	2010	unclear systematic			flotation	
Le site néolithique final de Ponteau_PH2	283	France	open air - dry	Phase 3	2010	systematic			wet-sieving	flotation
Le site néolithique final de Ponteau_PH3	283	France	open air - dry	Phase 3	2010	systematic			wet-sieving	flotation
Le site néolithique final de Ponteau_PH4	283	France	open air - dry	Phase 3	2010	systematic			wet-sieving	flotation
Charavines - Les Baigneurs	284	France	open air - wet	Phase 3	1970	integral sieving/ bloc / core			wet-sieving	
Brise-Lames	285	Switzerland	open air - wet	Phase 3	1970	judgement ?			unclear	
Pfyn-Breitenloo	286	Switzerland	open air - wet	Phase 2	2000	judgement ?			unclear	
Clairvaux VIII	287	France	open air - wet	Phase 2	1980	judgement?			flotation	
Cova de la Colomera	288	Spain	cave/shelter	Phase 1	2000	systematic			flotation	
La serreta_NACardial	289	Spain	open air - dry	Phase 1	2010	judgement?			flotation	
La serreta_NAE	289	Spain	open air - dry	Phase 1	2010	structures that could have remains			flotation	
La serreta_MN	289	Spain	open air - dry	Phase 2	2010	structures that could have remains			flotation	
La serreta_LN	289	Spain	open air - dry	Phase 3	2010	structures that could have remains			flotation	
Chalain 3 (layer VIII)	291	France	open air - wet	Phase 3	1980	all house and 3 ABCD 49 samples 2 metres				
Alleins Quartier Sainte-Anne	293	France	open air - dry	Phase 3	2010	Systematic?			flotation	
20 rue Fodéré, Villa Lympia	294	France	open air - dry	Phase 2	2010	cores			wet-sieving	
ZAC de la Farigoule	295	France	open air - dry	Phase 3	2010	unclear			wet-sieving	flotation
Mittelhoetzleinfeld	296	France	open air - dry	Phase 1	2000	100 % sediment			flotation	
Florival	297	France	open air - dry	Phase 1	2000	Systematic sampling			flotation	
Bergheim, Haut-Rhin, « Saulager » , zone d'activité du Muehlbach	301	France	open air - dry	Phase 1	2000	judgement?			flotation	
Didenheim Kahlberg	302	France	open air - dry	Neo	2000	judgement?			flotation	
Burgäschisee Süd	303	Switzerland	open air - wet	Phase 2	1950	n.d.			wet-sieving	
Sutz- Rütte V	306	Switzerland	open air - wet	Phase 3	1990	Judgement sampling			sieved	half flotation
Biel-Vingelz	307	Switzerland	open air - wet	Phase 3	1990	Judgement sampling			sieved	half flotation
Pfäffikon- Burg	308	Switzerland	open air - wet	Phase 3	1990	Systematic sampling			wet-sieving	
Auvernier/La Saunerie_Lüschers	309	Switzerland	open air - wet	Phase 3	1970	Systematic sampling			wet-sieving	
Auvernier/La Saunerie_Auvernier	309	Switzerland	open air - wet	Phase 3	1970	Systematic sampling			wet-sieving	
Auvernier/La Saunerie	309	Switzerland	open air - wet	Phase 3	1970	Systematic sampling			wet-sieving	
Burgäschisee Nord	311	Switzerland	open air - wet	Phase 2	1950	unpublish			sieved	half flotation
Petit Ruz_MN_Neol2	313	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Petit Ruz_LN_Neol5	313	Switzerland	open air - dry	Phase 3	1990	Judgement sampling			wet-sieving	flotation
Sur les Rochettes Est_Glockenb	314	Switzerland	open air - dry	Phase 3	2000	Systematic sampling			wet-sieving	flotation
Les Tilles_MN	315	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Les Tilles_2800-2500	315	Switzerland	open air - dry	Phase 3	1990	Judgement sampling			wet-sieving	flotation
Treytel_EN	316	Switzerland	open air - dry	Phase 2	2000	Judgement sampling			wet-sieving	flotation
Treytel_MN	316	Switzerland	open air - dry	Phase 2	2000	Judgement sampling			wet-sieving	flotation
Treytel_Cort_ancien	316	Switzerland	open air - dry	Phase 2	2000	Judgement sampling			wet-sieving	flotation
Treytel_Cort_classi	316	Switzerland	open air - dry	Phase 2	2000	Judgement sampling			wet-sieving	flotation
Treytel_LN	316	Switzerland	open air - dry	Phase 3	2000	Judgement sampling			wet-sieving	flotation
Entzheim « Les Terres de la Chapelle » (Bas-Rhin)	317	France	open air - dry	Phase 1	2000	Systematic sampling			no info	
Entzheim	318	France	open air - dry	Phase 1	1970	n.d.			no info	
Grotte Antonnaire	319	France	cave/shelter	Phase 3	1970	manual			no info	

Site name	ID	Country	Type of site	Phase	Date of excavation	Recovery method	Recovery method	Recovery method	Processing method	Processing method
Teuleria dels Àlbers-1	320	Spain	open air - dry	Phase 3	2000	structures that could have remains			flotation	
Zal del Port de Tarragona_MN	322	Spain	open air - dry	Phase 2	2010	silo and hearths			flotation	
Zal del Port de Tarragona_Neo	322	Spain	open air - dry	Neo	2010	silo and hearths			flotation	
Cinc Ponts	323	Spain	open air - dry	Phase 3	2010	judgement?			flotation	
Mas Pujó	324	spain	open air - dry	Phase 1	2010	judgement?			flotation	
Mas d'en Boixos	325	Spain	open air - dry	Phase 1	2000	systematic			flotation	
Thayngen Weier	326	Switzerland	open air - wet	Phase 3	1960	n.d.			wet-sieving	
Thayngen Weier_Profile III	326	Switzerland	open air - wet	Phase 3	1960	n.d.			wet-sieving	
Zurich Oberrieden	327	Switzerland	open air - wet	Phase 3	2000	Judgement sampling			no info	
Zug Vorstadt 26	328	Switzerland	open air - wet	Phase 3	1980	Judgement sampling			wet-sieving	
Grand Pré	329	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Les Maladières_Cort_ancien	330	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Les Maladières_Cort_classic	330	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Les Maladières_MN	330	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Les Maladières_camp	330	Switzerland	open air - dry	Phase 3	1990	Judgement sampling			wet-sieving	flotation
Les Maladières_Horgen	330	Switzerland	open air - dry	Phase 3	1990	Judgement sampling			wet-sieving	flotation
Les Pâquiers_Cortaillod Classique	331	Switzerland	open air - dry	Phase 2	2000	Judgement sampling			wet-sieving	flotation
Les Pâquiers_Cortaillod tardif/Port-Conty	331	Switzerland	open air - dry	Phase 3	2000	Judgement sampling			wet-sieving	flotation
Place d'Armes	332	Switzerland	open air - dry	Neo	1990	Judgement sampling			wet-sieving	flotation
Champs Devant_MNI	333	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Champs Devant_MN2	333	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Steckborn, Schanz	334	Switzerland	undefined	Neo	2000	Grab sampling			wet-sieving	
Oberbipp Steingasse	336	Switzerland	open air - dry	Neo	2010	Systematic sampling			half flotation	
Reinach Fleischbachstrasse	339	Switzerland	open air - dry	Neo	1990	n.d.			no info	
Aux Courbes Rayes	342	Switzerland	open air - dry	Phase 3	1990	Judgement sampling			wet-sieving	flotation
Bataillard	343	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Chézard-Littorail_Cort	344	Switzerland	open air - dry	Phase 2	1990	Systematic sampling			wet-sieving	flotation
Chézard-Littorail_Lüs	344	Switzerland	open air - dry	Phase 3	1990	Systematic sampling			wet-sieving	flotation
Chézard-Littorail_auver	344	Switzerland	open air - dry	Phase 3	1990	Systematic sampling			wet-sieving	flotation
Les Buchilles	345	Switzerland	open air - dry	Phase 2	2000	Judgement sampling			wet-sieving	flotation
Aux Buchilles	346	Switzerland	open air - dry	Phase 2	1990	Judgement sampling			wet-sieving	flotation
Müstair_ Sondierbohrung Joos	347	Switzerland	open air - dry	Neo	1990	n.d.			no info	
Baar Früebergstrasse	348	Switzerland	open air - dry	Phase 3	2000	n.d.			wet-sieving	
Zug Vorstadt	349	Switzerland	open air - wet	Phase 3	1990	n.d.			wet-sieving	
Clos de Roque - Chemin de Barjols_MN	353	France	open air - dry	Phase 2	2000	judgement?			flotation	
Clos de Roque - Chemin de Barjols_LN	353	France	open air - dry	Phase 3	2000	judgement?			flotation	
La Vella II & III	354	Italy	open air - dry	Neo	1970	judgement?			water-screening	
La Vella III	354	Italy	open air - dry	Phase 2	1970	judgement?			water-screening	

*Carugari 1993

Jesus, A. Crop dynamics in the NW Mediterra

Appendix C: Table 1 - Data quality, metadata

? = unsure
Poor
Satisfactory
Good

Site name	ID	Processing method	Processing method	Mesh (mm)	Type of record	Type of record	Type of publication	Type of publication	Charred	Waterlogged	Imprints	Data quality
Rocca di rivoli	1			Unknown	presence/absence		site level					Poor
Este - località Meggiaro	2			Unknown	absolute numbers		structure level		x			Poor
Monselice - via Valli	3			Unknown	presence/absence		site level		x			Poor
Masera	4			Unknown	absolute numbers		site level		x			Poor
Lugo di Grezzana	5			0.5	absolute numbers		structure level		x			Good
Fimon-Molino Casarotto	6			Unknown	presence/absence		site level			x		Poor
Fimon Le Fratte	7			0.35	absolute numbers		structure level		x	x		Good
Saint Martin de Corléans	8			0.35	absolute numbers		structure level		x			Good
Bannia	9			Unknown	absolute numbers		structure level		x			Poor
Arquata Scrivia, Località Moriassi	10			0.5	absolute numbers		site level		x			Satisfactory
Fagnigola	11			0.5	absolute numbers		structure level		x			Good
Canedole di Roverbella	12			1	presence/absence		site level		x			Poor
Sammardenchia	13			0.5	absolute numbers		site level		x			Satisfactory
Palù di Livenza	14			Unknown	presence/absence		site level			x		Poor
Pavia de Udine	15			unknown	presence/absence		site level		x			Poor
Valler	16			0.5	absolute numbers*		site level		x			Satisfactory
Meduno	17			0.5	absolute numbers		structure level		x			Good
Piancada	20			unknown	presence/absence		site level		x			Poor
Latsch_2	21			0.25	absolute numbers		SU level		x			Good
Latsch_1	21			0.25	absolute numbers		SU level		x			Good
Villandro_3	22			Unknown	absolute numbers		structure level		x			Poor
Villandro_2	22			Unknown	absolute numbers		structure level		x			Poor
Villandro_1	22			Unknown	absolute numbers		structure level		x			Poor
Riva del Garda	23			Unknown	presence/absence		site level		x			Poor
Isera peat bog	24			unknown	absolute numbers		site level		x			Poor
La Vella II	25			0.5	absolute numbers		site level		x			Satisfactory
La Vela di Trento vIII_1	26			Unknown	absolute numbers		site level		x			Poor
La Vela di Trento vIII_2	26			Unknown	absolute numbers		site level		x			Poor
Otzi	27			0.125	absolute numbers		site level			x		Satisfactory
Bressanone- Millan	28			2	presence/absence		site level		x			Poor
Velturno-Tanzgasse	29			0.5	absolute numbers		SU level		x			Good
Balm Chanto	30			Unknown	presence/absence		site level		x			Poor
Casalnoceto	31			Unknown	presence/absence		site level		x			Poor
Alba Corso Laghe 43	32			Unknown	absolute numbers		SU level		x			Poor
Alba- Corso Europa	33			Unknown	absolute numbers		SU level		x			Poor
Castello d ' Annone	34			Unknown	presence/absence		SU level		x			Poor
Valgrana -Tetto Chiappello	35			Unknown	absolute numbers		SU level		x			Poor
Caverna delle Arene Candide_3	37			1	absolute numbers		Cultural phase		x		x	Satisfactory
Caverna delle Arene Candide_1	37			1	absolute numbers		Cultural phase		x		x	Satisfactory
Caverna delle Arene Candide_2	37			1	absolute numbers		Cultural phase		x		x	Satisfactory
Caverna delle Arene Candide_4	37			1	absolute numbers		Cultural phase		x		x	Satisfactory
San Sebastiano di Perti	38			0.25	absolute numbers		site level		x			Satisfactory
Arma dell ' Aquila	39			Unknown	imprint		site level				x	Poor
Riparo sotto Roccia di Pian del Ciliegio_1	40			0.25	absolute numbers		Cultural phase		x			Good
Riparo sotto Roccia di Pian del Ciliegio_2	40			0.25	absolute numbers		Cultural phase		x			Good
Riparo sotto Roccia di Pian del Ciliegio_3	40			0.25	absolute numbers		Cultural phase		x			Good
Grotta del Sanguineto o della Matta	41			Unknown	imprint		site level				x	Poor
Grotta marina di Bergeggi	42			Unknown	imprint		site level				x	Poor
Riparo di Rocca Due Teste all'Alpicella_1	43			0.5	absolute numbers		Cultural phase		x			Good
Riparo di Rocca Due Teste all'Alpicella_2	43			0.5	absolute numbers		Cultural phase		x			Good
Riparo di Rocca Due Teste all'Alpicella_3	43			0.5	absolute numbers		Cultural phase		x			Good
Core BH1, Piazza della Vittoria	44			0.2	presence/absence		core level		x	x		Poor
Piazza Brignole - Foce del Torrente Bisagno	45			0.25	absolute numbers		SU level			x		Good
Novi Ligure, località Pieve	46			0.5	presence/absence		structure level		x	x		Poor
Castellare di Uscio	48			unknown	presence/absence		site level		x	x		Poor
Albinea	49			unknown	presence/absence		site level				x	Poor
Fiorano	50			unknown	presence/absence		site level		x			Poor
Lugo di Romagna	51			0.5	absolute numbers		SU level		x			Good
Ponte Ghiara	52			0.5	absolute numbers		structure level		x			Good

Site name	ID	Processing method	Processing method	Mesh (mm)	Type of record	Type of record	Type of publication	Type of publication	Charred	Waterlogged	Imprints	Data quality
Ponte Molino	53			0.5	absolute numbers		SU level		x			Good
Rivaltella- Ca Romensini	54			unclear	absolute numbers		SU level		x			Poor
Savignano	55			unknown	presence/absence		site level		x			Poor
Forlì via Navicella_2	56			0.2	absolute numbers		SU level		x			Good
Forlì via Navicella_3	56			0.2	absolute numbers		SU level		x			Good
Forlì via Navicella_1	56			0.2	absolute numbers		SU level		x			Good
Bazzarola_3	57			0.5	absolute numbers		structure level		x			Good
Bazzarola_2	57			0.5	absolute numbers		structure level		x			Good
Bazzarola_1	57			0.5	absolute numbers		structure level		x			Good
Chiozza di Scandiano	58			Unknown	presence/absence		site level		x			Poor
Levata di Curtatone	59			Unclear	absolute numbers		structure level		x			Poor
Parma via Guidorossi	60			0.2	absolute numbers		structure level		x			Satisfactory
Spilamberto - Cava via Macchioni	61			0.2	absolute numbers		structure level		x			Good
Provezza_1	62			0.2	absolute numbers		structure level		x			Good
Provezza_2	62			0.2	absolute numbers		structure level		x			Good
Provezza_3	62			0.2	absolute numbers		structure level		x			Good
Forlimpopoli - via Canalazzo	63			0.2	absolute numbers		structure level		x			Good
S. Andrea de Travo	64			0.2	absolute numbers		site level		x			Satisfactory
Cecima	65			unknown	presence/absence		site level		x			Poor
Isorella	66			2	absolute numbers		structure level		x		x	Poor
Dugali Alti	67			0.5	absolute numbers		structure level		x		x	Good
Pizzo di Bodio_1	68			unknown	presence/absence		site level		x			Poor
Pizzo di Bodio_2	68			unknown	presence/absence		site level		x			Poor
Vho di Piadena	69			unknown	absolute numbers		structure level		x			Poor
Acquanegra sul Mosio	70			Unknown	presence/absence		site level		x			Poor
Casatico di Marcaria	71			Unknown	presence/absence		site level		x			Poor
Isolino di Varese_MN	72			0.5	absolute numbers		SU level			x		Good
Rivarolo Mantovano	73			Unknown	presence/absence		site level		x			Poor
Lovere-Via Deccio Celeri	74			Unknown	absolute numbers		SU level		x			Poor
Lovere-Via Deccio Celeri	74			Unknown	absolute numbers		SU level		x			Poor
Monte Covolo_1	75			ca. 0.5	absolute numbers		Cultural phase		x			Poor
Monte Covolo_2	75			ca. 0.5	absolute numbers		Cultural phase		x			Satisfactory
Monte Covolo_3	75			ca. 0.5	absolute numbers		Cultural phase		x			Satisfactory
Lagozza di Besnate	76			Unknown	presence/absence		site level			x		Poor
Can Sadurní_Layer11	79	wet-sieving		0.5	absolute numbers		layer level		x			Good
Can Sadurní_Layer10	79	wet-sieving		0.5	absolute numbers		layer level		x			Good
Can Sadurní_layer18	79	wet-sieving		0.5	absolute numbers		layer level		x			Good
La Draga_SA	80			0.35	absolute numbers		Sample level	Raw data	x			Good
La Draga_SB_SD	80			0.35	absolute numbers		Sample level	Raw data	x	x		Good
Caserna de Sant Pau_Cardial	81			0.5	absolute numbers		structure level		x			Good
Caserna de Sant Pau_epicardial/postcardial	81			0.5	absolute numbers		structure level		x			Good
Font del Ros	82			0.5	absolute numbers	presence/absence	site level		x			Satisfactory
Cova de Sant Llorenç_MN	83			0.5	absolute numbers		layer level		x			Good
Cova de Sant Llorenç_LN	83			0.5	absolute numbers		layer level		x			Good
Cova de Sant Llorenç_EN	83			0.5	absolute numbers		layer level		x			Good
Cova de Sant Llorenç_LEN	83			0.5	absolute numbers		layer level		x			Good
Carrer Reina Amàlia, 31-33_MN	85			0.5	absolute numbers		chronological level	Raw data	x			Good
Carrer Reina Amàlia, 31-33_ EN	85			0.5	absolute numbers		chronological level	Raw data	x			Good
Plansallosa	86			no info	absolute numbers		site level		x			Poor
Cova del Sardo_MN	87			0.5	absolute numbers		phase level	Raw data	x			Good
Cova del Sardo_LMN	87			0.5	absolute numbers		phase level	Raw data	x			Good
Cova del Sardo_LN	87			0.5	absolute numbers		phase level	Raw data	x			Good
Cova del Sardo_LEN	87			0.5	absolute numbers		phase level	Raw data	x			Good
La Dou_EMN	88			0.5	absolute numbers		chronological level	Raw data	x			Good
La Dou_LEN	88			0.5	absolute numbers		chronological level	Raw data	x			Good
Codella	89			0.5	absolute numbers		site level	Raw data	x			Good
Camp del Colomer	90			0.5	absolute numbers		site level	Raw data	x			Good
Serra del Mas Bonet_MN	91			0.5	absolute numbers		chronological level	Raw data	x			Good
Serra del Mas Bonet_LN	91			0.5	absolute numbers		chronological level	Raw data	x			Good
Serra del Mas Bonet_LEN	91			0.5	absolute numbers		chronological level	Raw data	x			Good
120 Cave_Neol3	92			0.5	absolute numbers		structure level		x			Good
120 Cave_Neol2	92			0.5	absolute numbers		structure level		x			Good
Bòbila Madurell_MN/LN	93	hand pick		0.5	absolute numbers		chronological level		x			Poor
Bòbila Madurell_MN	93	hand pick		0.5	absolute numbers		chronological level		x			Satisfactory
Bòbila Madurell_LN	93	hand pick		0.5	absolute numbers		chronological level		x			Satisfactory
Mines of Gavà_4200-3800 BC	94	wet-sieving		no info	absolute numbers		structure level		x			Poor
Mines of Gavà_3200-2800 BC	94	wet-sieving		no info	absolute numbers		structure level		x			Poor
Espina C	95	wet-sieving		0.5	absolute numbers		SU level		x			Good
Pla del Gardelo	96			no info	absolute numbers		SU level		x			Poor
Puig del Collet / El Collet/Collet Puiggròs	97	wet-sieving		no info	absolute numbers		SU level		x			Poor
CIM "El Camp"_unknow	98			no info	absolute numbers		structure level		x			Poor
CIM "El Camp"_EMN	98			no info	absolute numbers		structure level		x			Poor
CIM "El Camp"_LEN	98			no info	absolute numbers		structure level		x			Poor
Pesseta Cave	99			0.5	presence/absence		site level		x			Poor
Camí dels Banys de la Mercè	100			0.5	absolute numbers		site level	Raw data	x			Good
Can Revella (Can Roqueta)	102			0.5	absolute numbers		structure level		x			Poor

Site name	ID	Processing method	Processing method	Mesh (mm)	Type of record	Type of record	Type of publication	Type of publication	Charred	Waterlogged	Imprints	Data quality
Castelnuovo di Teolo	103			unknown	absolute numbers		site level		x			Poor
Auvelles_neo2	104			0.5	unpublished		unpublished	Raw data	x			Poor
Auvelles_Postcardial	104			0.5	unpublished		unpublished	Raw data	x			Poor
Cova del Toll_MN	105			2	unpublished		unpublished	Raw data	x			Poor
Cova del Toll_LN	105			2	absolute numbers		site level		x			Poor
Pou Nou 2	110			0.25	absolute numbers		sample level		x			Good
L' escola Especial Meritxell	112			0.5	absolute numbers		SU level		x			Good
Rivoli Veronese	113			none?	presence/absence		site level		x			Poor
Barbiano	114			none?	presence/absence		site level		x			Poor
Aica di Fiè / Völs am Schlern/Volseraicha	115			none?	presence/absence		site level		x			Poor
Brescia S. Polo	116			Unknown	presence/absence		site level		x			Poor
Tolerait	117			Unknown	presence/absence		site level		x			Poor
Aspre del Paradís_EN	122			0.5	absolute numbers		structure level		x			Good
Aspre del Paradís_LN	122			0.5	absolute numbers		structure level		x			Good
Aulp du Seuil	123			0.5	absolute numbers		structure level		x			Good
Auriac	124			no info	absolute numbers		site level		x			Poor
Auriac-Golf	125			no info	absolute numbers		site level		x			Poor
Balma de l'Abeurador_epicardial	126			0.5	absolute numbers		Cultural phase		x			Satisfactory
Balma de l'Abeurador_Chassenclassic	126			0.5	absolute numbers		Cultural phase		x			Satisfactory
Balma de l'Abeurador_Chassenancien	126			0.5	absolute numbers		Cultural phase		x			Satisfactory
Balma Margineda_5472-4849	127	hand pick		0.5	absolute numbers		sample		x			Good
Balma Margineda_4793-4612	127	hand pick		0.5	absolute numbers		sample		x			Good
Barreau de la Devèze Sud_MN1	128			0.5	absolute numbers		structure level		x			Good
Barreau de la Devèze Sud_MN2	128			0.5	absolute numbers		structure level		x			Good
Barreau de la Devèze Sud_MN	128			0.5	absolute numbers		structure level		x			Good
Baume Bourbon	129			no info	absolute numbers		site level		x			Poor
Baume d'Oullins	130			no info	absolute numbers		site level		x			Poor
Baume Fontbrégoua_Cardial final	131			2	absolute numbers		chronological level		x			Poor
Baume Fontbrégoua_Cardialancien	131			2	absolute numbers		chronological level		x			Poor
Baume Fontbrégoua_Chassee recent	131			2	absolute numbers		chronological level		x			Poor
Baume Fontbrégoua_Chassen ancien	131			2	absolute numbers		chronological level		x			Poor
Baume Fontbrégoua_Pre_Chassen	131			2	absolute numbers		chronological level		x			Poor
Boulevard périphéerique Nord de Lyon_EN	132			mix (0,5)or 1	absolute numbers		chronological level		x			Satisfactory
Boulevard périphérique Nord de Lyon_MN	132			mix (0,5)or 1	absolute numbers		chronological level		x			Satisfactory
Boulevard périphérique Nord de Lyon_campaniforme	132			mix (0,5)or 1	absolute numbers		chronological level		x			Satisfactory
Caucade	134			no info	absolute numbers		site level		x			Poor
Claparouse	136			unknown mesh	absolute numbers		site level		x			Poor
Clos de Roque	137			0.2	absolute numbers		structure level		x	x		Good
Cova de l'Esperit	139			no info	absolute numbers		site level		x			Poor
Encombres	140			0.5	absolute numbers		structure level		x			Good
Font Juvénal_EN	141			no info	absolute numbers		site level		x			Poor
Font Juvénal_MN1	141			no info	absolute numbers	presence/absence	layer level		x			Poor
Font Juvénal_MN2	141			no info	absolute numbers	presence/absence	layer level		x			Poor
Font Juvénal_LN	141			no info	absolute numbers	presence/absence	layer level		x			Poor
Gardon_ENRhodanie	142			0.5	absolute numbers		layer level		x			Good
Gardon_MNSain-UZE	142			0.5	absolute numbers		layer level		x			Good
Grotte de l' Aigle	143			no info	absolute numbers		site level		x			Poor
Grotte de Montou Montbolo_MN	144			0.5	absolute numbers		chronological level		x			Satisfactory
Grotte de Montou Montbolo_LN	144			0.5	absolute numbers		chronological level		x			Satisfactory
Grotte du Taï_Early Neo 1	145			0.4	absolute numbers		chronological level	structure level	x			Good
Grotte du Taï_Early Neo 2	145			0.4	absolute numbers		chronological level	structure level	x			Good
Grotte du Taï_Middle Neolithic	145			0.4	absolute numbers		chronological level	structure level	x			Good
Grotte du Taï_Ferriéres	145			0.4	absolute numbers		chronological level	structure level	x			Good
Grotte du Taï_Fontbouisse	145			0.4	absolute numbers		chronological level	structure level	x			Good
Grotte G	147			no info	absolute numbers		site level		x			Poor
Grotte Gazel_5000	148			Fine	absolute numbers		chronological level		x			Satisfactory
Grotte Gazel_after5000	148			Fine	absolute numbers		chronological level		x			Satisfactory
Grotte Murée	149			no info	absolute numbers		site level		x			Poor
Grotte St Marcel_EN	150			no info	absolute numbers		site level		x			Poor
Grotte St Marcel_MN	150			no info	absolute numbers		layer level		x			Poor
Grotte St Marcel_LN	150			no info	absolute numbers		layer level		x			Poor
Jardins de Vert Parc_chass	151			0.5	absolute numbers		structure level		x			Good
La Grande Rivoire_EN	152			0.5	absolute numbers		sample level		x			Good

Site name	ID	Processing method	Processing method	Mesh (mm)	Type of record	Type of record	Type of publication	Type of publication	Charred	Waterlogged	Imprints	Data quality
La Grande Rivoire_MN1	152			0.5	absolute numbers		sample level		x			Good
La Grande Rivoire_MN2	152			0.5	absolute numbers		sample level		x			Good
La Grande Rivoire_LN	152			0.5	absolute numbers		sample level		x			Good
Clairvaux - La Motte aux Magnins V	153			0.2	absolute numbers		profile level			x		Satisfactory
La Resclauze	156			Coarse	absolute numbers		chronological level		x			Poor
La Roberte	157			unclear	absolute numbers	presence/absence	chronological level		x			Poor
La Salle	158			1	absolute numbers		site level		x			Satisfactory
Le Bousquetas	159			unclear	absolute numbers		structure level		x			Poor
Le Champ du Poste_Chassen ancien	160			unclear	absolute numbers		structure level		x			Poor
Le Champ du Poste_Verazien	160			unclear	absolute numbers		structure level		x			Poor
Le Chenet des Pierres_MN1	161			0.4	absolute numbers		sample level		x			Good
Le Chenet des Pierres_MN2	161			0.4	absolute numbers		sample level		x			Good
Le Crès	162			0.5	absolute numbers		sample level		x			Good
Le Font aux Pigeons	163			unclear	absolute numbers		sample level		x			Poor
Le Lagarel	164			0.5	absolute numbers		site level		x			Satisfactory
Le Logis de Berre	165			no info	absolute numbers		site level		x			Poor
Le Moulin	166			no info	absolute numbers	presence/absence	site level		x			Poor
Le Pirou	167	hand pick		0.5	absolute numbers	presence/absence	site level	structure level	x			Good
Le Puech Haut_LN1	168			0.5	absolute numbers		structure level		x			Good
Le Puech Haut_LN2	168			0.5	absolute numbers		structure level		x			Good
Le Puech Haut_LN3	168			0.5	absolute numbers		structure level		x			Good
Le Rochas	169			no info	presence/absence		site level		x			Poor
Le Serre de Boidon	170			no info	absolute numbers		site level		x			Poor
Le Valladas	171			no info	absolute numbers		structure level		x			Poor
Les Lauzières	174			not used	absolute numbers		per finding		x			Poor
Les Moulins	175			no info	absolute numbers		structure level		x			Poor
Les Plots	176			no info	absolute numbers		site level		x			Poor
Mas de Vignoles IX	177			0.4	absolute numbers		structure level		x	x		Good
Mas de Vignoles X	178			0.5	absolute numbers		SU level		x			Good
Mas Neuf	179			0.5	absolute numbers	presence/absence	SU level		x			Good
Montbeyre-La Cadoule	180			no info	absolute numbers	presence/absence	area level		x			Poor
Moulin de la Garonne	181			no info	absolute numbers		structure level		x			Poor
Mourre de la Barque_Neo2	182			0.5	unpublished		unclear		x			Poor
Mourre de la Barque_Neo3	182			0.5	unpublished		unclear		x			Poor
Peiro Signado	183			Fine	absolute numbers		site level		x			Satisfactory
Pendimoun_Impressa	184			0.5	absolute numbers	missing counts	chronological level		x			Satisfactory
Pendimoun_Cardial	184			0.5	absolute numbers	missing counts	chronological level		x			Satisfactory
Pendimoun_SMP	184			0.5	absolute numbers	missing counts	chronological level		x			Satisfactory
Plateau Raverre	185			no info	absolute numbers		site level		x			Poor
Pont de Roque Haute	186			0.5	absolute numbers		structure level		x			Good
Roc de Dourgne	187			unclear	absolute numbers		structure level		x			Poor
Roquemaure	188			no info	absolute numbers	presence/absence	? SU		x			Poor
St. Martin d'Azirou	191			no info	absolute numbers	presence/absence	site level		x			Poor
Clairvaux XIV	192			0.25	absolute numbers	presence/absence	profile level			x		Satisfactory
Toronde	193			not used	absolute numbers		site level		x			Poor
Vieux-Mounoï	195			no info	absolute numbers		site level		x			Poor
Villa Giribaldi	196			1	absolute numbers	presence/absence	structure level		x			Satisfactory
ZAC Feuilly_ Cardial	197			0.5	absolute numbers		sample level		x			Good
ZAC Feuilly_MNB	197			0.5	absolute numbers		sample level		x			Good
ZAC Saint-Antoine II_preCha4300	198			0.5	absolute numbers		structure level		x			Good
ZAC Saint-Antoine II_4330-4050	198			0.5	absolute numbers		structure level		x			Good
ZAC Saint-Antoine II_4100-3800	198			0.5	absolute numbers		structure level		x			Good
ZAC Saint-Antoine II_MN	198			0.5	absolute numbers		structure level		x			Good
Zürich - AKAD-Seehofstrasse	199			0.25	absolute numbers	presence/absence	sample level		x	x		Good
Zürich - Pressehaus_1_Horgen	200			0.5	presence/absence		profile level		x	x		Poor
Zürich - Pressehaus_2_Schnur	200			0.5	presence/absence		profile level		x	x		Poor
Arbon - Bleiche 3	201			0.5	absolute numbers		site level	Raw data	x	x		Good
Binningen-Friedhofstrasse	202			0.35	absolute numbers		sample level		x			Good
Seeberg - Burgäschisee SW	203			unclear	absolute numbers		unclear		x	x		Poor
Cham -St. Andreas	204			0.5	absolute numbers	presence/absence	sample level		x			Good
Egolzwil 3	205			0.25	absolute numbers		site level	Raw data	x	x		Good
Frasses - Praz au Doux	206			0.25	presence/absence		site level		x	x		Poor
Horgen-Scheller_ Horgen	208			0.5	absolute numbers		layer level		x	x		Good
Horgen-Scheller_Schnur	208			0.5	absolute numbers		layer level		x	x		Good
Kleiner Hafner_Ego	209			0.5	absolute numbers	presence/absence	layer level	Raw data	x	x		Good
Kleiner Hafner_Cort	209			0.5	absolute numbers	presence/absence	layer level	Raw data	x	x		Good
Lattringen - Haupstation (site VII)_Cord	210			0.25	absolute numbers		Cultural phase		x	x		Satisfactory
Lattringen - Haupstation (site VII)_Horg	210			0.25	absolute numbers		Cultural phase		x	x		Satisfactory
Lüscherz - Klein Station, inerdorf_1	211			0.25	absolute numbers		sample level		x	x		Good
Lüscherz - Klein Station, inerdorf_2	211			0.25	absolute numbers		sample level		x	x		Good
Lattringen -Riedstation (site VI)	212			0.25	absolute numbers		Cultural phase		x			Satisfactory
Zürich - Mozartstrasse_Cort	213			0.25	presence/absence		site level		x	x		Poor
Zürich - Mozartstrasse_Pyy1	213			0.25	presence/absence		site level		x	x		Poor
Zürich - Mozartstrasse_Pyy2	213			0.25	presence/absence		site level		x	x		Poor
Zürich - Mozartstrasse_FruheszentralCortaill	213			0.25	presence/absence		site level		x	x		Poor
Zürich - Mozartstrasse_Schnur	213			0.25	presence/absence		site level		x	x		Poor
Zürich - Mozartstrasse_Horgen	213			0.25	presence/absence		site level		x	x		Poor

Site name	ID	Processing method	Processing method	Mesh (mm)	Type of record	Type of record	Type of publication	Type of publication	Charred	Waterlogged	Imprints	Data quality
Mythenschloss_Horgen	214			0.25	presence/absence		site level		x	x		Poor
Mythenschloss_Schnur1	214			0.25	presence/absence		site level		x	x		Poor
Neftenbach_Aspach	215			1	absolute numbers		site level		x	sf?contamination?		Satisfactory
Nidau BKWi or Nidau 'Schlossmatte/ BKW	216			0.25	absolute numbers		site level		x	x		Satisfactory
Seedorf - Lobsigesee	219			0.35	absolute numbers		sample level		x	x		Good
Zürich, Seefeld KanSan_Horg	220			0.25	presence/absence		layer level		x	x		Poor
Zürich, Seefeld KanSan_Schnur	220			0.25	presence/absence		layer level		x	x		Poor
Zürich, Seefeld KanSan_Pfy	220			0.25	presence/absence		layer level		x	x		Poor
Sevelen - Pfäfersbüel	221			0.35	absolute numbers		sample level		x			Good
Stansstad-Kehrsiten_ 4250-3750_Corta	222			0.35	absolute numbers	presence/absence	unclear		x	x		Satisfactory
Stansstad-Kehrsiten_ 3750-3500_Pfyn	222			0.35	absolute numbers	presence/absence	unclear		x	x		Satisfactory
Port - Stüdeli_US_41	223			0.5	absolute numbers		sample level		x	x		Good
Villeneuve-La Baume Abri 1	224	semi-flotation	wash-over	0.35	absolute numbers		layer level		x			Good
Wetzikon, Kempten Tösstalerstr	225			0.35	absolute numbers		layer level		x			Good
Zizers- Friedau	226			0.35	absolute numbers		area level		x			Good
Zug-Riedmatt	227			0.35	densities		sample level		x	x		Poor
Delémont - En la Pran	228			0.5	absolute numbers		sample level		x	x		Good
Bauma del Serrat del Pont_LN	230			0.5	unclear		unclear		x			Poor
Bauma del Serrat del Pont_EN	230			0.5	unclear		unclear		x			Poor
Cova de les Portes	231			0.5	absolute numbers		site level		x			Satisfactory
El Cavet	232			0.5	no info		no info		x			Poor
Les Vautes	233			0.5	absolute numbers		SU level		x			Good
Grotte d' engorner	234			not used	absolute numbers		structure level		x			Poor
Boussargues	235			1	absolute numbers		sample level		x			Satisfactory
Roquessols	236			0.5	absolute numbers		sample/squares?		x			Good
Sion - La Planta	237			0.5	absolute numbers		structure level		x			Good
Sion - Tourbillon_2	238			0.5	absolute numbers		structure level		x			Good
Sion - Tourbillon_1	238			0.5	absolute numbers		structure level		x			Good
Sion- La Gillière 2	239			0.5	absolute numbers		structure level		x			Good
Sion - Ritz 33	240			0.5	absolute numbers		structure level		x			Good
Savièse - La Soie	241			0.5	absolute numbers		Cultural phase		x			Satisfactory
Petit-Chasseur IV_MNI 4500	242			0.5	absolute numbers		sample level		x			Good
Petit-Chasseur IV_'Cortaillod type Petit-Chasseur (4000-3800)	242			0.5	absolute numbers		sample level		x			Good
Saint-Aubin/Derrière la Croix_Cort	244			0.5	absolute numbers		structure level		x			Good
Saint-Aubin/Derrière la Croix_2800-2500	244			0.5	absolute numbers		structure level		x			Good
Concise- Sous Colachoz_ Cortaillod-Moyen	245			0.5	absolute numbers	presence/absence	sample level		x	x		Satisfactory
Zürich - Parkhaus Opera_Horgen	246			0.35	absolute numbers		layer level		x			Good
Gachnang, Niederwil	247			0.2	absolute numbers		sample level		x	x		Good
Yverdon- Avenue des Sports_Weber	248			no info	absolute numbers		site level		x	x		Poor
Yverdon- Avenue des Sports_Schilichtherle	248			1	absolute numbers	presence/absence	site level		x	x		Satisfactory
Auvernier	249			no info	presence/absence		site level		no info	no info		Poor
Saint-Blaise/Bains des Dames 4_Horgen	250			0.2	absolute numbers		sample level		x	x		Satisfactory
Saint-Blaise/Bains des Dames 4_Auvernier-Cordé ancien	250			0.2	absolute numbers		sample level		x	x		Satisfactory
Saint-Blaise/Bains des Dames 4_Auvernier-Cordé	250			0.2	absolute numbers		sample level		x	x		Satisfactory
Saint-Blaise/Bains des Dames 4_Auvernier-Cordé moyen	250			0.2	absolute numbers		sample level		x	x		Satisfactory
Saint-Blaise/Bains des Dames 4_Auvernier-Lüscherz	250			0.2	absolute numbers		sample level		x	x		Good
Twann_Cortaillod	251			0.25	absolute numbers		chronological level		x	x		Satisfactory
Twann_Middle Horgen	251			0.25	absolute numbers		chronological level		x	x		Satisfactory
Les Bagnoles_MN1	252			0.35	absolute numbers		structure level			x		Good
Les Bagnoles_MN2	252			0.35	absolute numbers		structure level			x		Good
Trou Arnaud	253			no info	percentage		site level		x			Poor
La Cavalade_LN2	254			0.5	absolute numbers		sample level		x			Good

Site name	ID	Processing method	Processing method	Mesh (mm)	Type of record	Type of record	Type of publication	Type of publication	Charred	Waterlogged	Imprints	Data quality
La Cavalade_LN3	254			0.5	absolute numbers		sample level		x			Good
Balmes_LN1	255	flotation		0.5	absolute numbers		sample level		x			Good
Balmes_MN2/LN1	255	flotation		0.5	absolute numbers		sample level		x			Poor
Clairvaux VII	256			0.3	absolute numbers		profile level	sample level		x		Good
Chalain 19	257			0.25	absolute numbers		sample level			x		Good
Clairvaux III	258			0.2	absolute numbers		profile level			x		Satisfactory
Clairvaux II	259			no info	absolute numbers		layer level			x		Poor
L'Héritière Cazan	260			0.5	presence/absence		structure level		x			Poor
Spilamberto S. Cesario Sito I	266			0.5	absolute numbers		structure level		x			Good
Spilamberto S. Cesario Sito VIII	266			0.5	absolute numbers		SU level		x			Good
ZAC Les Chalus II Lot 1	267			0.5	no detail about the species		no detail about the species		x			Poor
Route de Canohès Lotissement « Le Petit Prince »	268			0.5	preliminar not seen by specialist		preliminar not seen by speciallist		x			Poor
Jonquiere I	271			0.5	absolute numbers	presence/absence	structure level		x			Good
L' aéropole Tallard	272			0.5	absolute numbers		SU level		x			Good
Cepie_MN	273			0.5	absolute numbers		structure level		x			Good
Cepie_LN	273			0.5	absolute numbers		structure level		x			Good
509 avenue des Noyers	274			0.5	absolute numbers		SU level		x			Good
Trets ZAC la Burlière	275			0.5	absolute numbers		structure level		x			Good
Quincieux Grange Rouge_MN	276			0.5	absolute numbers		sample level		x			Good
Quincieux Grange Rouge_LN	276			0.5	absolute numbers		sample level		x			Good
Lattes Port-Ariane III_MN	277			0.5	absolute numbers		structure level		x			Good
Lattes Port-Ariane III_LN	277			0.5	absolute numbers		structure level		x			Good
Chens-sur-Léman Pré dAncy	278			0.5	no seeds found		no seeds found		x			Good
Clos Roque Route de Barjols MN2	279			0.5	absolute numbers		sample level		x			Good
Clos Roque Route de Barjols LN	279			0.5	absolute numbers		sample level		x			Good
Clos Roque Route de Barjols MN2/LN	279			0.5	absolute numbers		sample level		x			Poor
Gap Lachaup	280			0.5	not analysed		not analysed		x			Poor
A8 Rousset_Le Plan	281			0.5	absolute numbers		SU level		x			Good
Velaux, La Bastide Neuve III	282			0.5	absolute numbers		structure level		x			Good
Le site néolithique final de Ponteau_PH2	283	dry-sieving		0.3	absolute numbers		phase level		x			Satisfactory
Le site néolithique final de Ponteau_PH3	283	dry-sieving		0.3	absolute numbers		phase level		x			Satisfactory
Le site néolithique final de Ponteau_PH4	283	dry-sieving		0.3	absolute numbers		phase level		x			Satisfactory
Charavines - Les Baigneurs	284			0.5	absolute numbers		profile level?			x		Satisfactory
Brise-Lames	285			0.2	absolute numbers		profile level		x	x		Satisfactory
Pfyn-Breitenloo	286			unclear	absolute numbers		site level		x	x		Poor
Clairvaux VIII	287			0.5	absolute numbers		site level			x		Satisfactory
Cova de la Colomera	288			unclear	absolute numbers		structure level		x			Poor
La serreta_NACardial	289			0.5	absolute numbers		SU level		x			Good
La serreta_NAE	289			0.5	absolute numbers		SU level		x			Good
La serreta_MN	289			0.5	absolute numbers		SU level		x			Good
La serreta_LN	289			0.5	absolute numbers		SU level		x			Good
Chalain 3 (layer VIII)	291			0.25	absolute numbers		sample level			x		Good
Alleins Quartier Sainte-Anne	293			0.5	absolute numbers		structure level		x			Good
20 rue Fodéré, Villa Lympia	294	water-screening		1	absolute numbers		SU level		x			Satisfactory
ZAC de la Farigoule	295			0.4	absolute numbers		structure level		x			Good
Mittelhoetzleinfeld	296			0.35	absolute numbers		structure level		x			Good
Florival	297			0.315	absolute numbers		structure level		x			Good
Bergheim, Haut-Rhin, « Saulager » , zone d'activité du Muehlbach	301			0.315	absolute numbers		structure level		x			Good
Didenheim Kahlberg	302			0.315	sterile		sterile		x			Poor
Burgäschisee Süd	303			0.5	unclear		site level		x	x		Satisfactory
Sutz- Rütte V	306			0.35	absolute numbers	proportions	site level		x	x		Satisfactory
Biel-Vingelz	307			0.35	absolute numbers	proportions	site level		x	x		Satisfactory
Pfäffikon- Burg	308			0.5			site level	unclear	x	x		Satisfactory
Auvernier/La Saunerie_Lüschers	309			0.5	range		sample level		x	x		Poor
Auvernier/La Saunerie_Auvernier	309			0.5	range		sample level		x	x		Poor
Auvernier/La Saunerie	309			0.5	range		sample level		x	x		Poor
Burgäschisee Nord	311			0.35	unclear		unclear		x	x		Poor
Petit Ruz_MN_Neol2	313			0.5	absolute numbers		structure level		x			Good
Petit Ruz_LN_Neol5	313			0.5	absolute numbers		structure level		x			Good
Sur les Rochettes Est_Glockenb	314			0.5	absolute numbers		structure level		x			Good
Les Tilles_MN	315			0.5	absolute numbers		structure level		x			Good
Les Tilles_2800-2500	315			0.5	absolute numbers		structure level		x			Good
Treytel_EN	316			0.5	absolute numbers		sample level		x			Good
Treytel_MN	316			0.5	absolute numbers		sample level		x			Good
Treytel_Cort_ancien	316			0.5	absolute numbers		sample level		x			Good
Treytel_Cort_classi	316			0.5	absolute numbers		sample level		x			Good
Treytel_LN	316			0.5	absolute numbers		sample level		x			Good
Entzheim « Les Terres de la Chapelle » (Bas-Rhin)	317			no info	sterile		sterile		steril			Poor
Entzheim	318			no info	absolute numbers		no info		x			Poor
Grotte Antonnaire	319			no info	absolute numbers		per finding		x			Poor

Site name	ID	Processing method	Processing method	Mesh (mm)	Type of record	Type of record	Type of publication	Type of publication	Charred	Waterlogged	Imprints	Data quality
Teuleria dels Àlbers-1	320			0.5	absolute numbers		structure level		x			Good
Zal del Port de Tarragona_MN	322			0.5	absolute numbers		structure level		x			Good
Zal del Port de Tarragona_Neo	322			0.5	absolute numbers		structure level		x			Poor
Cinc Ponts	323			0.5	absolute numbers		SU level		x			Good
Mas Pujó	324			0.5	absolute numbers		SU level		x			Good
Mas d'en Boixos	325			0.5	absolute numbers		structure level		x			Good
Thayngen Weier	326			0.4	absolute numbers	range	profile level		x	x		Satisfactory
Thayngen Weier_Profile III	326			0.4	absolute numbers		profile level		x	x		Satisfactory
Zurich Oberrieden	327			unclear	estimate		site level		x			Poor
Zug Vorstadt 26	328			0.2	absolute numbers		sample level		x			Good
Grand Pré	329			0.5	presence/absence		structure level		x	x		Poor
Les Maladières_Cort_ancien	330			0.5	absolute numbers		sample level		x			Good
Les Maladières_Cort_classic	330			0.5	absolute numbers		sample level		x			Good
Les Maladières_MN	330			0.5	absolute numbers		sample level		x			Good
Les Maladières_camp	330			0.5	absolute numbers		sample level		x			Good
Les Maladières_Horgen	330			0.5	absolute numbers		sample level		x			Good
Les Pâquiers_Cortaillod Classique	331			0.5	absolute numbers		structure level		x			Good
Les Pâquiers_Cortaillod tardif/Port-Conty	331			0.5	absolute numbers		structure level		x			Good
Place d'Armes	332			0.5	unclear		unclear		x			Poor
Champs Devant_MNI	333			0.5	absolute numbers		structure level		x			Good
Champs Devant_MN2	333			0.5	absolute numbers		structure level		x			Good
Steckborn, Schanz	334			0.25	absolute numbers		site level		x	x		Poor
Oberbipp Steingasse	336			0.35	absolute numbers		sample level		x			Poor
Reinach Fleischbachstrasse	339			unknown	absolute numbers		structure level		x			Poor
Aux Courbes Rayes	342			0.5	absolute numbers		sample level		x			Good
Bataillard	343			0.5	presence/absence		structure level		x			Poor
Chézard-Littorail_Cort	344			0.5	absolute numbers		sample level		x			Good
Chézard-Littorail_Lüs	344			0.5	absolute numbers		sample level		x			Good
Chézard-Littorail_auver	344			0.5	absolute numbers		sample level		x			Good
Les Buchilles	345			0.5	absolute numbers		sample level		x			Good
Aux Buchilles	346			0.5	absolute numbers		sample level		x			Good
Müstair_ Sondierbohrung Joos	347			unclear	absolute numbers		profile level		x	x		Poor
Baar Früebergstrasse	348			0.25	absolute numbers		layer level		x			Good
Zug Vorstadt	349			0.2	absolute numbers		layer level		x	x		Good
Clos de Roque - Chemin de Barjols_MN	353			0.5	absolute numbers		structure level		x			Good
Clos de Roque - Chemin de Barjols_LN	353			0.5	absolute numbers		structure level		x			Good
La Vella II & III	354			0.5	absolute numbers		site level		x			Poor
La Vella III	354			0.5	absolute numbers		site level		x			Satisfactory

*Carugari 1993

Appendix D: Les Bagnoles

This Appendix shows the archaeobotanical results of the Les Bagnoles site. Table 1 Archaeobotanical data from well 990 and Table 2 from well 994.

Jesus, A 2022_Crop dynamics in the NW Mediterranean area and the Swiss Plateau ~The role of opium poppy (*P. somniferum/setigerum*)

Appendix D: Archaeobotanical results from well 990
Chapter 5. The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal BC)

Les Bagnoles: Well 990 Raw data				Samples	Pr18	Pr20	Pr21	Dry_sum	sum/litre	Dry	% frequency per sample	Pr68	Pr69	Pr25	Pr70	Pr71	Pr26	Pr72	Pr73	Pr74	Pr28	wet_sum	sum/litre	wet	% frequency per sample
				Vol.	0.5	0.5	0.9	5	1.9			8	7	0.9	9	7	0.4	8	9	9	0.4	18742	**58.70**		
Taxon	**Habitat group**	**Plant remains**	**Preservation**																						
Grains										3															
Hordeum distichon/vulgare	cultivated	grain	ch									1	2		9	4		12		4		32	0.54	6	60%
Triticum aestivum /durum/turgidum	cultivated	grain	ch											1	4	4		3		1		13	0.22	5	50%
Triticum monococcum/dicoccum	cultivated	grain	ch												1							1	0.02	1	10%
Triticum sp.	cultivated	grain	ch										1	1								2	0.03	2	20%
Cerealia indet.	cultivated	grain	ch												3					2		5	0.08	2	20%
Cerealia indet.	cultivated	Testa	un										2	6	9	30	1			2	2	52	0.88	7	70%
Other crops																									
Linum usitatissimum	cultivated	seed	un										5	2	4	12			4	8	1	36	0.61	7	70%
Linum usitatissimum	cultivated	capsule	un											2	14	10	1	1	3	2	1	34	0.58	8	80%
Linum usitatissimum	cultivated	capsule dent	ch													1	1					2	0.03	2	20%
Linum usitatissimum	cultivated	capsule dent	un										8	14	43	63	1	23	7	6	2	167	2.83	9	90%
Papaver somniferum	cultivated	seed	un										3	1	3	2	2	5	6	1	1	24	0.41	9	90%
Pisum sativum	cultivated	seed	un										4			100						104	1.76	2	20%
Pisum sativum	cultivated	seed/fruit	un																	1		1	0.02	1	10%
Pisum sativum	cultivated	stalk	un													2						2	0.03	1	10%
Pisum sativum	cultivated	hilum	un													1						1	0.02	1	10%
Chaff																									
Hordeum distichon/vulgare	cultivated	rachis segment	ch									1	18	9	56	105	8	19		50	1	267	4.53	9	90%
Hordeum distichon/vulgare	cultivated	rachis segment	un									1	58	37	340	884	12	109	32	981	8	2462	41.73	10	100%
Hordeum vulgare undiff.	cultivated	rachis segment	ch																15			15	0.25	1	10%
Hordeum vulgare undiff.	cultivated	rachis segment	un																104			104	1.76	1	10%
Triticum aestivum /durum/turgidum	cultivated	rachis segment	ch										27	2	43	1	2	1	17		3	96	1.63	8	80%
Triticum aestivum /durum/turgidum	cultivated	rachis segment	un										156	175		26	35	4	156	24	10	586	9.93	8	80%
Triticum cf. *aestivum*	cultivated	rachis segment	ch									1		5								6	0.10	2	20%
Triticum cf. aestivum	cultivated	rachis segment	un											4								4	0.07	1	10%
Triticum durum/turgidum	cultivated	rachis segment	un												362	1738		166		9		2275	38.56	4	40%
Triticum cf. *durum/turgidum*	cultivated	rachis segment	ch													95		12		68		175	2.97	3	30%
Triticum cf. *durum/turgidum*	cultivated	rachis segment	un												1					736		737	12.49	2	20%
Triticum dicoccum	cultivated	glume base	ch										3	1	6	3		1		7		21	0.36	6	60%
Triticum dicoccum	cultivated	glume base	un										13	2	117	21	10	24	67	447	5	706	11.97	9	90%
Triticum cf. *dicoccum*	cultivated	glume base	un												13							13	0.22	1	10%
Triticum monococcum	cultivated	glume base	ch				2	2	1.053	1	33%			1	8	3		1		4		17	0.29	5	50%
Triticum monococcum	cultivated	glume base	un										21		14	28	2	24	9	190		288	4.88	7	70%
Triticum spelta	cultivated	rachis segment	ch																4			4	0.07	1	10%
Triticum spelta	cultivated	rachis segment	un																2			2	0.03	1	10%
Triticum timopheevii	cultivated	glume base	ch										10		1	2				8		21	0.36	4	40%
Triticum timopheevii	cultivated	glume base	un										2									2	0.03	1	10%
Triticum monococcum/dicoccum	cultivated	glume base	ch																	1		1	0.02	1	10%
Triticum monococcum/dicoccum	cultivated	glume base	un												12	2				92		106	1.80	3	30%
Triticum sp.	cultivated	glume	ch											1		4						5	0.08	2	20%
Triticum sp.	cultivated	glume	un										16	29								45	0.76	2	20%
Cerealia indet.	cultivated	base of the ear	ch												4					1		5	0.08	2	20%
Cerealia indet.	cultivated	base of the ear	un										1			3		4		1		9	0.15	4	40%
Cerealia indet.	cultivated	glume	ch		1		1	2	1.053	2	67%	2	1	73	14	3			15		2	110	1.86	7	70%
Cerealia indet.	cultivated	glume	un										8	229	136	202	15	115	199	532	6	1442	24.44	9	90%
Cerealia indet.	cultivated	rachis segment	un											3		1				10		14	0.24	3	30%
Cerealia indet.	cultivated	culm node	ch												7					3		10	0.17	2	20%
Cerealia indet.	cultivated	culm node	un													1		1				2	0.03	2	20%
Other plants																									
Abies sp.	no group	leaf/needle	un													3						3	0.05	1	10%
Achillea sp.	Varia	seed/fruit	un														1					1	0.02	1	10%
Adonis sp.	winter crop annual weeds	seed/fruit	un													2		2	1	4		9	0.15	4	40%
Aethusa cynapium	*summer crop annual weeds, annual ruderals*	seed/fruit	un													12						12	0.20	1	10%
Agrimonia eupatoria	*woodland clearing edges*	seed/fruit	un													1						1	0.02	1	10%
Agrimonia sp.	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un												3					1		4	0.07	2	20%

Appendix D: Archaeobotanical results from well 990
Chapter 5. The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal BC)

Les Bagnoles: Well 990 Raw data				Samples	Pr18	Pr20	Pr21	Dry_sum	sum/litre	Dry	% frequency per sample	Pr68	Pr69	Pr25	Pr70	Pr71	Pr26	Pr72	Pr73	Pr74	Pr28	wet_sum	sum/litre	wet	% frequency per sample
				Vol.	0.5	0.5	0.9	5	1.9			8	7	0.9	9	7	0.4	8	9	9	0.4	18742	**58.70**		
Taxon	**Habitat group**	**Plant remains**	**Preservation**																						
Ajuga chamaepitys	*winter crop annual weeds*	seed/fruit	un											2	2				1	2		7	0.12	4	40%
Ajuga sp.	Varia	seed/fruit	un																1			1	0.02	1	10%
Alisma cf. *plantago-aquatica*	reed-swamp and carr vegetation	seed/fruit	un									1		28	3	14	3	7		9		65	1.10	7	70%
Alisma plantago-aquatica	*reed-swamp and carr vegetation*	seed/fruit	un												3		1				6	10	0.17	3	30%
Alisma sp.	reed-swamp and carr vegetation	seed/fruit	un														1		35			36	0.61	2	20%
Amaranthaceae	summer crop annual weeds, annual ruderals	seed/fruit	un											6								6	0.10	1	10%
Anagallis sp.	summer crop annual weeds, annual ruderals	seed/fruit	un												3							3	0.05	1	10%
Anethum graveolens	*cultivated and imported taxa*	seed/fruit	un																	1		1	0.02	1	10%
Anthriscus sylvestris	*grassland vegetation*	seed/fruit	un																1			1	0.02	1	10%
Apiaceae	*Varia*	seed/fruit	un										3			2	1		5	1		12	0.20	5	50%
Apium cf. *nodiflorum*	bank / floodplain vegetation	seed/fruit	un														1					1	0.02	1	10%
Apium graveolens	*cultivated and imported taxa*	seed/fruit	un														1		2			3	0.05	2	20%
Arctium sp.	perennial ruderals	flower	un										1									1	0.02	1	10%
Arenaria serpyllifolia agg.	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un											4		2	2	28		4	1	41	0.69	6	60%
Asteraceae	Varia	seed/fruit	ch											1			1					2	0.03	2	20%
Asteraceae	Varia	flower	un											4	1				34		1	40	0.68	4	40%
Asteraceae	Varia	seed/fruit	un												13				3	2		18	0.31	3	30%
Asteraceae	Varia	other	un																1			1	0.02	1	10%
Atriplex sp.	summer crop annual weeds, annual ruderals	seed/fruit	un											1	4	1						6	0.10	3	30%
Avena sp.	*winter crop annual weeds*	awn	ch															1		1		2	0.03	2	20%
Avena sp.	*winter crop annual weeds*	seed/fruit	ch												2							2	0.03	1	10%
Brassicaceae	Varia	seed/fruit	un											2					60			62	1.05	2	20%
Bromus sp.	*Varia*	seed/fruit	ch													1						1	0.02	1	10%
Bupleurum sp.	no group	seed/fruit	un													3		3	1	1		8	0.14	4	40%
Calamagrostis cf. *canescens*	*Deciduous forests / bushes*	seed/fruit	ch													1						1	0.02	1	10%
Capsella sp.	summer crop annual weeds, annual ruderals	seed/fruit	un										1									1	0.02	1	10%
Carex sp.	wetland plants various	seed/fruit	un																400			400	6.78	1	10%
Carex sp.	wetland plants various	unknown	un																1			1	0.02	1	10%
Carex sp. bicarpellat	wetland plants various	seed/fruit	ch												1	4			1			6	0.10	3	30%
Carex sp. bicarpellat	wetland plants various	seed/fruit	un										18		15	57	4	7	19	34	3	157	2.66	8	80%
Carex sp. tricarpellat	wetland plants various	seed/fruit	ch											1						2		3	0.05	2	20%
Carex sp. tricarpellat	wetland plants various	seed/fruit	un										22	11	29	34		14	22	18	4	154	2.61	8	80%
Carthamus cf. *lanatus*	*summer crop annual weeds, annual ruderals*	seed/fruit	ch										1									1	0.02	1	10%
Carthamus cf. *lanatus*	*summer crop annual weeds, annual ruderals*	seed/fruit	un										5	1								6	0.10	2	20%
Carthamus lanatus	*summer crop annual weeds, annual ruderals*	seed/fruit	un												12					2		14	0.24	2	20%
Carthamus sp.	*summer crop annual weeds, annual ruderals*	seed/fruit	un										1									1	0.02	1	10%
Caryophyllaceae	Varia	seed/fruit	un											2					44			46	0.78	2	20%
Centaurea sp.	grassland vegetation	seed/fruit	un												2	2						4	0.07	2	20%
Cerastium sp.	Varia	seed/fruit	un																2			2	0.03	1	10%
cf. Chenopodiaceae	summer crop annual weeds, annual ruderals	seed/fruit	un			1		1	0.526	1	33%												0.00	0	0%
cf. *Abies alba*	deciduous forest deciduous mesophilic (incl.abies) (med-mont)	leaf/needle	un											1								1	0.02	1	10%
cf. *Ajuga* sp.	Varia	seed/fruit	un																1			1	0.02	1	10%
cf. *Androsace maxima*	winter crop annual weeds	seed/fruit	un											3								3	0.05	1	10%
cf. *Apium graveolens*	cultivated and imported taxa	seed/fruit	un																	1		1	0.02	1	10%
cf. *Bupleurum* sp.	no group	seed/fruit	un																	1		1	0.02	1	10%
cf. *Capsella* sp.	summer crop annual weeds, annual ruderals	seed/fruit	un													1		20		1		22	0.37	3	30%
cf. *Carthamus* sp.	summer crop annual weeds, annual ruderals	seed/fruit	un																4			4	0.07	1	10%
cf. *Fallopia convolvulus*	winter crop annual weeds	seed/fruit	ch														1					1	0.02	1	10%
cf. *Filipendula* sp.	no group	seed/fruit	un														2					2	0.03	1	10%
cf. *Fragaria vesca*	floodplain / quarry forest including damp herb edges	seed/fruit	ch														1					1	0.02	1	10%
cf. *Ranunculus* sp.	Varia	seed/fruit	un											1								1	0.02	1	10%
cf. *Veronica* sp.	Varia	seed/fruit	un																	1		1	0.02	1	10%
Chara sp.	aquatic plants	oogonium	un										1									1	0.02	1	10%
Chenopodiaceae	summer crop annual weeds, annual ruderals	seed/fruit	un									3	5			31		22	36	2		99	1.68	6	60%
Chenopodium album	*summer crop annual weeds, annual ruderals*	seed/fruit	un									1							178			179	3.03	2	20%
Chenopodium cf. *album*	summer crop annual weeds, annual ruderals	seed/fruit	un									3	87	91	101	46	17	79		54	16	494	8.37	9	90%
Chenopodium sp.	summer crop annual weeds, annual ruderals	seed/fruit	un														1					1	0.02	1	10%
Cichorium sp.	perennial ruderals	seed/fruit	un																1			1	0.02	1	10%
Cirsium arvense	*summer crop annual weeds, annual ruderals*	seed/fruit	un													14				6		20	0.34	2	20%
Cirsium/Carduus	*perennial ruderals*	seed/fruit	un										3		1	16		4	3	3		30	0.51	6	60%

Appendix D: Archaeobotanical results from well 990
Chapter 5. The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal BC)

Taxon	Habitat group	Plant remains	Preservation	Samples	Pr18	Pr20	Pr21	Dry_sum	sum/litre	Dry	% frequency per sample	Pr68	Pr69	Pr25	Pr70	Pr71	Pr26	Pr72	Pr73	Pr74	Pr28	wet_sum	sum/litre	wet	% frequency per sample
Les Bagnoles: Well 990 Raw data				**Vol.**	0.5	0.5	0.9	5	1.9			8	7	0.9	9	7	0.4	8	9	9	0.4	18742	**58.70**		
Cladium mariscus	*reed-swamp and carr vegetation*	seed/fruit	un										2		1	2				1		6	0.10	4	40%
Coronopus squamatus	*Grassland vegetation*	seed/fruit	un													1						1	0.02	1	10%
Corylus avellana	*floodplain / quarry forest including damp herb edges*	seed/fruit	ch																	1		1	0.02	1	10%
Corylus avellana	*floodplain / quarry forest including damp herb edges*	seed/fruit	un													1		1				2	0.03	2	20%
Crepis sp.	Varia	seed/fruit	un													1						1	0.02	1	10%
Cupressus sp.	*no group*	leaf/needle	ch													1						1	0.02	1	10%
Cyperaceae	Varia	seed/fruit	ch																1			1	0.02	1	10%
Cyperaceae	Varia	seed/fruit	un											14	3	16		39	3			75	1.27	5	50%
Cyperus fuscus/Scirpus sylvaticus	*shore line pioneers*	seed/fruit	un											1								1	0.02	1	10%
Cyperus sp.	*shore line pioneers*	seed/fruit	un												1	3					1	5	0.08	3	30%
Cyperus/Scirpus	*shore line pioneers*	seed/fruit	un																3	3		6	0.10	2	20%
Daucus carota	*perennial ruderals*	seed/fruit	un										2	2			2		3	3		12	0.20	5	50%
Dianthus sp.	grassland vegetation	seed/fruit	un																1			1	0.02	1	10%
Dipsacus laciniatus	*floodplain / quarry forest including damp herb edges*	seed/fruit	un										1	1								2	0.03	2	20%
Eleocharis palustris agg.	reed-swamp and carr vegetation	seed/fruit	un														2		3			5	0.08	2	20%
Eleocharis cf. *palustris* agg.	reed-swamp and carr vegetation	seed/fruit	un											2								2	0.03	1	10%
Eleocharis ovata/uniglumis	reed-swamp and carr vegetation	seed/fruit	ch										1									1	0.02	1	10%
Eleocharis ovata/uniglumis	reed-swamp and carr vegetation	seed/fruit	un										40	3		27		32	40	1		143	2.42	6	60%
Euphorbia falcata	*winter crop annual weeds*	seed/fruit	un																1			1	0.02	1	10%
Euphorbia helioscopia	*summer crop annual weeds, annual ruderals*	seed/fruit	un									1	4	2	12	4		1	4	11		39	0.66	8	80%
Euphorbia sp.	Varia	seed/fruit	un															1		1		2	0.03	2	20%
Fabaceae	Varia	whole fruit	ch													1						1	0.02	1	10%
Fabaceae	Varia	whole fruit	un												18	26	1	18		13	1	77	1.31	6	60%
Fabaceae	Varia	hilum	un														1					1	0.02	1	10%
Fabaceae	Varia	stalk	un																	3		3	0.05	1	10%
Fabaceae Trifolium -Typ	*grassland vegetation*	seed/fruit	ch																	1		1	0.02	1	10%
Fallopia convolvulus	*winter crop annual weeds*	seed/fruit	un										15	8	9	30	1	14	414	27		518	8.78	8	80%
Festuca/Lolium	*grassland vegetation*	seed/fruit	ch																	1		1	0.02	1	10%
Filipendula sp.	no group	seed/fruit	un																2			2	0.03	1	10%
Filipendula ulmaria	*wet grassland vegetation*	seed/fruit	un											1	1							2	0.03	2	20%
Fragaria sp.	*floodplain / quarry forest including damp herb edges*	seed/fruit	un												21		7	21		1	16	66	1.12	5	50%
Fragaria vesca	*floodplain / quarry forest including damp herb edges*	seed/fruit	un									1		1		2				2		6	0.10	4	40%
Fragaria/Potentilla	*grassland vegetation*	seed/fruit	un															1				1	0.02	1	10%
Fumaria sp.	*summer crop annual weeds, annual ruderals*	seed/fruit	ch													3			1		1	5	0.08	3	30%
Fumaria sp.	*summer crop annual weeds, annual ruderals*	seed/fruit	un									22	122	24	203	140	10	117	491	240	7	1376	23.32	10	100%
Galeopsis sp.	summer crop annual weeds, annual ruderals	seed/fruit	un										1									1	0.02	1	10%
Galium aparine	*winter crop annual weeds*	seed/fruit	ch										1		1							2	0.03	2	20%
Galium cf. *aparine*	*winter crop annual weeds*	seed/fruit	un													1						1	0.02	1	10%
Galium sp.	Varia	seed/fruit	un												2			1				3	0.05	2	20%
Heliotropium europaeum	*summer crop annual weeds, annual ruderals*	seed/fruit	un									3	3	1	1	1		1	1	2		13	0.22	8	80%
Hordeum cf. *murinum*	*summer crop annual weeds, annual ruderals*	rachis segment	ch										2				1					3	0.05	2	20%
Hordeum cf. *murinum*	*summer crop annual weeds, annual ruderals*	seed/fruit	un													34						34	0.58	1	10%
Hordeum cf. *murinum*	*summer crop annual weeds, annual ruderals*	rachis segment	un										3		3	28	1	15		32	1	83	1.41	7	70%
Hordeum murinum	*summer crop annual weeds, annual ruderals*	rachis segment	un												1				1			2	0.03	2	20%
Hyoscyamus niger	*perennial ruderals*	seed/fruit	un										1		5	2		1	1	2		12	0.20	6	60%
cf. *Juncus* sp.	wetland plants various	seed/fruit	un											5								5	0.08	1	10%
Juncus sp.	wetland plants various	seed/fruit	un										1	2	1	24	2	24	68	1	1	124	2.10	9	90%
Lactuca cf. *serriola*	*perennial ruderals*	seed/fruit	un																	3		3	0.05	1	10%
Lactuca serriola	*perennial ruderals*	seed/fruit	un										1									1	0.02	1	10%
Lactuca sp.	Ruderal vegetation	seed/fruit	un													1						1	0.02	1	10%
Lamiaceae	Varia	seed/fruit	un										1		7	1		2		1	1	13	0.22	6	60%
Lamium sp.	Varia	seed/fruit	un									2	2			11		2	3	6		26	0.44	6	60%
Lychnis/Silene	*grassland vegetation*	seed/fruit	un																20			20	0.34	1	10%
Lycopus europaeus	*reed-swamp and carr vegetation*	seed/fruit	un										2	1	4	3		1	3	2		16	0.27	7	70%
Lythrum sp.	wet grassland vegetation	seed/fruit	un													1						1	0.02	1	10%
Malus/Pyrus	*floodplain / quarry forest including damp herb edges*	pulp	ch																	1		1	0.02	1	10%
Malus/Pyrus	*floodplain / quarry forest including damp herb edges*	pericarp	un															1		2		3	0.05	2	20%
Malus/Pyrus	*floodplain / quarry forest including damp herb edges*	seed/fruit	un												1							1	0.02	1	10%
Malva alcea	*perennial ruderals*	seed/fruit	un										2			1						3	0.05	2	20%
Malva cf. *alcea*	perennial ruderals	seed/fruit	un											7	24	14	6				3	54	0.92	5	50%
Malva sp.	*summer crop annual weeds, annual ruderals*	seed/fruit	ch												1							1	0.02	1	10%
Malva sp.	*summer crop annual weeds, annual ruderals*	seed/fruit	un										5	2	1				4	2		14	0.24	5	50%

Appendix D: Archaeobotanical results from well 990
Chapter 5. The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal BC)

Les Bagnoles: Well 990 Raw data

Taxon	Habitat group	Plant remains	Preservation	Samples	Pr18	Pr20	Pr21	Dry_sum	sum/litre	Dry	% frequency per sample	Pr68	Pr69	Pr25	Pr70	Pr71	Pr26	Pr72	Pr73	Pr74	Pr28	wet_sum	sum/litre	wet	% frequency per sample
				Vol.	0.5	0.5	0.9	5	1.9			8	7	0.9	9	7	0.4	8	9	9	0.4	18742	**58.70**		
Malva sylvestris	*summer crop annual weeds, annual ruderals*	seed/fruit	un										1	3		1			6			11	0.19	4	40%
Malvaceae	no group	seed/fruit	un															2				2	0.03	1	10%
Medicago minima	*Grassland, xerophilic (steppe / dry grassland "Garigue")*	whole fruit	un									1	1		3	2				1		8	0.14	5	50%
Medicago minima	*Grassland, xerophilic (steppe / dry grassland "Garigue")*	seed/fruit	un													10				1		11	0.19	2	20%
Medicago sp.	*Grassland, xerophilic (steppe / dry grassland "Garigue")*	unknown	un																4			4	0.07	1	10%
Mentha aquatica/arvensis	*wetland plants various*	seed/fruit	un												1		1			1		3	0.05	3	30%
Mentha sp.	Varia	seed/fruit	un												1							1	0.02	1	10%
Neslia sp.	winter crop annual weeds	seed/fruit	un												9							9	0.15	1	10%
Onopordum acanthium	*perennial ruderals*	seed/fruit	un									1	8	1	11	12	2	1	4	10		50	0.85	9	90%
Origanum vulgare	*Evergreen hardwood forest including medit. Pine stocks*	seed/fruit	un											2								2	0.03	1	10%
Panicoideae	Varia	seed/fruit	un														1	1				2	0.03	2	20%
Pastinaca sativa	*perennial ruderals*	seed/fruit	un													3		1		2		6	0.10	3	30%
Pastinaca sp.	no group	seed/fruit	un												1							1	0.02	1	10%
Petrorhagia prolifera	*Grassland, xerophilic (steppe / dry grassland "Garigue")*	seed/fruit	un												2		1					3	0.05	2	20%
Petrorhagia sp.	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un										1									1	0.02	1	10%
Physalis alkekengi	*floodplain / quarry forest including damp herb edges*	seed/fruit	un											1	4	1				6		12	0.20	4	40%
Picris hieracioides	*Grassland, xerophilic (steppe / dry grassland "Garigue")*	seed/fruit	un																	4		4	0.07	1	10%
Plantago cf. *lanceolata*	grassland vegetation	seed/fruit	un														1					1	0.02	1	10%
Plantago lanceolata	*grassland vegetation*	seed/fruit	un																	2		2	0.03	1	10%
Plantago major	*perennial ruderals*	seed/fruit	un										2	33	24	21	2		20	2		104	1.76	7	70%
Plantago sp.	grassland vegetation	seed/fruit	un																		1	1	0.02	1	10%
Poaceae	Varia	whole fruit	ch											4	1	10			1		1	17	0.29	5	50%
Poaceae	Varia	glume	ch															1				1	0.02	1	10%
Poaceae	Varia	seed/fruit	ch										1		20	3		3		2		29	0.49	5	50%
Poaceae	Varia	whole fruit	un										4	1	12	58	4	44	20	157	3	303	5.14	9	90%
Poaceae	Varia	seed/fruit	un									2	172	63	161	137	34	131	149	27	11	887	15.03	10	100%
Poaceae	Varia	rachis segment	un																96			96	1.63	1	10%
Poaceae	Varia	testa	un											7								7	0.12	1	10%
Polygonaceae	Varia	seed/fruit	un														1					1	0.02	1	10%
Polygonaceae/Cyperaceae	Varia	seed/fruit	un											1					1			2	0.03	2	20%
Polygonum aviculare agg.	*summer crop annual weeds, annual ruderals*	seed/fruit	ch													1						1	0.02	1	10%
Polygonum aviculare agg.	*summer crop annual weeds, annual ruderals*	seed/fruit	un										42	10	72	112	5	50	35	96	6	428	7.25	9	90%
Potentilla sp.	*Varia*	seed/fruit	ch										1									1	0.02	1	10%
Potentilla sp.	Varia	seed/fruit	un										52	60	3	70		21	102	3		311	5.27	7	70%
Primula sp.	Varia	seed/fruit	un												1	11	1	2		23		38	0.64	5	50%
Primulaceae	Varia	seed/fruit	un										6		4			16	38		1	65	1.10	5	50%
Prunella cf. *vulgaris*	*grassland vegetation*	seed/fruit	un										1									1	0.02	1	10%
Prunella vulgaris	*grassland vegetation*	seed/fruit	un											1				1		3		5	0.08	3	30%
Prunus spinosa	*floodplain / quarry forest including damp herb edges*	seed/fruit	ch									1										1	0.02	1	10%
Prunus spinosa	*floodplain / quarry forest including damp herb edges*	seed/fruit	un										1					1	1	1		4	0.07	4	40%
Quercus sp.	Evergreen hardwood forest including medit. Pine stocks	cupule	un																	1		1	0.02	1	10%
Quercus sp.	Evergreen hardwood forest including medit. Pine stocks	pericarp	un													1				1		2	0.03	2	20%
Ranunculus aquatilis agg.	aquatic plants	seed/fruit	un																	1		1	0.02	1	10%
cf. *Ranunculus repens*	perennial ruderals	seed/fruit	un										3		4						1	8	0.14	3	30%
cf. *Ranunculus* sp.	Varia	seed/fruit	un																		1	1	0.02	1	10%
Ranunculus repens	*perennial ruderals*	seed/fruit	un													24		4		2		30	0.51	3	30%
Ranunculus sp.	Varia	seed/fruit	un											1								1	0.02	1	10%
Reseda lutea	*Ruderal vegetation*	seed/fruit	un									2										2	0.03	1	10%
Reseda luteola	*perennial ruderals*	seed/fruit	un														1					1	0.02	1	10%
Rubiaceae	Varia	seed/fruit	ch																1			1	0.02	1	10%
Rubus caesius	*floodplain / quarry forest including damp herb edges*	seed/fruit	un												1					4		5	0.08	2	20%
Rubus cf. *caesius*	*floodplain / quarry forest including damp herb edges*	seed/fruit	un										1									1	0.02	1	10%
Rubus sp.	*floodplain / quarry forest including damp herb edges*	thorn/prickle	un											1								1	0.02	1	10%
Rubus sp.	*floodplain / quarry forest including damp herb edges*	seed/fruit	un																	2		2	0.03	1	10%
Rumex sp.	Varia	seed/fruit	ch									1								1		2	0.03	2	20%
Rumex sp.	Varia	flower	un													1						1	0.02	1	10%
Rumex sp.	Varia	seed/fruit	un										2			12		3	1	2		20	0.34	5	50%
Salix alba	*Deciduous forests / bushes*	seed/fruit	un																	1		1	0.02	1	10%
Sambucus cf. *ebulus*	*perennial ruderals*	seed/fruit	ch				1	1		1	33%					1				1		2	0.03	2	20%
Sambucus cf. *ebulus*	*perennial ruderals*	seed/fruit	un									7	10		15	1		2	4	7	2	48	0.81	8	80%
Sambucus sp.	Varia	seed/fruit	un											2					400			402	6.81	2	20%
Schoenoplectus lacustris	*reed-swamp and carr vegetation*	seed/fruit	un													2		2	5	1		10	0.17	4	40%

Appendix D: Archaeobotanical results from well 990
Chapter 5. The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal BC)

Les Bagnoles: Well 990 Raw data				Samples	Pr18	Pr20	Pr21	Dry_sum	sum/litre	Dry	% frequency per sample	Pr68	Pr69	Pr25	Pr70	Pr71	Pr26	Pr72	Pr73	Pr74	Pr28	wet_sum	sum/litre	wet	% frequency per sample
				Vol.	0.5	0.5	0.9	5	1.9			8	7	0.9	9	7	0.4	8	9	9	0.4	18742	**58.70**		
Taxon	**Habitat group**	**Plant remains**	**Preservation**																						
Schoenoplectus sp.	reed-swamp and carr vegetation	seed/fruit	un											2						18		20	0.34	2	20%
Scirpus sp.	Bank / floodplain vegetation	seed/fruit	un														2	1				3	0.05	2	20%
Silene sp.	Varia	seed/fruit	un											1								1	0.02	1	10%
Solanaceae	Varia	seed/fruit	un																2			2	0.03	1	10%
Solanum nigrum	*summer crop annual weeds, annual ruderals*	seed/fruit	un																	1		1	0.02	1	10%
Sonchus oleraceus	*summer crop annual weeds, annual ruderals*	seed/fruit	un													1						1	0.02	1	10%
Stellaria media	*summer crop annual weeds, annual ruderals*	seed/fruit	un																28			28	0.47	1	10%
Stellaria media agg.	summer crop annual weeds, annual ruderals	seed/fruit	un									1		1		2	1			5		10	0.17	5	50%
Stellaria sp.	Varia	seed/fruit	un													2		2	3	2		9	0.15	4	40%
Taraxacum officinale agg.	grassland vegetation	seed/fruit	un																4	1		5	0.08	2	20%
Teucrium chamaedrys	*Evergreen hardwood forest including medit. Pine stocks*	seed/fruit	un										1	1	1							3	0.05	3	30%
Tordylium maximum	*perennial ruderals*	seed/fruit	un											2								2	0.03	1	10%
Torilis sp.	Varia	seed/fruit	un										2						1	3		6	0.10	3	30%
Trifolium sp.	grassland vegetation	seed/fruit	ch											1				1				2	0.03	2	20%
Trifolium sp.	grassland vegetation	flower	un										1									1	0.02	1	10%
Trifolium sp.	grassland vegetation	seed/fruit	un													1		1				2	0.03	2	20%
Typha sp.	*reed-swamp and carr vegetation*	seed/fruit	ch															1				1	0.02	1	10%
Typha sp.	*reed-swamp and carr vegetation*	seed/fruit	un												1	2		4	2	2		11	0.19	5	50%
Valerianella locusta	*winter crop annual weeds*	seed/fruit	un													31			1			32	0.54	2	20%
Valerianella rimosa	*winter crop annual weeds*	seed/fruit	un											9		1			23			33	0.56	3	30%
Valerianella sp.	*winter crop annual weeds*	seed/fruit	ch												1							1	0.02	1	10%
Valerianella sp.	*winter crop annual weeds*	seed/fruit	un										10	1	11			1	13		6	42	0.71	6	60%
Verbascum sp.	perennial ruderals	seed/fruit	un											1				1				2	0.03	2	20%
Verbena officinalis	*perennial ruderals*	seed/fruit	ch																	1		1	0.02	1	10%
Verbena officinalis	*perennial ruderals*	seed/fruit	un									3	4	9	4	47	9	29	76	29	8	218	3.69	10	100%
Vicia cf. *faba*	*pulses*	seed/fruit	ch										1									1	0.02	4	40%
Viola sp.	Varia	seed/fruit	un													1			1			2	0.03	2	20%
Vitis vinifera ssp. *sylvestris*	floodplain / quarry forest including damp herb edges	seed/fruit	un												1					1		2	0.03	2	20%
Indeterminata		seed/fruit	ch										1	1			3	4	1	3		13	0.22		
Indeterminata		bread/pulp	ch											4				1		51		56	0.95		
Indeterminata		seed/fruit	un									1	12	57	29	19	8	57		17	9	209	3.54		
Indeterminata		stem/culm fragment	un																	5		5	0.08		
Indeterminata		unknown	un																181			181	3.07		
Indeterminata		stalk	un												1							1	0.02		

Appendix D: Archaeobotanical results from well 994
Chapter 5. The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal BC)

			Samples	Pr20	Pr38_1	Pr38_2	Pr41_1	Pr41_2	Pr42_1	Pr42_2	Pr43_1	Pr43_2	Pr44_1	Pr44_2	Pr45_1	Pr45_2	Total	sum/litre	Total samples	% frequency per sample
Les Bagnoles: Well 994 Raw data			**vol.**	0.2	0	0	7.5	8.5	8	8	8	9	9	9	9	8	4595	84.20	**13**	
Taxon	**Habitat group**	**Plant remain**	**Preservation**																	
Grains																				
Hordeum distichon/vulgare	cultivated	grain	ch	1			2	1	3	1		1		1			10	0.12	7	54%
Triticum aestivum /durum/turgidum	cultivated	grain	ch				1	3	3					1			8	0.10	4	31%
Triticum cf. *aestivum /durum/turgidum*	cultivated	grain	ch											1			1	0.01	1	8%
Triticum durum/turgidum	cultivated	grain	ch							2							2	0.02	1	8%
Triticum monococcum	cultivated	grain	ch						4	1	3						8	0.10	3	23%
Triticum cf. *monococcum*	cultivated	grain	ch							1						1	2	0.02	2	15%
Triticum sp.	cultivated	grain	ch						3		1					1	5	0.06	3	23%
Cerealia indet.	cultivated	grain	un				1										1	0.01	1	8%
Cerealia indet.	cultivated	grain	ch				1	1	132		1	1	3		1		140	1.66	7	54%
Cerealia indet.	cultivated	testa	un					1	40	1	2						44	0.52	4	31%
Other crops																				
Linum usitatissimum	cultivated	seed	un						1			1			1	1	4	0.05	4	31%
Linum usitatissimum	cultivated	capsule	un					1	1								2	0.02	2	15%
Linum usitatissimum	cultivated	capsule dent	un						1		1						2	0.02	2	15%
Papaver somniferum	cultivated	seed	un				2	3	2		1	1		4	1	1	15	0.18	8	62%
Pisum sativum	cultivated	seed	ch								1						1	0.01	1	8%
cf. *Pisum sativum*	cultivated	rachilla	un						1								1	0.01	1	8%
cf. *Pisum sativum*	cultivated	whole fruit	un						3								3	0.04	1	8%
Chaff																				
Hordeum distichon/vulgare	cultivated	rachis segment	ch				5	2	9	5	4	2	2			1	30	0.36	8	62%
Hordeum cf. *distichon/vulgare*	cultivated	rachis segment	ch					2									2	0.02	1	8%
Hordeum distichon/vulgare	cultivated	rachis segment	un					1	3	4	1						9	0.11	4	31%
Triticum aestivum /durum/turgidum	cultivated	rachis segment	ch				1	3	6		7	3			2	2	24	0.29	7	54%
Triticum aestivum /durum/turgidum	cultivated	rachis segment	un				1	5									6	0.07	2	15%
Triticum durum/turgidum	cultivated	rachis segment	ch							30							30	0.36	1	8%
Triticum cf. *durum/turgidum*	cultivated	rachis segment	ch						8								8	0.10	1	8%
Triticum durum/turgidum	cultivated	rachis segment	un							16							16	0.19	1	8%
Triticum cf. *aestivum*	cultivated	rachis segment	ch						7								7	0.08	1	8%
Triticum cf. *aestivum*	cultivated	rachis segment	un						16								16	0.19	1	8%
Triticum monococcum	cultivated	rachis segment	ch							1							1	0.01	1	8%
Triticum monococcum	cultivated	glume base	ch	2			5	11	17	13	5	3				6	62	0.74	8	62%
Triticum monococcum	cultivated	glume base	un						63	9	5						77	0.91	3	23%
Triticum dicoccum	cultivated	glume base	ch				1		3								4	0.05	2	15%
Triticum dicoccum	cultivated	glume base	un						6								6	0.07	1	8%
Triticum cf. *dicoccum*	cultivated	glume base	ch					2		1	2	2					7	0.08	4	31%
Triticum cf. *dicoccum*	cultivated	glume base	un							1							1	0.01	1	8%
Triticum cf. *timopheevii*	cultivated	glume base	ch				2										2	0.02	1	8%
Triticum monococcum/dicoccum	cultivated	glume base	un					1	12			2					15	0.18	3	23%
Triticum sp.	cultivated	base of the ear	ch						2								2	0.02	1	8%
Cerealia indet.	cultivated	rachis segment	un						2								2	0.02	1	8%
Cerealia indet.	cultivated	glume	ch				2	14	74	8	15	5		2	3	6	129	1.53	9	69%
Cerealia indet.	cultivated	glume	un				6	4	68	49	3	7			2		139	1.65	7	54%
Triticum sp.	cultivated	glume	ch				12			1							13	0.15	2	15%
Triticum sp.	cultivated	glume	un							9							9	0.11	1	8%
Cerealia indet.	cultivated	awn fragment	ch	1							1						2	0.02	2	15%
Hordeum distichon/vulgare	cultivated	awn fragment	un						1								1	0.01	1	8%
Triticum sp.	cultivated	awn fragment	ch						3								3	0.04	1	8%
cf. Cerealia	cultivated	culm node	un							2							2	0.02	1	8%

Appendix D: Archaeobotanical results from well 994
Chapter 5. The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal BC)

			Samples	Pr20	Pr38_1	Pr38_2	Pr41_1	Pr41_2	Pr42_1	Pr42_2	Pr43_1	Pr43_2	Pr44_1	Pr44_2	Pr45_1	Pr45_2	Total	sum/litre	Total samples	% frequency per sample
Les Bagnoles: Well 994 Raw data			vol.	0.2	0	0	7.5	8.5	8	8	8	9	9	9	9	8	4595	84.20	**13**	
Taxon	**Habitat group**	**Plant remain**	**Preservation**																	
Other plants																				
Agrimonia sp.	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un						3								3	0.04	1	8%
Alisma cf. *plantago-aquatica*	reed-swamp and carr vegetation	seed/fruit	un	3			20		25	65				6		61	180	2.14	6	46%
Alisma plantago-aquatica	reed-swamp and carr vegetation	seed/fruit	un					64			38	36	12		22		172	2.04	5	38%
Apiaceae	Varia	seed/fruit	un						1							1	2	0.02	2	15%
cf. *Apiaceae*	Varia	seed/fruit	un						5								5	0.06	1	8%
Arenaria serpyllifolia agg.	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un	5			28	16	130	158	26	10	1				374	4.44	8	62%
Asteraceae	Varia	flower part/flower	un				4			13	1					1	19	0.23	4	31%
Asteraceae	Varia	seed/fruit	un				10	2	6	4			1	2	2	2	29	0.34	8	62%
cf. *Asteraceae*	Varia	flower part/flower	un						30								30	0.36	1	8%
Atriplex sp.	summer crop annual weeds, annual ruderals	seed/fruit	un				1		2								3	0.04	2	15%
Avena sp.	winter crop annual weeds	awn fragment	ch	1			2	1		2	3				1	1	11	0.13	7	54%
Avena sp.	winter crop annual weeds	seed/fruit	ch					1		1							2	0.02	2	15%
cf. *Betula* sp.	woodlands	seed/fruit	un					1									1	0.01	1	8%
Betula pendula/pubescens	floodplain / quarry forest including damp herb edges	seed/fruit	un						1								1	0.01	1	8%
Bromus sp.	Varia	seed/fruit	un					2	1								3	0.04	2	15%
Bupleurum sp.	no group	seed/fruit	un					1				1					2	0.02	2	15%
Capsella sp.	summer crop annual weeds, annual ruderals	seed/fruit	un								1						1	0.01	1	8%
Carex sp. bicarpellat	wetland plants various	whole fruit	un						7								7	0.08	1	8%
Carex sp. bicarpellat	wetland plants various	seed/fruit	ch					1	1	2						1	5	0.06	4	31%
Carex sp. bicarpellat	wetland plants various	seed/fruit	un				23	1	125	51	24	14			1	2	241	2.86	8	62%
Carex sp. tricarpellat	wetland plants various	seed/fruit	un				2	3	5	4	6	1					21	0.25	6	46%
Carthamus cf. *lanatus*	summer crop annual weeds, annual ruderals	seed/fruit	ch						2								2	0.02	1	8%
Carthamus cf. *lanatus*	summer crop annual weeds, annual ruderals	seed/fruit	un	1					6	3							10	0.12	3	23%
Carthamus lanatus	summer crop annual weeds, annual ruderals	seed/fruit	un					1									1	0.01	1	8%
Caryophyllaceae	Varia	seed/fruit	un					3	4		6		1				14	0.17	4	31%
Chara sp.	aquatic plants	Oog	un				1										1	0.01	1	8%
Chara sp.	aquatic plants	OogK	un						1								1	0.01	1	8%
Chenopodiaceae	summer crop annual weeds, annual ruderals	seed/fruit	un						1								1	0.01	1	8%
Chenopodium cf. *album*	summer crop annual weeds, annual ruderals	seed/fruit	un	8			23	15	114	166	43	4		1		5	379	4.50	9	69%
Chenopodium cf. *album*	summer crop annual weeds, annual ruderals	seed/fruit	ch				1			2	1						4	0.05	3	23%
Chenopodium cf. *polyspermum*	summer crop annual weeds, annual ruderals	seed/fruit	un						1								1	0.01	1	8%
Chenopodium sp.	summer crop annual weeds, annual ruderals	seed/fruit	ch					2								1	3	0.04	2	15%
Cirsium/Carduus	perennial ruderals	seed/fruit	un						1	2							3	0.04	2	15%
Corylus avellana	floodplain / quarry forest including damp herb edges	seed/fruit	un					1	3	1	1						6	0.07	4	31%
Cyperaceae	Varia	seed/fruit	ch							1							1	0.01	1	8%
Cyperaceae	Varia	seed/fruit	un							1							1	0.01	1	8%
Cyperus cf. *longus*	reed-swamp and carr vegetation	seed/fruit	un										1				1	0.01	1	8%
Cyperus fuscus	shore line pioneers	seed/fruit	un												6		6	0.07	1	8%
Cyperus sp.	shore line pioneers	seed/fruit	ch								1						1	0.01	1	8%
Cyperus sp.	shore line pioneers	seed/fruit	un				2	3		43	18	18				6	90	1.07	6	46%
cf. *Daucus carota*	perennial ruderals	seed/fruit	un						1								1	0.01	1	8%
Dipsacus laciniatus	floodplain / quarry forest including damp herb edges	seed/fruit	un	1			6	8	2	15	37	7		1	2	1	80	0.95	10	77%
Eleocharis ovata/uniglumis	reed-swamp and carr vegetation	seed/fruit	un						3								3	0.04	1	8%
Eryngium campestre	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un						2								2	0.02	1	8%
cf. *Eryngium campestre*	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un						1								1	0.01	1	8%
Euphorbia helioscopia	summer crop annual weeds, annual ruderals	seed/fruit	ch							1							1	0.01	1	8%
Euphorbia helioscopia	summer crop annual weeds, annual ruderals	seed/fruit	un	2			3	11	50	37	9	7			1	2	122	1.45	9	69%

Appendix D: Archaeobotanical results from well 994
Chapter 5. The contribution of waterlogged deposits to the study of a crop change: Middle Neolithic agricultural practice (4400-3500 cal BC)

Les Bagnoles: Well 994 Raw data			**Samples**	**Pr20**	**Pr38_1**	**Pr38_2**	**Pr41_1**	**Pr41_2**	**Pr42_1**	**Pr42_2**	**Pr43_1**	**Pr43_2**	**Pr44_1**	**Pr44_2**	**Pr45_1**	**Pr45_2**	**Total**	**sum/litre**	**Total samples**	**% frequency per sample**
			vol.	0.2	0	0	7.5	8.5	8	8	8	9	9	9	9	8	4595	84.20	**13**	
Taxon	**Habitat group**	**Plant remain**	**Preservation**																	
Fabaceae Trifolium -Typ	grassland vegetation	seed/fruit	ch								1						1	0.01	1	8%
cf. *Fabaceae*	grassland vegetation	whole fruit	un													1	1	0.01	1	8%
Fallopia cf. *convolvulus*	winter crop annual weeds	seed/fruit	un						1								1	0.01	1	8%
Festuca/Lolium	grassland vegetation	seed/fruit	un							1							1	0.01	1	8%
Festuca/Lolium	grassland vegetation	seed/fruit	ch							1							1	0.01	1	8%
cf. *Fragaria* sp.	floodplain / quarry forest including damp herb edges	seed/fruit	un					2									2	0.02	1	8%
cf. *Fragaria* sp.	floodplain / quarry forest including damp herb edges	seed/fruit	un							1							1	0.01	1	8%
Fragaria/Potentilla	grassland vegetation	seed/fruit	un				5										5	0.06	1	8%
Fumaria sp.	summer crop annual weeds, annual ruderals	seed/fruit	ch						3	2							5	0.06	2	15%
Fumaria sp.	summer crop annual weeds, annual ruderals	seed/fruit	un	1			15	41	112	98	30	15	4		4	12	332	3.94	10	77%
Galium (small)	Varia	seed/fruit	ch						1								1	0.01	1	8%
Galium sp.	Varia	seed/fruit	ch													1	1	0.01	1	8%
Heliotropium europaeum	summer crop annual weeds, annual ruderals	seed/fruit	un				2	3	3	5		1					14	0.17	5	38%
Hieracium sp.	Varia	seed/fruit	un				1										1	0.01	1	8%
Hordeum cf. *murinum*	summer crop annual weeds, annual ruderals	seed/fruit	ch						3								3	0.04	1	8%
Hordeum cf. *murinum*	summer crop annual weeds, annual ruderals	seed/fruit	un							2							2	0.02	1	8%
Hordeum cf. *murinum*	summer crop annual weeds, annual ruderals	rachis segment	un						2	1	3	3					9	0.11	4	31%
cf. *Humulus lupulus*	floodplain / quarry forest including damp herb edges	seed/fruit	un						1								1	0.01	1	8%
Hyoscyamus niger	perennial ruderals	seed/fruit	un						1	4	1						6	0.07	3	23%
Hypericum perforatum	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un						1								1	0.01	1	8%
Hypericum sp.	Varia	seed/fruit	un				2	2		1	1	1					7	0.08	5	38%
Juncus sp.	wetland plants various	seed/fruit	ch											1			1	0.01	1	8%
Juncus sp.	wetland plants various	seed/fruit	un						1		2	1			1		5	0.06	4	31%
Lithospermum/Buglossoides sp.	Varia	seed/fruit	un									1					1	0.01	1	8%
Luzula sp.	grassland, mesophilic (incl. "Grassland-like" veg.)	seed/fruit	un									1					1	0.01	1	8%
Lycopus europaeus	reed-swamp and carr vegetation	seed/fruit	un					1	1	2					1		5	0.06	4	31%
Malus/Pyrus	floodplain / quarry forest including damp herb edges	seed/fruit	un				1									2	3	0.04	2	15%
Malva cf. *alcea*	perennial ruderals	seed/fruit	un				2	8	19		4					2	35	0.42	5	38%
Malva sp.	summer crop annual weeds, annual ruderals	seed/fruit	ch				1			1							2	0.02	2	15%
Malva sp.	summer crop annual weeds, annual ruderals	seed/fruit	un							1							1	0.01	1	8%
Medicago minima	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	ch				1										1	0.01	1	8%
Medicago minima	Grassland, xerophilic (steppe / dry grassland "Garigue")	whole fruit	un	1			1	2	8			1					13	0.15	5	38%
Medicago sp.	Grassland, xerophilic (steppe / dry grassland "Garigue")	whole fruit	un							1							1	0.01	1	8%
Medicago sp.	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	ch							2							2	0.02	1	8%
Medicago sp.	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un							1							1	0.01	1	8%
cf. *Medicago* sp.	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	ch					1									1	0.01	1	8%
Medicago/Trifolium	grassland, mesophilic (incl. "Grassland-like" veg.)	seed/fruit	ch											1			1	0.01	1	8%
Mentha aquatica/arvensis	wetland plants various	seed/fruit	un					12			2					1	15	0.18	3	23%
Onopordum acanthium	perennial ruderals	seed/fruit	ch							1							1	0.01	1	8%
Onopordum acanthium	perennial ruderals	seed/fruit	un					3	5	4	2	1			1		16	0.19	6	46%
Origanum vulgare	Evergreen hardwood forest including medit. Pine stocks	seed/fruit	un						35								35	0.42	1	8%
Petrorhagia prolifera	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un				2		3		1					1	7	0.08	4	31%
Petrorhagia sp.	Grassland, xerophilic (steppe / dry grassland "Garigue")	seed/fruit	un							2							2	0.02	1	8%
Phragmites australis	reed-swamp and carr vegetation	seed/fruit	un						1								1	0.01	1	8%
Physalis alkekengi	floodplain / quarry forest including damp herb edges	seed/fruit	un							1						1	2	0.02	2	15%
Plantago lanceolata	grassland vegetation	seed/fruit	ch	1						2						1	4	0.05	3	23%
Plantago major	perennial ruderals	seed/fruit	un						1	2							3	0.04	2	15%
Plantago sp.	grassland vegetation	seed/fruit	ch					1	1								2	0.02	2	15%
Plantago sp.	grassland vegetation	seed/fruit	un				1										1	0.01	1	8%
Poaceae	Varia	whole fruit	un				2		4	2		15					23	0.27	4	31%
Poaceae	Varia	whole fruit	ch					1	9	2							12	0.14	3	23%

Les Bagnoles: Well 994 Raw data

Taxon	Habitat group	Plant remain	Preservation	Pr20	Pr38_1	Pr38_2	Pr41_1	Pr41_2	Pr42_1	Pr42_2	Pr43_1	Pr43_2	Pr44_1	Pr44_2	Pr45_1	Pr45_2	Total	sum/litre	Total samples	% frequency per sample
			vol.	0.2	0	0	7.5	8.5	8	8	8	9	9	9	9	8	4595	84.20	**13**	
cf. *Poaceae*	Varia	whole fruit	ch									1					1	0.01	1	8%
Poaceae	Varia	seed/fruit	ch	1			22	2	2	2			1				30	0.36	6	46%
Poaceae	Varia	seed/fruit	un	1			14	56	90	72	47					2	282	3.35	7	54%
Poaceae Bromus/Festuca- Typ	grassland vegetation	seed/fruit	ch					1									1	0.01	1	8%
Polygonum aviculare agg.	summer crop annual weeds, annual ruderals	seed/fruit	un	1			1	15	17	11	2	1	2	1	2	2	55	0.65	11	85%
cf. *Polygonum minus*	shore line pioneers	seed/fruit	ch						1								1	0.01	1	8%
Polygonum sp.	Varia	seed/fruit	un							1							1	0.01	1	8%
Portulaca oleracea	summer crop annual weeds, annual ruderals	seed/fruit	un												1		1	0.01	1	8%
Potentilla cf. *reptans*	perennial ruderals	seed/fruit	un				1										1	0.01	1	8%
Potentilla reptans	perennial ruderals	seed/fruit	un									1					1	0.01	1	8%
Potentilla sp.	Varia	seed/fruit	un	1								1					2	0.02	1	8%
cf. *Potentilla* sp.	Varia	seed/fruit	un							2							2	0.02	1	8%
Primulaceae	Varia	seed/fruit	un				1				1						2	0.02	2	15%
Prunus cf. *mahaleb*	Evergreen Hartlaub forest incl. Medit. Pine stocks	seed/fruit	un						5								5	0.06	1	8%
Pyrus sp.	Evergreen Hartlaub forest incl. Medit. Pine stocks	seed/fruit	un									1					1	0.01	1	8%
Ranunculus cf. *repens*	perennial ruderals	seed/fruit	un					4	17	6	1					1	29	0.34	5	38%
Ranunculus sp.	Varia	seed/fruit	un							1							1	0.01	1	8%
Rosaceae	Varia	seed/fruit	un													1	1	0.01	1	8%
Rubus caesius	floodplain / quarry forest including damp herb edges	seed/fruit	un					1	6	4	7	4				1	23	0.27	6	46%
Rubus fruticosus agg.	floodplain / quarry forest including damp herb edges	seed/fruit	un						1		3	3					7	0.08	3	23%
Rubus sp.	floodplain / quarry forest including damp herb edges	seed/fruit	un								5						5	0.06	1	8%
Rumex sp.	Varia	seed/fruit	ch						1								1	0.01	1	8%
Rumex sp.	Varia	seed/fruit	un						5	6	1						12	0.14	3	23%
Rumex sp.	Varia	flower part/flower	un						6	6		1					13	0.15	3	23%
Sambucus cf. *ebulus*	perennial ruderals	seed/fruit	un				9	5	4	3	2	1			1	2	27	0.32	8	62%
Sambucus sp.	Varia	seed/fruit	ch						1								1	0.01	1	8%
Sambucus sp.	Varia	seed/fruit	un						2	1				1			4	0.05	3	23%
Schoenoplectus sp.	reed-swamp and carr vegetation	seed/fruit	un					1	3		4						8	0.10	3	23%
Silene pratensis	perennial ruderals	seed/fruit	un						1								1	0.01	1	8%
Silene sp.	Varia	seed/fruit	un							1							1	0.01	1	8%
Solanaceae	Varia	seed/fruit	un				1										1	0.01	1	8%
Stellaria media agg.	summer crop annual weeds, annual ruderals	seed/fruit	un						2								2	0.02	1	8%
Stellaria sp.	Varia	seed/fruit	un							1	2						3	0.04	2	15%
Teucrium chamaedrys	Evergreen hardwood forest including medit. Pine stocks	seed/fruit	un				4	4	13	5	1	2				1	30	0.36	7	54%
Typha sp.	reed-swamp and carr vegetation	seed/fruit	un				1	1	2		2	1			1		8	0.10	6	46%
Verbena officinalis	perennial ruderals	seed/fruit	un				58	24	160	144	56	18		1	4	13	478	5.68	9	69%
Verbena officinalis	perennial ruderals	seed/fruit	ch				1		2								3	0.04	2	15%
cf. *Veronica* sp.	Varia	seed/fruit	un					1									1	0.01	1	8%
Vicia cf. *angustifolia* *(sativa* ssp. *nigra)*	winter crop annual weeds	seed/fruit	ch						2								2	0.02	1	8%
Vicia (small)	winter crop annual weeds	seed/fruit	ch				1			3							4	0.05	2	15%
Vicieae	winter crop annual weeds	seed/fruit	ch				1										1	0.01	1	8%
Viola sp.	Varia	seed/fruit	un				1							1			2	0.02	2	15%
Vitis vinifera ssp. *sylvestris*	floodplain / quarry forest including damp herb edges	seed/fruit	ch							1							1	0.01	1	8%
Vitis vinifera ssp. *sylvestris*	floodplain / quarry forest including damp herb edges	seed/fruit	un						2								2	0.02	1	8%
Vitis vinifera ssp. *sylvestris*	floodplain / quarry forest including damp herb edges	stalk	un							1							1	0.01	1	8%
Zannichellia palustris	aquatic plants	seed/fruit	un							3							3	0.04	1	8%
Indeterminata		seed/fruit	un				24	4	50	41	31	4	1	5	5	4	169	2.01	10	77%
Indeterminata		seed/fruit	ch				6	3	6	8	10	1	1	1		1	37	0.44	9	69%
Indeterminata		whole fruit	un							1							1	0.01	1	8%
Indeterminata		porridge/(flat) bread/pulp	ch					1	6	2							9	0.11	3	23%
Indeterminata		stalk	un									1					1	0.01	1	8%

Appendix E: Protocol for application of GMM to archaeobotanical material

Tools and Programs

- A digital camera on the binocular
- Photoshop
- Image J
- Rstudio

<u>Image</u>

Equipment

In order to check for distortion on the equipment is important to check every time you start to take photos. This way you know that there is no distortion and can continue to take photos. The procedure is to take a photo of the graph paper. Then on the photo, check if there is any distortion on the edges (Figure E1). Also, check the scale of the program and the millimetre sheet if they are the same.

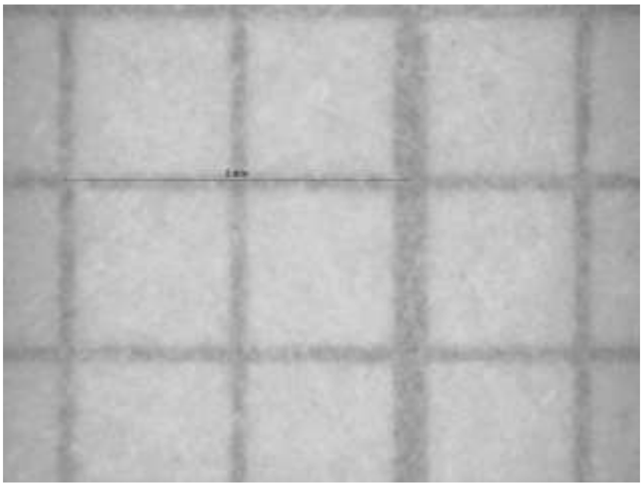

Figure E1- Check for distortion as well as checking the scales

Background

Seeds are tiny and extremely fragile. No **background** was used to aid with the cleaning of the photos, which made the process quicker. We did try to use plasticine (Figure E1), however, this method was not good and made the cleaning of the image slower. RS used a post-it in order to position the seeds.

The different attempts to clean the background of the photos made the process slower, and several photos were repeated. Usually, this step is quick and automatized; however, due to the size of the seed, the photo commonly would have shadows, or the seeds were too light, and not enough contrast was made. Even the white background had shadows (Figure E2). RS changed the contrast of the photos and turned them all white, which helped to "select" the outline of the seed using the "wand" tool on Photoshop.

Figure E2 Examples of problematic backgrounds, blue plasticine and white background without the contracts

Position

The positioning of the seed is crucial. This part was as well longstanding. Keeping a photo as a reference of how the seed should be positioned is essential (example of Figure E11). Several photos were repeated as the seeds were not well-positioned.

The seeds are tiny, between 0.5 to 1 mm; they are globoid; therefore, they are not easy to position as cereal grains. For example, barley is large and flat compared with the poppy seed. The size and volume of the seed made it very hard to position (examples of wrong positions Figure E4). However, two guidelines should be followed (Figure E3):

- First, the seed should be orientated with the hilum to the right, with the larger side down. It should also be centred so that we did not need to manually move the seeds in Photoshop when we needed to measure them.
- Second, to position, in the same way, all the time, the "nose" and the small cells next to the hilum should be visible (Position 2)

Tip. A small post-it was used in the most challenging seeds to make them in the perfect position. Maybe using this method from the beginning would have made the process quicker.

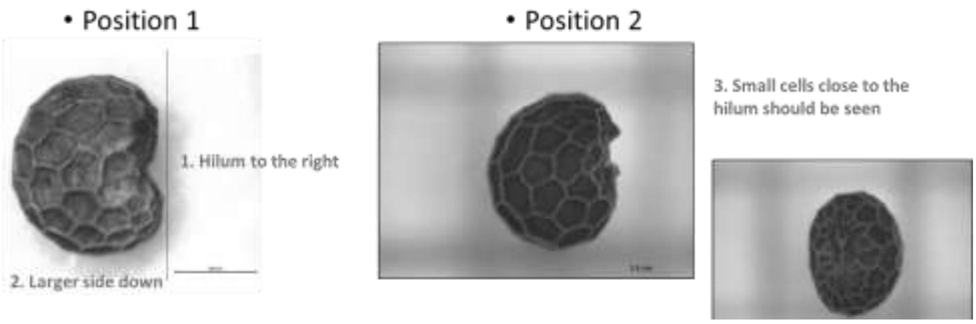

Figure E3 – How to correctly position the seeds

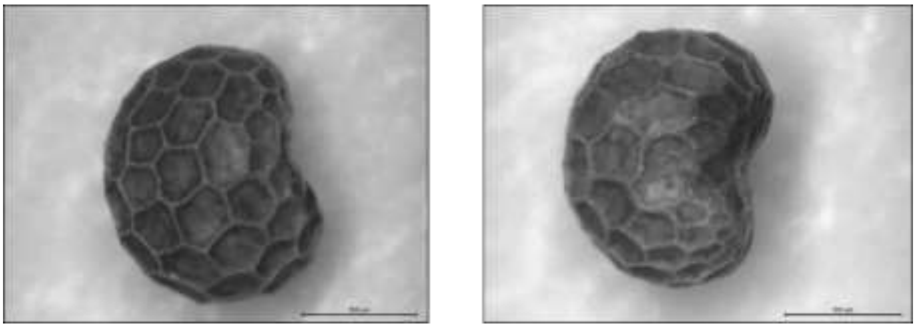

Figure E4 – Wrong position, left the hilum is not visible, and right the hilum is too visible.

Scale bar

Add a scale bar without borders as it proved easier to measure in Image J (Figure E5).

Figure E5 – It is better to have just a line and count the all-black line, instead of this type or at least have only one type of scale for all the photos and use the same method constantly

Save photos as tiff

Photos are harder to clean and select the outline when the quality is distorted; therefore, using Photoshop to clean, it is better to use tiff—only converting to jpg when making the black mask.

<u>**Archaeological seeds**</u>

The seeds analysed here were preserved in a waterlogged environment; after being identified, the seeds were preserved in a tube with a conserving agent (mix of thymol, ethanol, glycerine and water). For the photos, the seeds were removed from the conserving agent and drop on a container with distilled water solution and then partially dried with an optical cloth (Hama Lens cleaning tissue). This process was necessary to prevent light reflection due to the water without leaving tiny hairs or traces on the seeds. Finally, the partially dried seeds were easier to position and allowed to take clear photographs. RS developed this method. These processes might damage the seeds; some were deformed after taking them out of the solution as well some were more easily broken.

In the case of our binocular camera: Two sets of photos are saved.

1) Mounted photo produced by several layered photos that clearly show the cells of the seeds and 2) unmounted photo, only one photo to measure the seeds.

These were separated because the mounted photos show the variability of pixies that might influence the measuring since the seeds are tiny, and such pixel variation might affect the results.

Organization tips

One folder, called Original, keeps the **original** photos in a tiff with the code given by the technician (Figure E6). **Size** folder with all the unmounted photos in jpeg as image J gives an error when imported a heavy photo in a tiff. The cleaning folder should be copies of all originals—these copies will be clean in Photoshop.

After cleaning, a mask is created using an automatization script from Photoshop that ensures all photos are transformed. For the landmark folder, a copy with all the masks and here is where text files with landmarks coordinates will be saved using the Image J. Cells folder with all the mounted photos to count the cells. Saved using snipping tool as the Image J only saves with tiff, and it is only visible when open throw Image J and not by another image visualizer. Maybe another method would be helpful to be able to double-check the cell counting.

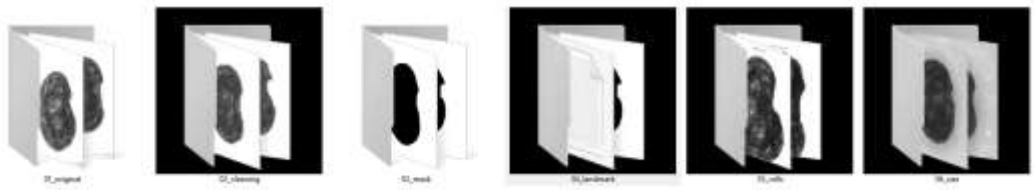

Figure E6 - Folders organization

Measuring process
(Have a folder only for the measured photos, unmounted photos)

The final photo is a combination of different photos stacked in one; the number of photos varies and can go from 6 up to 12 photos. We call this method – mounted photos; we realize that the number of pixels and size was different from all the photos; therefore, to prevent this type of error, we decided to pick one photo out of the stack, in principle the best one is the most focus. RS took all photos, and the best focuses ones were as well pick by him.

The maximum length and width is measured using the rectangular tool from the Image J program (Figure E7).

Figure E7 – Measuring the seed with a rectangular tool from Image J

As mentioned before, the photos should be centred as errors such as these should not happen (Figure E8). At first, the photos seem the same. However, the left one is more curved. The alignment would be solved by using a millimetric paper; however, at the time, a white background was chosen. Tip: Use a paper as a guide to see if the photos are centred and parallel to the opposite line of the photo or when you use the Image J, square, you will not see that the photo is not centred. Either way, if you want to be detailed or not, consistency is the key. In order to spend the process, ideally, position the seeds the correct way from the beginning.

Another important note on the measuring is on the calibration on the scale bar. Our photos, unmounted photos with a scale measuring the all bar of the scale, sometimes the scales are pixel, and the end of the scale bar is incorrect. We measure all the black lines of the bar.

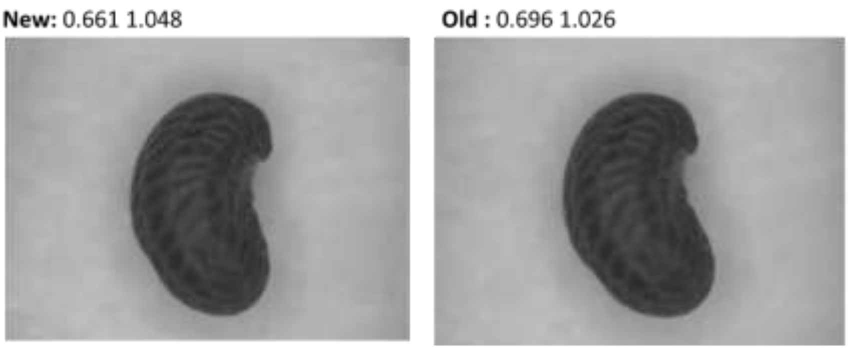

Figure E8 The position of the seed is also important when measuring. We want all the seeds to have an imagining line from nose down (left) and less belly (right). However, either way, it should be done constantly.

<u>Cleaning process</u>

(Have a folder with the original photos and another with the clean photos)

There are two things to be removed for the cleaning process to prepare the photos for the next step (Figure E9). Clean the background and the yellow fresh hilum tissue that is in the middle of the seed. For the modern seeds, the colour of the seeds is white, and the background (plate of the stereoscopic) is white; this then prevents the use of a selection tool from Photoshop as the selection goes inside the seed. To prevent this, we tried to use plasticine (blue and pink); however, this did even worse, the photo then had some shadow, and it was better to have just a white background.

The white background also has shadows and some noise in the background (even with the white plate) which meant it had to be removed. The first tests were made with the selection tool and Lasso tool from Photoshop. These tests had a high variation due to the cleaning; therefore, a new approach was used. These entail using the paint tool in black and slowly had to the parts where the selection tool would penetrate the seed. After "closing" all the entrances, use an eraser tool, white colour, and go around the outline of the seed and clean any noise, shadow, or any back paint excess. Removing this tissue is important because the archaeological might not have it, and the landmarks are found in this place; therefore, this part should be removed only to expose the outline of the seed. This process cannot be done with the selection tool of Photoshop.

Figure E9 Cleaning process the seed is light-toned, white; when clicking on the selection tool in Photoshop, the selection goes inside the seed; therefore is necessary to close those points of entry and painted black. The removal of the yellow soft tissue is as well important.

Preparing the photos

1. Clean the background, remove soft tissues (yellow parts) using rubber in different sizes, and go around the seed. This manual process is as well long. The previous trials used the lapso and the wand tools for the program to select the outline of the seeds; however, the selection keeps not selecting the outline but random points of the seed. Therefore, in order to minimize that error, a manual approach was taken.
2. Ideally, the landmarks should have been taken while the photos were in their natural colour; however, the procedure was done in a black and white mask where the shape is more predominant.
3. The mask was done using Photoshop.
4. The photos were then used as a jpeg.

Mask

After cleaning each poppy seed photo, it was possible to select the outline and invert colours making the inside of the seed black and the outside white. This process we call mask, was performed using the automatization feature in Photoshop. Landmarks were added to each mask photo.

Landmark position

(Have a folder for the Landmark photos and coordinates text)

Five points are homogeneous in all *Papaver* seeds. The first three are located in the hilum and are supposed to be influenced by it (Figure E10 and E11). These three points are represented by an arch (Figure E11 b), and it changes with the curves of the seed using eye extrapolation. The first should be where it begins, and the third point is where it ends. However, in some cases, it was necessary to highlight some exceptions. The order is as follow:

1) Landmark 1

The point of the poppy "nose". Some seeds (Figure E10) have a pointy edge where the hilum and soft yellow flesh is located; the landmark one is located in the most right and down part of that nose.

Figure E 10 - Papaver setigerum CSIBUB with a circle indicating the first landmark on the “nose"

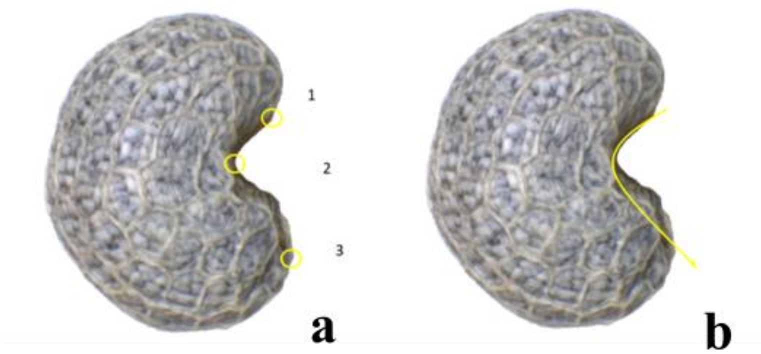

Figure E 11- Papaver nigrum with all the landmarks present (a) and with the "arch" of the hilum (b)

However, some seeds do not have a pronounced nose, such as the case of *Papaver nigrum* (Figure E11). In this case, the beginning of the hilum is the most inside part; however, sometimes, these are not easily visible.

2) Landmark 2

It is located in the centre of the seed, where the symmetry point of the parabola is found (Figure E 11). Sometimes, this point is unclear; therefore, the seed's middle is selected using eye extrapolation (Figure E 10).

3) Landmark 3

The third mark was challenging to select the most intuitive place at the end of the arch (Figure E 10 and E 11.), close to the landmark 2. However, the hilum does not always end in that part; as it can be in Figure E11b, a darker part is most probably related to the hilum. Therefore, the third point is generally after the end of the hilum and the fresh yellow skin.

4) Landmark 4 and 5

These two landmarks are located in the top and bottom extremities of the seed (Figure E10 and E 11).

Selecting the landmarks is a fast process by using the multi-point tool of ImageJ (Figure E 12). Tip use a colourful colour, increase the font, and always use the same sequence of landmark (ldk) 1-3 the hilum part of the seed and 4-5 the extremities.

The process was, as follow, import all 30 photos one species at a time (jpeg format) into the ImageJ and do the landmarks from the same species all at once because they usually are very similar between themselves, so if there is a point that is not common or that you would like to repeat it is easier to detect in this way.

While doing this process is important to have some figures as examples with the landmark points. This helps to speed the process as the landmarking should be intuitive. All the measurements then have to save as XY coordinates (text format).

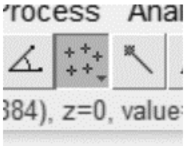

Figure E12 - Image J – multi-point tool.

Counting cells

We try three methods. Two of them gave similar results, drawing a horizontal or vertical line in the middle of the seeds and count the cells were the lines pass. Especially for the *P. sominiferum* and *P. setigerum*, there was not much difference; however, counting all the cells from the right side of the seed gave better results. Therefore, we pick this last method, counting the total of the cells (Figure E13).

We also try to see if three different people would count the same way, unfortunately that did not happen. Some cells are unclear, or they are only half present in the photo. In order to simplify, all cells were counted and should be a quick and intuitive process. The cells at the corner and the small ones are counted. This should be consistent and count for all the species.

Figure E13 Counting cells with the multi-point tool from Image J

Data export

Create an Excel spreadsheet with the species as rows and add all details about the individual seeds, see Table E1.

Testing

The data collection was tested and rechecked several times (Figure E14). Five images of each specimen were taken (not all at once; on different days, make sure photographic methods are consistent), then landmark them (also at different times). Then look at the within-specimen variance relative to other sources to assess the degree to which it might affect the analyses.

Table E1 Information details for each seed

Codes	Label
	GMM code
Photos Info	Photo date
	Photographer
Preservation	modern/charred/waterlogged
Archaeological Info	Site code
	Sample number
	Fraction
	SU
	Excavation year
	Chronology
	Structure
Seed location Info	Country
	Country code
	Region/Canton
	City
Botanical Info	Institution
	Locus
	Family
	Genus
	Species
	Subspecies
	Full name of the plant
	Prior identification
	HORTUS BOTANICUS
	Same capsule
	Year
	Observations
Seed info	Colour
	Number of cells
	Width
	Length

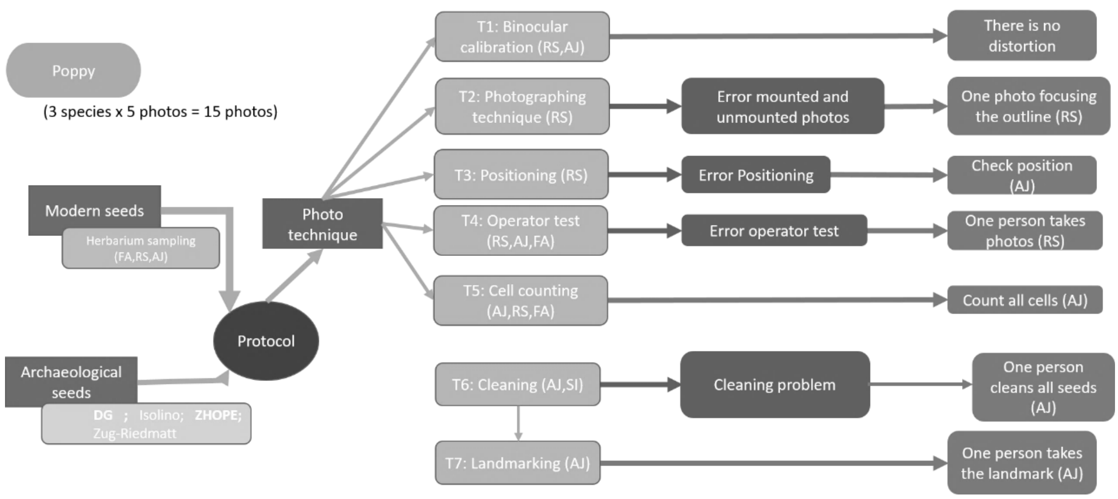

Figure E14 Poppy workflow after checking the error analyses

Appendix F: Metadata of the morphometric study of poppy seeds

This Appendix shows all the details recorded for the geometric morphometric analysis. One row has the information for each seed used for the analysis (including some that were not used).

GMM code e.g.	CSIBUB_Re_CH_Pset_2000_10	
CSIBUB	Re	CH
Site code	Preservation code	Country code

Appendix F: Metadata of the morphometric study of poppy seeds

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
CSIBUB_01_01	CSIBUB_Re_CH_Pset_2000_01	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_02	CSIBUB_Re_CH_Pset_2000_02	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_03	CSIBUB_Re_CH_Pset_2000_03	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_04	CSIBUB_Re_CH_Pset_2000_04	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_05	CSIBUB_Re_CH_Pset_2000_05	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_06	CSIBUB_Re_CH_Pset_2000_06	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_07	CSIBUB_Re_CH_Pset_2000_07	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_08	CSIBUB_Re_CH_Pset_2000_08	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_09	CSIBUB_Re_CH_Pset_2000_09	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_10	CSIBUB_Re_CH_Pset_2000_10	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_11	CSIBUB_Re_CH_Pset_2000_11	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_12	CSIBUB_Re_CH_Pset_2000_12	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_13	CSIBUB_Re_CH_Pset_2000_13	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_14	CSIBUB_Re_CH_Pset_2000_14	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_15	CSIBUB_Re_CH_Pset_2000_15	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_16	CSIBUB_Re_CH_Pset_2000_16	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_17	CSIBUB_Re_CH_Pset_2000_17	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_18	CSIBUB_Re_CH_Pset_2000_18	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_19	CSIBUB_Re_CH_Pset_2000_19	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_20	CSIBUB_Re_CH_Pset_2000_20	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_21	CSIBUB_Re_CH_Pset_2000_21	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_22	CSIBUB_Re_CH_Pset_2000_22	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_23	CSIBUB_Re_CH_Pset_2000_23	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_24	CSIBUB_Re_CH_Pset_2000_24	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_25	CSIBUB_Re_CH_Pset_2000_25	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_26	CSIBUB_Re_CH_Pset_2000_26	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_27	CSIBUB_Re_CH_Pset_2000_27	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_28	CSIBUB_Re_CH_Pset_2000_28	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_29	CSIBUB_Re_CH_Pset_2000_29	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_01_30	CSIBUB_Re_CH_Pset_2000_30	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_01	CSIBUB_Re_CH_Pnig_2000_01	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_06	CSIBUB_Re_CH_Pnig_2000_02	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_08	CSIBUB_Re_CH_Pnig_2000_03	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_10	CSIBUB_Re_CH_Pnig_2000_04	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_11	CSIBUB_Re_CH_Pnig_2000_05	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_14	CSIBUB_Re_CH_Pnig_2000_06	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_15	CSIBUB_Re_CH_Pnig_2000_07	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_17	CSIBUB_Re_CH_Pnig_2000_08	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_18	CSIBUB_Re_CH_Pnig_2000_09	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_19	CSIBUB_Re_CH_Pnig_2000_10	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_20	CSIBUB_Re_CH_Pnig_2000_11	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_21	CSIBUB_Re_CH_Pnig_2000_12	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_24	CSIBUB_Re_CH_Pnig_2000_13	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_25	CSIBUB_Re_CH_Pnig_2000_14	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_26	CSIBUB_Re_CH_Pnig_2000_15	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_27	CSIBUB_Re_CH_Pnig_2000_16	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_30	CSIBUB_Re_CH_Pnig_2000_17	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_31	CSIBUB_Re_CH_Pnig_2000_18	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_32	CSIBUB_Re_CH_Pnig_2000_19	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_33	CSIBUB_Re_CH_Pnig_2000_20	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_34	CSIBUB_Re_CH_Pnig_2000_21	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_35	CSIBUB_Re_CH_Pnig_2000_22	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_36	CSIBUB_Re_CH_Pnig_2000_23	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_37	CSIBUB_Re_CH_Pnig_2000_24	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_38	CSIBUB_Re_CH_Pnig_2000_25	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_39	CSIBUB_Re_CH_Pnig_2000_26	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_40	CSIBUB_Re_CH_Pnig_2000_27	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
CSIBUB_02_42	CSIBUB_Re_CH_Pnig_2000_28	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_44	CSIBUB_Re_CH_Pnig_2000_29	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_02_45	CSIBUB_Re_CH_Pnig_2000_30	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Basel
CSIBUB_03_01	CSIBUB_Re_CH_Psom_2004_01	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_02	CSIBUB_Re_CH_Psom_2004_02	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_03	CSIBUB_Re_CH_Psom_2004_03	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_04	CSIBUB_Re_CH_Psom_2004_04	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_05	CSIBUB_Re_CH_Psom_2004_05	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_06	CSIBUB_Re_CH_Psom_2004_06	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_07	CSIBUB_Re_CH_Psom_2004_07	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_08	CSIBUB_Re_CH_Psom_2004_08	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_09	CSIBUB_Re_CH_Psom_2004_09	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_10	CSIBUB_Re_CH_Psom_2004_10	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_11	CSIBUB_Re_CH_Psom_2004_11	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_12	CSIBUB_Re_CH_Psom_2004_12	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_13	CSIBUB_Re_CH_Psom_2004_13	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_14	CSIBUB_Re_CH_Psom_2004_14	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_15	CSIBUB_Re_CH_Psom_2004_15	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_16	CSIBUB_Re_CH_Psom_2004_16	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_17	CSIBUB_Re_CH_Psom_2004_17	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_18	CSIBUB_Re_CH_Psom_2004_18	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_19	CSIBUB_Re_CH_Psom_2004_19	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_20	CSIBUB_Re_CH_Psom_2004_20	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_21	CSIBUB_Re_CH_Psom_2004_21	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_22	CSIBUB_Re_CH_Psom_2004_22	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_23	CSIBUB_Re_CH_Psom_2004_23	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_24	CSIBUB_Re_CH_Psom_2004_24	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_25	CSIBUB_Re_CH_Psom_2004_25	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_26	CSIBUB_Re_CH_Psom_2004_26	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_27	CSIBUB_Re_CH_Psom_2004_27	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_28	CSIBUB_Re_CH_Psom_2004_28	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_29	CSIBUB_Re_CH_Psom_2004_29	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
CSIBUB_03_30	CSIBUB_Re_CH_Psom_2004_30	2018	Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	Porrentruy
DG0002	DG_WG_ES_Parch_MP3_02		Raül Soteras	waterlogged	WG	DG	MP3M9.12	Surface sample	5/5 2mm	VII	2010	5300-5000		Spain	ES	Banyoles
DG0003	DG_WG_ES_Parch_MS324_03		Raül Soteras	waterlogged	WG	DG	MS324.KC80NE.VIII	Surface sample	0,35mm SM1 5/5	VII	2010	5300-5000		Spain	ES	Banyoles
DG0004	DG_WG_ES_Parch_MP3_04		Raül Soteras	waterlogged	WG	DG	MS324.KC80NE.VIII	Surface sample	0,35mm SM1 5/5	VII	2010	5300-5000		Spain	ES	Banyoles
DG0005	DG_WG_ES_Parch_MP3_05		Raül Soteras	waterlogged	WG	DG	MS324.KC80NE.VIII	Surface sample	0,35mm SM1 5/5	VII	2010	5300-5000		Spain	ES	Banyoles
DG0008	DG_WG_ES_Parch_M13_08		Raül Soteras	WG	WG	DG	MP3M13.15	profile sample	0,35m 5/5	VII	2010	5300-5000		Spain	ES	Banyoles
DG0009	DG_Ch_ES_Parch_JB41_09		Raül Soteras	Charred	CH		DG14-247_JB41-E258/1	Surface sample	0.5	VII	2014	5300-5000		Spain	ES	Banyoles
DG0010	DG_Ch_ES_Parch_JO_10		Raül Soteras	Charred	CH		DG204JOJE78/7001	Surface sample	0.5	7001	2011	5300-5000		Spain	ES	Banyoles
DG0011	DG_Ch_ES_Parch_JO_11		Raül Soteras	Charred	CH		DG204JOJE78/7001	Surface sample	0.5	7001	2011	5300-5000		Spain	ES	Banyoles
DG0014	DG_Ch_ES_Parch_JH_14		Raül Soteras	Charred	CH		lo98.JH84,85II	Surface sample		VII	1998	5300-5000		Spain	ES	Banyoles
DG0023	DG_WG_ES_Parch_VIII_23		Raül Soteras	WG	WG	DG10MS.343,80,NEVIIIM 8,11	DG10MS.343,80,NEVIIIM 8,11	Surface sample	0,5SM2	VII	2010	5300-5000		Spain	ES	Banyoles
DG0029	DG_WG_ES_Parch_VIII_29		Raül Soteras	WG	WG	DG10MS.343,80,NEVIIIM 8,11	DG10MS.343,80,NEVIIIM 8,11	Surface sample	0,5SM2	VII	2010	5300-5000		Spain	ES	Banyoles
DG0038	DG_WG_ES_Parch_MS32_38		Raül Soteras	WG	WG	DG12.MS32 REST PROBE	DG12.MS32 REST PROBE	Surface sample	0.35	VII	2010	5300-5000		Spain	ES	Banyoles
DG0039	DG_WG_ES_Parch_MS32_39		Raül Soteras	WG	WG	DG12.MS32 REST PROBE	DG12.MS32 REST PROBE	Surface sample	0.35	VII	2010	5300-5000		Spain	ES	Banyoles
DG0040	DG_WG_ES_Parch_MS32_40		Raül Soteras	WG	WG	DG12.MS32 REST PROBE	DG12.MS32 REST PROBE	Surface sample	0.35	VII	2010	5300-5000		Spain	ES	Banyoles
DG0041	DG_WG_ES_Parch_MS32_41		Raül Soteras	WG	WG	DG12.MS32 REST PROBE	DG12.MS32 REST PROBE	Surface sample	0.35	VII	2010	5300-5000		Spain	ES	Banyoles
DG0043	DG_WG_ES_Parch_MS82_43		Raül Soteras	WG	WG	DG12MS82IJ81NEVIISP1	DG12MS82IJ81NEVIISP1	Surface sample	0.35	VII	2012	5300-5000		Spain	ES	Banyoles
DG0045	DG_WG_ES_Parch_MP3_45		Raül Soteras	WG	WG	DG10MP3M7-8	DG10MP3M7-8	profile sample	2MM	VII	2010	5300-5000		Spain	ES	Banyoles
DG0047	DG_WG_ES_Parch_MP3_47		Raül Soteras	WG	WG	DG10MP3M7-8	DG10MP3M7-8	profile sample	2MM	VII	2010	5300-5000		Spain	ES	Banyoles
DG0048	DG_WG_ES_Parch_MS40_48		Raül Soteras	WG	WG	DG10MS407KA78NEVIII	DG10MS407KA78NEVIII	Surface sample		VII	2010	5300-5000		Spain	ES	Banyoles
DG0049	DG_WG_ES_Parch_MP3_49		Raül Soteras	WG	WG	DG10.MP3M6.7	DG10.MP3M6.7	profile sample	2MM	VII	2010	5300-5000		Spain	ES	Banyoles
DG0051	DG_WG_ES_Parch_MP3_51		Raül Soteras	WG	WG	DG10.MP3M6.7	DG10.MP3M6.7	profile sample	2MM	VII	2010	5300-5000		Spain	ES	Banyoles
DG0052	DG_WG_ES_Parch_MP3_52		Raül Soteras	WG	WG	DG10.MP3M6.7	DG10.MP3M6.7	profile sample	2MM	VII	2010	5300-5000		Spain	ES	Banyoles
DG0059	DG_WG_ES_Parch_MS3_59		Raül Soteras	WG	WG	DG10.MS324KC80NEVIII	DG10.MS324KC80NEVIII	Surface sample	2	VII	2010	5300-5000		Spain	ES	Banyoles
DG0062	DG_WG_ES_Parch_MS40_62		Raül Soteras	WG	WG	DG10MS407SMKA78NE VIII	DG10MS407SMKA78NE VIII	Surface sample	0.35	VII	2010	5300-5000		Spain	ES	Banyoles
DG0066	DG_WG_ES_Parch_MP3_66		Raül Soteras	WG	WG	DG10MP3.M9.12	DG10MP3.M9.12	profile sample	0.35	VII	2010	5300-5000		Spain	ES	Banyoles
DG0067	DG_WG_ES_Parch_MP3_67		Raül Soteras	WG	WG	DG10MP3.M9.12	DG10MP3.M9.12	profile sample	0.35	VII	2010	5300-5000		Spain	ES	Banyoles
DG0068	DG_WG_ES_Parch_MP3_68		Raül Soteras	WG	WG	DG10MP3.M9.12	DG10MP3.M9.12	profile sample	0.35	VII	2010	5300-5000		Spain	ES	Banyoles
DG0071	DG_WG_ES_Parch_MP3_71		Raül Soteras	WG	WG	DG10MP3.M9.12	DG10MP3.M9.12	profile sample	0.35	VII	2010	5300-5000		Spain	ES	Banyoles
ZHOPE0001	ZHOPE_WG_CH_Parch_12015_01		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
ZHOPE0002	ZHOPE_WG_CH_Parch_12015_02		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0003	ZHOPE_WG_CH_Parch_12015_03		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0004	ZHOPE_WG_CH_Parch_12015_04		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0005	ZHOPE_WG_CH_Parch_12015_05		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0006	ZHOPE_WG_CH_Parch_12015_06		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0007	ZHOPE_WG_CH_Parch_12015_07		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0008	ZHOPE_WG_CH_Parch_12015_08		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0009	ZHOPE_WG_CH_Parch_12015_09		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0011	ZHOPE_WG_CH_Parch_12015_11		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0012	ZHOPE_WG_CH_Parch_12015_12		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0013	ZHOPE_WG_CH_Parch_12015_13		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0014	ZHOPE_WG_CH_Parch_12015_14		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0015	ZHOPE_WG_CH_Parch_12015_15		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0016	ZHOPE_WG_CH_Parch_12015_16		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0017	ZHOPE_WG_CH_Parch_12015_17		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0018	ZHOPE_WG_CH_Parch_12015_18		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0019	ZHOPE_WG_CH_Parch_12015_19		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0020	ZHOPE_WG_CH_Parch_12015_20		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0021	ZHOPE_WG_CH_Parch_12015_21		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0022	ZHOPE_WG_CH_Parch_12015_22		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0023	ZHOPE_WG_CH_Parch_12015_23		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0024	ZHOPE_WG_CH_Parch_12015_24		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0025	ZHOPE_WG_CH_Parch_12015_25		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0026	ZHOPE_WG_CH_Parch_12015_26		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0027	ZHOPE_WG_CH_Parch_12015_27		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0028	ZHOPE_WG_CH_Parch_12015_28		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0029	ZHOPE_WG_CH_Parch_12015_29		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0030	ZHOPE_WG_CH_Parch_12015_30		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0031	ZHOPE_WG_CH_Parch_12015_31		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0032	ZHOPE_WG_CH_Parch_12015_32		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0033	ZHOPE_WG_CH_Parch_12015_33		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
ZHOPE0034	ZHOPE_WG_CH_Parch_12015_34		Raül Soteras	WG	WG	ZHOPE	12015.18.	profile sample	0,35mm	13	2011	3200-3100		Switzerland	CH	Zurich
GRA001_01	Gra_Re_FR_Pset_0000_01		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_02	Gra_Re_FR_Pset_0000_02		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_03	Gra_Re_FR_Pset_0000_03		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_04	Gra_Re_FR_Pset_0000_04		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_05	Gra_Re_FR_Pset_0000_05		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_06	Gra_Re_FR_Pset_0000_06		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_07	Gra_Re_FR_Pset_0000_07		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_08	Gra_Re_FR_Pset_0000_08		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_09	Gra_Re_FR_Pset_0000_09		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_10	Gra_Re_FR_Pset_0000_10		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_11	Gra_Re_FR_Pset_0000_11		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_12	Gra_Re_FR_Pset_0000_12		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_13	Gra_Re_FR_Pset_0000_13		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_14	Gra_Re_FR_Pset_0000_14		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_15	Gra_Re_FR_Pset_0000_15		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_16	Gra_Re_FR_Pset_0000_16		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_17	Gra_Re_FR_Pset_0000_17		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_18	Gra_Re_FR_Pset_0000_18		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_19	Gra_Re_FR_Pset_0000_19		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_20	Gra_Re_FR_Pset_0000_20		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_21	Gra_Re_FR_Pset_0000_21		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_22	Gra_Re_FR_Pset_0000_22		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_23	Gra_Re_FR_Pset_0000_23		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_24	Gra_Re_FR_Pset_0000_24		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_25	Gra_Re_FR_Pset_0000_25		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_26	Gra_Re_FR_Pset_0000_26		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_27	Gra_Re_FR_Pset_0000_27		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_28	Gra_Re_FR_Pset_0000_28		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_29	Gra_Re_FR_Pset_0000_29		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA001_30	Gra_Re_FR_Pset_0000_30		Raül Soteras	Modern	RE	GRA								France	Fr	

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
GRA002_01	Gra_Re_FR_Psom_0000_01		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_02	Gra_Re_FR_Psom_0000_02		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_03	Gra_Re_FR_Psom_0000_03		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_04	Gra_Re_FR_Psom_0000_04		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_05	Gra_Re_FR_Psom_0000_05		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_06	Gra_Re_FR_Psom_0000_06		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_07	Gra_Re_FR_Psom_0000_07		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_08	Gra_Re_FR_Psom_0000_08		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_09	Gra_Re_FR_Psom_0000_09		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_10	Gra_Re_FR_Psom_0000_10		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_11	Gra_Re_FR_Psom_0000_11		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_12	Gra_Re_FR_Psom_0000_12		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_13	Gra_Re_FR_Psom_0000_13		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_14	Gra_Re_FR_Psom_0000_14		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_15	Gra_Re_FR_Psom_0000_15		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_16	Gra_Re_FR_Psom_0000_16		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_17	Gra_Re_FR_Psom_0000_17		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_18	Gra_Re_FR_Psom_0000_18		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_19	Gra_Re_FR_Psom_0000_19		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_20	Gra_Re_FR_Psom_0000_20		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_21	Gra_Re_FR_Psom_0000_21		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_22	Gra_Re_FR_Psom_0000_22		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_23	Gra_Re_FR_Psom_0000_23		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_24	Gra_Re_FR_Psom_0000_24		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_25	Gra_Re_FR_Psom_0000_25		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_26	Gra_Re_FR_Psom_0000_26		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_27	Gra_Re_FR_Psom_0000_27		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_28	Gra_Re_FR_Psom_0000_28		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_29	Gra_Re_FR_Psom_0000_29		Raül Soteras	Modern	RE	GRA								France	Fr	
GRA002_30	Gra_Re_FR_Psom_0000_30		Raül Soteras	Modern	RE	GRA								France	Fr	
IPNA_001_01	IPNA_Re_Hu_Psom_1988_01		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_02	IPNA_Re_Hu_Psom_1988_02		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_03	IPNA_Re_Hu_Psom_1988_03		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_04	IPNA_Re_Hu_Psom_1988_04		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_05	IPNA_Re_Hu_Psom_1988_05		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_06	IPNA_Re_Hu_Psom_1988_06		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_07	IPNA_Re_Hu_Psom_1988_07		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_08	IPNA_Re_Hu_Psom_1988_08		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_09	IPNA_Re_Hu_Psom_1988_09		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_10	IPNA_Re_Hu_Psom_1988_10		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_11	IPNA_Re_Hu_Psom_1988_11		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_12	IPNA_Re_Hu_Psom_1988_12		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_13	IPNA_Re_Hu_Psom_1988_13		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_14	IPNA_Re_Hu_Psom_1988_14		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_15	IPNA_Re_Hu_Psom_1988_15		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_16	IPNA_Re_Hu_Psom_1988_16		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_17	IPNA_Re_Hu_Psom_1988_17		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_18	IPNA_Re_Hu_Psom_1988_18		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_19	IPNA_Re_Hu_Psom_1988_19		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_20	IPNA_Re_Hu_Psom_1988_20		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_21	IPNA_Re_Hu_Psom_1988_21		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_22	IPNA_Re_Hu_Psom_1988_22		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_23	IPNA_Re_Hu_Psom_1988_23		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_24	IPNA_Re_Hu_Psom_1988_24		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_25	IPNA_Re_Hu_Psom_1988_25		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_26	IPNA_Re_Hu_Psom_1988_26		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_27	IPNA_Re_Hu_Psom_1988_27		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_28	IPNA_Re_Hu_Psom_1988_28		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_29	IPNA_Re_Hu_Psom_1988_29		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA_001_30	IPNA_Re_Hu_Psom_1988_30		Raül Soteras	Modern	RE	IPNA								Hungary	Hu	
IPNA002_01	IPNA_Re_IT_Pset_1983_01		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_02	IPNA_Re_IT_Pset_1983_02		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_03	IPNA_Re_IT_Pset_1983_03		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_04	IPNA_Re_IT_Pset_1983_04		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_05	IPNA_Re_IT_Pset_1983_05		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_06	IPNA_Re_IT_Pset_1983_06		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_07	IPNA_Re_IT_Pset_1983_07		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_08	IPNA_Re_IT_Pset_1983_08		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_09	IPNA_Re_IT_Pset_1983_09		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_10	IPNA_Re_IT_Pset_1983_10		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_11	IPNA_Re_IT_Pset_1983_11		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_12	IPNA_Re_IT_Pset_1983_12		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
IPNA002_13	IPNA_Re_IT_Pset_1983_13		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_14	IPNA_Re_IT_Pset_1983_14		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_15	IPNA_Re_IT_Pset_1983_15		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_16	IPNA_Re_IT_Pset_1983_16		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_17	IPNA_Re_IT_Pset_1983_17		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_18	IPNA_Re_IT_Pset_1983_18		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_19	IPNA_Re_IT_Pset_1983_19		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_20	IPNA_Re_IT_Pset_1983_20		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_21	IPNA_Re_IT_Pset_1983_21		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_22	IPNA_Re_IT_Pset_1983_22		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_23	IPNA_Re_IT_Pset_1983_23		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_24	IPNA_Re_IT_Pset_1983_24		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_25	IPNA_Re_IT_Pset_1983_25		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_26	IPNA_Re_IT_Pset_1983_26		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_27	IPNA_Re_IT_Pset_1983_27		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_28	IPNA_Re_IT_Pset_1983_28		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_29	IPNA_Re_IT_Pset_1983_29		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
IPNA002_30	IPNA_Re_IT_Pset_1983_30		Raül Soteras	Modern	RE	IPNA								Italy	IT	Elba island
CSIBUB05_01	CSIBUB_Re_Au_Prho_1982_01		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_02	CSIBUB_Re_Au_Prho_1982_02		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_03	CSIBUB_Re_Au_Prho_1982_03		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_04	CSIBUB_Re_Au_Prho_1982_04		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_05	CSIBUB_Re_Au_Prho_1982_05		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_06	CSIBUB_Re_Au_Prho_1982_06		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_07	CSIBUB_Re_Au_Prho_1982_07		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_08	CSIBUB_Re_Au_Prho_1982_08		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_09	CSIBUB_Re_Au_Prho_1982_09		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_10	CSIBUB_Re_Au_Prho_1982_10		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_11	CSIBUB_Re_Au_Prho_1982_11		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_12	CSIBUB_Re_Au_Prho_1982_12		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_13	CSIBUB_Re_Au_Prho_1982_13		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_14	CSIBUB_Re_Au_Prho_1982_14		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_15	CSIBUB_Re_Au_Prho_1982_15		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_16	CSIBUB_Re_Au_Prho_1982_16		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_17	CSIBUB_Re_Au_Prho_1982_17		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_18	CSIBUB_Re_Au_Prho_1982_18		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_19	CSIBUB_Re_Au_Prho_1982_19		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_20	CSIBUB_Re_Au_Prho_1982_20		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_21	CSIBUB_Re_Au_Prho_1982_21		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_22	CSIBUB_Re_Au_Prho_1982_22		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_23	CSIBUB_Re_Au_Prho_1982_23		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_24	CSIBUB_Re_Au_Prho_1982_24		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_25	CSIBUB_Re_Au_Prho_1982_25		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_26	CSIBUB_Re_Au_Prho_1982_26		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_27	CSIBUB_Re_Au_Prho_1982_27		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_28	CSIBUB_Re_Au_Prho_1982_28		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_29	CSIBUB_Re_Au_Prho_1982_29		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB05_30	CSIBUB_Re_Au_Prho_1982_30		Raül Soteras	Modern	RE	CSIBUB								Austria	A	Salzburg
CSIBUB06_1	CSIBUB_Re_DE_Phyb_1984_01		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_2	CSIBUB_Re_DE_Phyb_1984_02		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_3	CSIBUB_Re_DE_Phyb_1984_03		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_4	CSIBUB_Re_DE_Phyb_1984_04		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_5	CSIBUB_Re_DE_Phyb_1984_05		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_6	CSIBUB_Re_DE_Phyb_1984_06		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_7	CSIBUB_Re_DE_Phyb_1984_07		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_8	CSIBUB_Re_DE_Phyb_1984_08		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_9	CSIBUB_Re_DE_Phyb_1984_09		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_10	CSIBUB_Re_DE_Phyb_1984_10		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_11	CSIBUB_Re_DE_Phyb_1984_11		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_12	CSIBUB_Re_DE_Phyb_1984_12		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_13	CSIBUB_Re_DE_Phyb_1984_13		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_14	CSIBUB_Re_DE_Phyb_1984_14		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_15	CSIBUB_Re_DE_Phyb_1984_15		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_16	CSIBUB_Re_DE_Phyb_1984_16		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_17	CSIBUB_Re_DE_Phyb_1984_17		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_18	CSIBUB_Re_DE_Phyb_1984_18		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_19	CSIBUB_Re_DE_Phyb_1984_19		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_20	CSIBUB_Re_DE_Phyb_1984_20		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_21	CSIBUB_Re_DE_Phyb_1984_21		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_22	CSIBUB_Re_DE_Phyb_1984_22		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_23	CSIBUB_Re_DE_Phyb_1984_23		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_24	CSIBUB_Re_DE_Phyb_1984_24		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
CSIBUB06_25	CSIBUB_Re_DE_Phyb_1984_25		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_26	CSIBUB_Re_DE_Phyb_1984_26		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_27	CSIBUB_Re_DE_Phyb_1984_27		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_28	CSIBUB_Re_DE_Phyb_1984_28		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_29	CSIBUB_Re_DE_Phyb_1984_29		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB06_30	CSIBUB_Re_DE_Phyb_1984_30		Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Karlsruhe
CSIBUB08_01	CSIBUB_Re_De_Parg_1976_01	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_02	CSIBUB_Re_De_Parg_1976_02	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_03	CSIBUB_Re_De_Parg_1976_03	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_04	CSIBUB_Re_De_Parg_1976_04	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_05	CSIBUB_Re_De_Parg_1976_05	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_06	CSIBUB_Re_De_Parg_1976_06	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_07	CSIBUB_Re_De_Parg_1976_07	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_08	CSIBUB_Re_De_Parg_1976_08	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_09	CSIBUB_Re_De_Parg_1976_09	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_10	CSIBUB_Re_De_Parg_1976_10	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_11	CSIBUB_Re_De_Parg_1976_11	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_12	CSIBUB_Re_De_Parg_1976_12	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_13	CSIBUB_Re_De_Parg_1976_13	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_14	CSIBUB_Re_De_Parg_1976_14	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_15	CSIBUB_Re_De_Parg_1976_15	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_16	CSIBUB_Re_De_Parg_1976_16	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_17	CSIBUB_Re_De_Parg_1976_17	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_18	CSIBUB_Re_De_Parg_1976_18	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_19	CSIBUB_Re_De_Parg_1976_19	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_20	CSIBUB_Re_De_Parg_1976_20	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_21	CSIBUB_Re_De_Parg_1976_21	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_22	CSIBUB_Re_De_Parg_1976_22	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_23	CSIBUB_Re_De_Parg_1976_23	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_24	CSIBUB_Re_De_Parg_1976_24	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_25	CSIBUB_Re_De_Parg_1976_25	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_26	CSIBUB_Re_De_Parg_1976_26	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_27	CSIBUB_Re_De_Parg_1976_27	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_28	CSIBUB_Re_De_Parg_1976_28	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_29	CSIBUB_Re_De_Parg_1976_29	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB08_30	CSIBUB_Re_De_Parg_1976_30	May 2019	Raül Soteras	Modern	RE	CSIBUB								Germany	DE	Tübingen
CSIBUB07_01	CSIBUB_Re_CH_Pdub_1997_01		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_02	CSIBUB_Re_CH_Pdub_1997_02		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_03	CSIBUB_Re_CH_Pdub_1997_03		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_04	CSIBUB_Re_CH_Pdub_1997_04		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_05	CSIBUB_Re_CH_Pdub_1997_05		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_06	CSIBUB_Re_CH_Pdub_1997_06		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_07	CSIBUB_Re_CH_Pdub_1997_07		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_08	CSIBUB_Re_CH_Pdub_1997_08		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_09	CSIBUB_Re_CH_Pdub_1997_09		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_10	CSIBUB_Re_CH_Pdub_1997_10		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_11	CSIBUB_Re_CH_Pdub_1997_11		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_12	CSIBUB_Re_CH_Pdub_1997_12		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_13	CSIBUB_Re_CH_Pdub_1997_13		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_14	CSIBUB_Re_CH_Pdub_1997_14		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_15	CSIBUB_Re_CH_Pdub_1997_15		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_16	CSIBUB_Re_CH_Pdub_1997_16		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_17	CSIBUB_Re_CH_Pdub_1997_17		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_18	CSIBUB_Re_CH_Pdub_1997_18		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_19	CSIBUB_Re_CH_Pdub_1997_19		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_20	CSIBUB_Re_CH_Pdub_1997_20		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_21	CSIBUB_Re_CH_Pdub_1997_21		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_22	CSIBUB_Re_CH_Pdub_1997_22		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_23	CSIBUB_Re_CH_Pdub_1997_23		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_24	CSIBUB_Re_CH_Pdub_1997_24		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_25	CSIBUB_Re_CH_Pdub_1997_25		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_26	CSIBUB_Re_CH_Pdub_1997_26		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_27	CSIBUB_Re_CH_Pdub_1997_27		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_28	CSIBUB_Re_CH_Pdub_1997_28		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_29	CSIBUB_Re_CH_Pdub_1997_29		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
CSIBUB07_30	CSIBUB_Re_CH_Pdub_1997_30		Raül Soteras	Modern	RE	CSIBUB								Switzerland	CH	
ISBA_01_01	ISBA_WG_FR_Psom_St990_P28S01		Raül Soteras	waterlogged	WG	ISBA	P28		0,35mm		2015	4100-4000	Well 990	France	FR	Isle-sur-la-Sorgue
ISBA_02_01	ISBA_WG_FR_Psom_St990_P70S01		Raül Soteras	waterlogged	WG	ISBA	P70		0,35mm	615	2015	4100-4000	Well 990	France	FR	Isle-sur-la-Sorgue
ISBA_03_01	ISBA_WG_FR_Psom_St990_P73S01		Raül Soteras	waterlogged	WG	ISBA	P73		0,35mm	618	2015	4100-4000	Well 990	France	FR	Isle-sur-la-Sorgue
ISBA_03_02	ISBA_WG_FR_Psom_St990_P73S02		Raül Soteras	waterlogged	WG	ISBA	P73		0,35mm	618	2015	4100-4000	Well 990	France	FR	Isle-sur-la-Sorgue
ISBA_03_03	ISBA_WG_FR_Psom_St990_P73S03		Raül Soteras	waterlogged	WG	ISBA	P73		0,35mm	618	2015	4100-4000	Well 990	France	FR	Isle-sur-la-Sorgue

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
ISBA_04_01	ISBA_WG_FR_Psom_St990_P74S01		Raül Soteras	waterlogged	WG	ISBA	P74	dug in spits (artificial levels) of 20 and 10 cm	0,35mm	619	2015	4100-4000	Well 990	France	FR	Isle-sur-la-Sorgue
ISBA_05_01	ISBA_WG_FR_Psom_St994_P41S01		Raül Soteras	waterlogged	WG	ISBA	P41		1mm	621	2015	4000-3800	Well 994	France	FR	Isle-sur-la-Sorgue
ISBA_06_01	ISBA_WG_FR_Psom_St994_P42S01		Raül Soteras	waterlogged	WG	ISBA	P42		0.35	622	2015	4000-3800	Well 994	France	FR	Isle-sur-la-Sorgue
ISBA_09_01	ISBA_WG_FR_Psom_St994_P44_2S09		Raül Soteras	waterlogged	WG	ISBA	P44 2 eimer		0.35	624	2015	4000-3800	Well 994	France	FR	Isle-sur-la-Sorgue
ISBA_10_01	ISBA_WG_FR_Psom_St250N_P40S01		Raül Soteras	waterlogged	WG	ISBA	P40		0.35	399	2014	4300-4100	Well 250N	France	FR	Isle-sur-la-Sorgue
ISBA_11_01	ISBA_WG_FR_Psom_St250N_P41S01		Raül Soteras	waterlogged	WG	ISBA	P41		0.35	410	2014	4300-4100	Well 250N	France	FR	Isle-sur-la-Sorgue
ISBA_13_07	ISBA_WG_FR_Psom_St250N_P41S10		Raül Soteras	waterlogged	WG	ISBA	P41 2 eimer		0.35	410	2014	4300-4100	Well 250N	France	FR	Isle-sur-la-Sorgue
ISBA_14_01	ISBA_WG_FR_Psom_St250N_P41S12		Raül Soteras	waterlogged	WG	ISBA	P41 3 eimer		0.35	410	2014	4300-4100	Well 250N	France	FR	Isle-sur-la-Sorgue
ISBA_14_04	ISBA_WG_FR_Psom_St250N_P41S15		Raül Soteras	waterlogged	WG	ISBA	P41 3 eimer		0.35	410	2014	4300-4100	Well 250N	France	FR	Isle-sur-la-Sorgue
ISBA_15_01	ISBA_WG_FR_Psom_St250N_P42S01		Raül Soteras	waterlogged	WG	ISBA	P42		0.35	401	2014	4300-4100	Well 250N	France	FR	Isle-sur-la-Sorgue
ISBA_16_01	ISBA_WG_FR_Psom_St250N_P42S02		Raül Soteras	waterlogged	WG	ISBA	P42		0.35	401	2014	4300-4100	Well 250N	France	FR	Isle-sur-la-Sorgue
Arb_3803_01	Arb_WG_CH_Psom_LN_01		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_02	Arb_WG_CH_Psom_LN_02		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_03	Arb_WG_CH_Psom_LN_03		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_04	Arb_WG_CH_Psom_LN_04		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_05	Arb_WG_CH_Psom_LN_05		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_06	Arb_WG_CH_Psom_LN_06		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_07	Arb_WG_CH_Psom_LN_07		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_08	Arb_WG_CH_Psom_LN_08		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_09	Arb_WG_CH_Psom_LN_09		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_10	Arb_WG_CH_Psom_LN_10		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_11	Arb_WG_CH_Psom_LN_11		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_12	Arb_WG_CH_Psom_LN_12		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_13	Arb_WG_CH_Psom_LN_13		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_14	Arb_WG_CH_Psom_LN_14		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_15	Arb_WG_CH_Psom_LN_15		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_16	Arb_WG_CH_Psom_LN_16		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_17	Arb_WG_CH_Psom_LN_17		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_18	Arb_WG_CH_Psom_LN_18		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_19	Arb_WG_CH_Psom_LN_19		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_20	Arb_WG_CH_Psom_LN_20		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_21	Arb_WG_CH_Psom_LN_21		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_22	Arb_WG_CH_Psom_LN_22		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_23	Arb_WG_CH_Psom_LN_23		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_24	Arb_WG_CH_Psom_LN_24		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_25	Arb_WG_CH_Psom_LN_25		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_26	Arb_WG_CH_Psom_LN_26		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_27	Arb_WG_CH_Psom_LN_27		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_28	Arb_WG_CH_Psom_LN_28		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_29	Arb_WG_CH_Psom_LN_29		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
Arb_3803_30	Arb_WG_CH_Psom_LN_30		Raül Soteras	waterlogged	WG	Arbon Bleiche	3803	surface sampling	0.05	3803?	1993-1995	3400-3350	House 14	Switzerland	CH	Arbon
KH_1010_01	KH5_WG_CH_Psom_1010_01		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010_02	KH5_WG_CH_Psom_1010_02		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010_03	KH5_WG_CH_Psom_1010_03		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010_04	KH5_WG_CH_Psom_1010_04		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010_05	KH5_WG_CH_Psom_1010_05		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010_06	KH5_WG_CH_Psom_1010_06		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010_07	KH5_WG_CH_Psom_1010_07		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010_08	KH5_WG_CH_Psom_1010_08		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_09	KH5_WG_CH_Psom_1010L_09		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_10	KH5_WG_CH_Psom_1010L_10		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_11	KH5_WG_CH_Psom_1010L_11		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_12	KH5_WG_CH_Psom_1010L_12		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_13	KH5_WG_CH_Psom_1010L_13		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_14	KH5_WG_CH_Psom_1010L_14		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_15	KH5_WG_CH_Psom_1010L_15		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_16	KH5_WG_CH_Psom_1010L_16		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_17	KH5_WG_CH_Psom_1010L_17		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_18	KH5_WG_CH_Psom_1010L_18		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_19	KH5_WG_CH_Psom_1010L_19		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_20	KH5_WG_CH_Psom_1010L_20		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_21	KH5_WG_CH_Psom_1010L_21		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1010L_22	KH5_WG_CH_Psom_1010L_22		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1009_23	KH5_WG_CH_Psom_1009_23		Raül Soteras	waterlogged	WG	Kleiner Hafner	1009	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1009_24	KH5_WG_CH_Psom_1009_24		Raül Soteras	waterlogged	WG	Kleiner Hafner	1010	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1009_25	KH5_WG_CH_Psom_1009_25		Raül Soteras	waterlogged	WG	Kleiner Hafner	1011	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
KH_1009_26	KH5_WG_CH_Psom_1009_26		Raül Soteras	waterlogged	WG	Kleiner Hafner	1012	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1009_27	KH5_WG_CH_Psom_1009_27		Raül Soteras	waterlogged	WG	Kleiner Hafner	1013	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1009_28	KH5_WG_CH_Psom_1009_28		Raül Soteras	waterlogged	WG	Kleiner Hafner	1014	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1009_29	KH5_WG_CH_Psom_1009_29		Raül Soteras	waterlogged	WG	Kleiner Hafner	1015	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
KH_1009_30	KH5_WG_CH_Psom_1009_30		Raül Soteras	waterlogged	WG	Kleiner Hafner	1016	profile columns		Layer 5	1967-69;1981-84;1985	4300-4000		Switzerland	CH	Zürich
E_3_01	EG3_WG_CH_Psom_86_01		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_02	EG3_WG_CH_Psom_86_02		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_03	EG3_WG_CH_Psom_86_03		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_04	EG3_WG_CH_Psom_86_04		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_05	EG3_WG_CH_Psom_86_05		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_06	EG3_WG_CH_Psom_86_06		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_07	EG3_WG_CH_Psom_86_07		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_08	EG3_WG_CH_Psom_86_08		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_09	EG3_WG_CH_Psom_86_09		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_10	EG3_WG_CH_Psom_86_10		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_11	EG3_WG_CH_Psom_86_11		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_12	EG3_WG_CH_Psom_86_12		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_13	EG3_WG_CH_Psom_86_13		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_14	EG3_WG_CH_Psom_86_14		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_15	EG3_WG_CH_Psom_86_15		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_16	EG3_WG_CH_Psom_86_16		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_17	EG3_WG_CH_Psom_86_17		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_18	EG3_WG_CH_Psom_86_18		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_19	EG3_WG_CH_Psom_86_19		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_20	EG3_WG_CH_Psom_86_20		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_21	EG3_WG_CH_Psom_86_21		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_22	EG3_WG_CH_Psom_86_22		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_23	EG3_WG_CH_Psom_86_23		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_24	EG3_WG_CH_Psom_86_24		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_25	EG3_WG_CH_Psom_86_25		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_26	EG3_WG_CH_Psom_86_26		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_27	EG3_WG_CH_Psom_86_27		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_28	EG3_WG_CH_Psom_86_28		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_29	EG3_WG_CH_Psom_86_29		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
E_3_30	EG3_WG_CH_Psom_86_30		Raül Soteras	waterlogged	WG	Egolzwil	86	profile column; systematic;judgemnet		3	1950;52;1985-88	4300-4000		Switzerland	CH	Egolzwil
ISVA18_B_243_01	ISVA18_WG_IT_Psom_B243_01		Raül Soteras	waterlogged	WG	Isolino	B243	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_243_02	ISVA18_WG_IT_Psom_B243_02		Raül Soteras	waterlogged	WG	Isolino	B243	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_243_04	ISVA18_WG_IT_Psom_B243_04		Raül Soteras	waterlogged	WG	Isolino	B243	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_243_12	ISVA18_WG_IT_Psom_B243_12		Raül Soteras	waterlogged	WG	Isolino	B243	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_1	ISVA18_WG_IT_Psom_B263_01		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_3	ISVA18_WG_IT_Psom_B263_03		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_5	ISVA18_WG_IT_Psom_B263_05		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_8	ISVA18_WG_IT_Psom_B263_08		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_10	ISVA18_WG_IT_Psom_B263_10		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_12	ISVA18_WG_IT_Psom_B263_12		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_13	ISVA18_WG_IT_Psom_B263_13		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_14	ISVA18_WG_IT_Psom_B263_14		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_15	ISVA18_WG_IT_Psom_B263_15		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_263_16	ISVA18_WG_IT_Psom_B263_16		Raül Soteras	waterlogged	WG	Isolino	B263	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_264_02	ISVA18_WG_IT_Psom_B264_02		Raül Soteras	waterlogged	WG	Isolino	B264	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_264_03	ISVA18_WG_IT_Psom_B264_03		Raül Soteras	waterlogged	WG	Isolino	B264	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_264_05	ISVA18_WG_IT_Psom_B264_05		Raül Soteras	waterlogged	WG	Isolino	B264	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_264_06	ISVA18_WG_IT_Psom_B264_06		Raül Soteras	waterlogged	WG	Isolino	B264	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_264_08	ISVA18_WG_IT_Psom_B264_08		Raül Soteras	waterlogged	WG	Isolino	B264	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_264_09	ISVA18_WG_IT_Psom_B264_09		Raül Soteras	waterlogged	WG	Isolino	B264	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_264_10	ISVA18_WG_IT_Psom_B264_10		Raül Soteras	waterlogged	WG	Isolino	B264	thin bores			2018	5000-4800		Switzerland	CH	Varese
ISVA18_B_297_02	ISVA18_WG_IT_Psom_B297_02		Raül Soteras	waterlogged	WG	Isolino	B297	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_297_06	ISVA18_WG_IT_Psom_B297_06		Raül Soteras	waterlogged	WG	Isolino	B297	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_297_08	ISVA18_WG_IT_Psom_B297_08		Raül Soteras	waterlogged	WG	Isolino	B297	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_297_09	ISVA18_WG_IT_Psom_B297_09		Raül Soteras	waterlogged	WG	Isolino	B297	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_01	ISVA18_WG_IT_Psom_B298_01		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_04	ISVA18_WG_IT_Psom_B298_04		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_05	ISVA18_WG_IT_Psom_B298_05		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_06	ISVA18_WG_IT_Psom_B298_06		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_08	ISVA18_WG_IT_Psom_B298_08		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_09	ISVA18_WG_IT_Psom_B298_09		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_10	ISVA18_WG_IT_Psom_B298_10		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
ISVA18_B_298_11	ISVA18_WG_IT_Psom_B298_11		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_12	ISVA18_WG_IT_Psom_B298_12		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_14	ISVA18_WG_IT_Psom_B298_14		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_15	ISVA18_WG_IT_Psom_B298_15		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_298_16	ISVA18_WG_IT_Psom_B298_16		Raül Soteras	waterlogged	WG	Isolino	B298	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_300_01	ISVA18_WG_IT_Psom_B300_01		Raül Soteras	waterlogged	WG	Isolino	B300	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_300_02	ISVA18_WG_IT_Psom_B300_02		Raül Soteras	waterlogged	WG	Isolino	B300	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_300_03	ISVA18_WG_IT_Psom_B300_03		Raül Soteras	waterlogged	WG	Isolino	B300	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_300_04	ISVA18_WG_IT_Psom_B300_04		Raül Soteras	waterlogged	WG	Isolino	B300	thin bores			2018	4300-4000		Switzerland	CH	Varese
ISVA18_B_300_05	ISVA18_WG_IT_Psom_B300_05		Raül Soteras	waterlogged	WG	Isolino	B300	thin bores			2018	4300-4000		Switzerland	CH	Varese
KSZ9_1401_001	KSZ9_WG_CH_Parch_1401_01		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_002	KSZ9_WG_CH_Parch_1401_02		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_003	KSZ9_WG_CH_Parch_1401_03		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_004	KSZ9_WG_CH_Parch_1401_04		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_005	KSZ9_WG_CH_Parch_1401_05		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_006	KSZ9_WG_CH_Parch_1401_06		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_007	KSZ9_WG_CH_Parch_1401_07		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_008	KSZ9_WG_CH_Parch_1401_08		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_009	KSZ9_WG_CH_Parch_1401_09		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_010	KSZ9_WG_CH_Parch_1401_10		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_011	KSZ9_WG_CH_Parch_1401_11		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_012	KSZ9_WG_CH_Parch_1401_12		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_013	KSZ9_WG_CH_Parch_1401_13		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_014	KSZ9_WG_CH_Parch_1401_14		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_015	KSZ9_WG_CH_Parch_1401_15		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_016	KSZ9_WG_CH_Parch_1401_16		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_017	KSZ9_WG_CH_Parch_1401_17		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_018	KSZ9_WG_CH_Parch_1401_18		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_019	KSZ9_WG_CH_Parch_1401_19		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1401_020	KSZ9_WG_CH_Parch_1401_20		Raül Soteras	waterlogged	WG	KanSan	1401	profile column; judgemnet		9	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_021	KSZ9_WG_CH_Parch_1341_21		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_022	KSZ9_WG_CH_Parch_1341_22		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_023	KSZ9_WG_CH_Parch_1341_23		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_024	KSZ9_WG_CH_Parch_1341_24		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_025	KSZ9_WG_CH_Parch_1341_25		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_026	KSZ9_WG_CH_Parch_1341_26		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_027	KSZ9_WG_CH_Parch_1341_27		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_028	KSZ9_WG_CH_Parch_1341_28		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_029	KSZ9_WG_CH_Parch_1341_29		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
KSZ9_1341_030	KSZ9_WG_CH_Parch_1341_30		Raül Soteras	waterlogged	WG	KanSan	1341	profile column; judgemnet		D	1986–1988	3900-3700		Switzerland	CH	Zürich
ZGRI_73.7.01	ZGRI_WG_CH_Parch_LN_01		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.02	ZGRI_WG_CH_Parch_LN_02		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.03	ZGRI_WG_CH_Parch_LN_03		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.04	ZGRI_WG_CH_Parch_LN_04		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.05	ZGRI_WG_CH_Parch_LN_05		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.06	ZGRI_WG_CH_Parch_LN_06		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.07	ZGRI_WG_CH_Parch_LN_07		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.08	ZGRI_WG_CH_Parch_LN_08		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.09	ZGRI_WG_CH_Parch_LN_09		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.10	ZGRI_WG_CH_Parch_LN_10		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.11	ZGRI_WG_CH_Parch_LN_11		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.12	ZGRI_WG_CH_Parch_LN_12		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.13	ZGRI_WG_CH_Parch_LN_13		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.14	ZGRI_WG_CH_Parch_LN_14		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.15	ZGRI_WG_CH_Parch_LN_15		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.16	ZGRI_WG_CH_Parch_LN_16		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.17	ZGRI_WG_CH_Parch_LN_17		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.18	ZGRI_WG_CH_Parch_LN_18		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.19	ZGRI_WG_CH_Parch_LN_19		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.20	ZGRI_WG_CH_Parch_LN_20		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.21	ZGRI_WG_CH_Parch_LN_21		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.22	ZGRI_WG_CH_Parch_LN_22		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.23	ZGRI_WG_CH_Parch_LN_23		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.24	ZGRI_WG_CH_Parch_LN_24		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.25	ZGRI_WG_CH_Parch_LN_25		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.26	ZGRI_WG_CH_Parch_LN_26		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.27	ZGRI_WG_CH_Parch_LN_27		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug

Codes		Photos Info		Preservation	Preservation code	Site	Archaeological Info							Seed location Info		
Label	GMM code	Photo date	Photographer				Sample number	Sample type	Fraction	Layer number/SU	Excavation year	Chronology	Structure	Country	Country code	City
ZGRI_73.7.28	ZGRI_WG_CH_Parch_LN_28		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.29	ZGRI_WG_CH_Parch_LN_29		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZGRI_73.7.30	ZGRI_WG_CH_Parch_LN_30		Raül Soteras	waterlogged	WG	Zug Riedmatt	73.7	profile sample		U6	2006-2008	3250-3100	settlement layers	Switzerland	CH	Zug
ZUS_1430_01	ZUS_WG_CH_Parch_LB_01		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_02	ZUS_WG_CH_Parch_LB_02		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_03	ZUS_WG_CH_Parch_LB_03		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_04	ZUS_WG_CH_Parch_LB_04		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_05	ZUS_WG_CH_Parch_LB_05		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_06	ZUS_WG_CH_Parch_LB_06		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_07	ZUS_WG_CH_Parch_LB_07		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_08	ZUS_WG_CH_Parch_LB_08		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_09	ZUS_WG_CH_Parch_LB_09		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_10	ZUS_WG_CH_Parch_LB_10		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_11	ZUS_WG_CH_Parch_LB_11		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_12	ZUS_WG_CH_Parch_LB_12		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_13	ZUS_WG_CH_Parch_LB_13		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_14	ZUS_WG_CH_Parch_LB_14		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_15	ZUS_WG_CH_Parch_LB_15		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_16	ZUS_WG_CH_Parch_LB_16		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_17	ZUS_WG_CH_Parch_LB_17		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_18	ZUS_WG_CH_Parch_LB_18		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_19	ZUS_WG_CH_Parch_LB_19		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_20	ZUS_WG_CH_Parch_LB_20		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_21	ZUS_WG_CH_Parch_LB_21		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_22	ZUS_WG_CH_Parch_LB_22		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_23	ZUS_WG_CH_Parch_LB_23		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_24	ZUS_WG_CH_Parch_LB_24		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_25	ZUS_WG_CH_Parch_LB_25		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_26	ZUS_WG_CH_Parch_LB_26		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_27	ZUS_WG_CH_Parch_LB_27		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_28	ZUS_WG_CH_Parch_LB_28		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_29	ZUS_WG_CH_Parch_LB_29		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug
ZUS_1430_30	ZUS_WG_CH_Parch_LB_30		Raül Soteras	waterlogged	WG	Zug Sumpf	1430	Pottery sample?			1923-37	1050-850		Switzerland	CH	Zug

	Pset	2000	10
Appendix F: Metadata of the morphom	Species initials	Year of harvest for modern samples and chronology for archaeological seeds	GMM sample number

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
CSIBUB_01_01	Collectio Seminum Instituti Botanici Universitatis Basiliensis	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum 371	Tina Eruy-Rodmann	Basel		2000		brown	24	0.793	0.919
CSIBUB_01_02	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	31	0.733	0.887
CSIBUB_01_03	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	36	0.758	0.925
CSIBUB_01_04	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	26	0.731	0.906
CSIBUB_01_05	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	32	0.739	0.916
CSIBUB_01_06	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	29	0.767	0.893
CSIBUB_01_07	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	29	0.762	0.96
CSIBUB_01_08	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	32	0.754	0.894
CSIBUB_01_09	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	33	0.826	0.97
CSIBUB_01_10	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	32	0.736	0.97
CSIBUB_01_11	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	33	0.725	0.915
CSIBUB_01_12	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	32	0.767	0.909
CSIBUB_01_13	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	34	0.728	0.887
CSIBUB_01_14	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	30	0.823	0.958
CSIBUB_01_15	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	34	0.72	0.928
CSIBUB_01_16	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	35	0.761	0.968
CSIBUB_01_17	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	26	0.745	0.902
CSIBUB_01_18	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	28	0.733	0.903
CSIBUB_01_19	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	34	0.703	0.925
CSIBUB_01_20	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	29	0.702	0.829
CSIBUB_01_21	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	27	0.723	0.88
CSIBUB_01_22	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	26	0.774	0.915
CSIBUB_01_23	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	28	0.761	0.902
CSIBUB_01_24	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	31	0.732	0.915
CSIBUB_01_25	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	29	0.758	0.964
CSIBUB_01_26	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	31	0.751	0.932
CSIBUB_01_27	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	31	0.755	0.896
CSIBUB_01_28	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	27	0.736	0.883
CSIBUB_01_29	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	40	0.726	0.935
CSIBUB_01_30	CSIBUB	Botanischen Garten Basel	Papaver Setigerum ssp. Setigerum	Tina Eruy-Rodmann	Basel		2000		brown	30	0.773	0.923
CSIBUB_02_01	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp. Somniferum com. Somnif. Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	51	0.965	1.181
CSIBUB_02_06	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000	La majoria son com les 01 a la 03, la 4 es una seleccionada puntual de fosca, 5 algunes mes petites	white blueish grey	50	0.901	1.161
CSIBUB_02_08	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	47	1.104	1.31
CSIBUB_02_10	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	47	0.961	1.188
CSIBUB_02_11	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	61	1.157	1.355
CSIBUB_02_14	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	48	0.961	1.152
CSIBUB_02_15	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	45	0.978	1.21
CSIBUB_02_17	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	68	1.064	1.307
CSIBUB_02_18	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	50	1.068	1.268
CSIBUB_02_19	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	56	1.049	1.277
CSIBUB_02_20	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	49	1.093	1.317
CSIBUB_02_21	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	64	0.967	1.17
CSIBUB_02_24	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	51	0.935	1.145
CSIBUB_02_25	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	53	0.987	1.22
CSIBUB_02_26	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	44	0.981	1.196
CSIBUB_02_27	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	48	0.913	1.101
CSIBUB_02_30	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	48	0.88	1.164
CSIBUB_02_31	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	49	0.961	1.167
CSIBUB_02_32	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	49	0.99	1.159
CSIBUB_02_33	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	48	0.968	1.225
CSIBUB_02_34	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	54	0.886	1.128
CSIBUB_02_35	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	50	0.959	1.155
CSIBUB_02_36	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	39	0.97	1.222
CSIBUB_02_37	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	36	0.964	1.204
CSIBUB_02_38	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	47	0.984	1.204
CSIBUB_02_39	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	39	0.983	1.213
CSIBUB_02_40	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	50	0.967	1.193

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
CSIBUB_02_42	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	52	0.971	1.217
CSIBUB_02_44	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	56	0.893	1.171
CSIBUB_02_45	CSIBUB	Botanischen Garten Basel	Papaver Somniferum L. ssp.Var. Nigrum Heyne	Tina Eruy-Rodmann	Basel		2000		white blueish grey	42	0.929	1.154
CSIBUB_03_01	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		blue greyish	38	0.833	1.007
CSIBUB_03_02	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	44	0.912	1.149
CSIBUB_03_03	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown grey	34	0.784	1.017
CSIBUB_03_04	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	38	0.887	1.122
CSIBUB_03_05	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown blue	35	0.815	0.971
CSIBUB_03_06	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	35	0.865	1.083
CSIBUB_03_07	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	37	0.828	1.03
CSIBUB_03_08	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	34	0.886	1.11
CSIBUB_03_09	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	36	0.786	0.942
CSIBUB_03_10	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	34	0.896	1.061
CSIBUB_03_11	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	41	0.915	1.125
CSIBUB_03_12	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	37	0.893	1.035
CSIBUB_03_13	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown caramel white	35	0.936	1.138
CSIBUB_03_14	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown caramel	46	0.888	1.141
CSIBUB_03_15	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	31	0.784	0.961
CSIBUB_03_16	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	32	0.92	1.112
CSIBUB_03_17	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	32	0.935	1.141
CSIBUB_03_18	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	37	0.839	1.084
CSIBUB_03_19	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	45	0.971	1.181
CSIBUB_03_20	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	32	0.875	1.033
CSIBUB_03_21	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2005		brown	40	0.891	1.093
CSIBUB_03_22	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2006		brown	43	0.871	1.133
CSIBUB_03_23	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2007		brown	42	0.839	1.09
CSIBUB_03_24	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2008		brown	36	0.817	0.98
CSIBUB_03_25	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2009		brown	44	0.909	1.132
CSIBUB_03_26	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2010		brown	38	0.894	1.07
CSIBUB_03_27	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2011		brown caramel	38	0.933	1.167
CSIBUB_03_28	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2012		brown	39	0.829	1.065
CSIBUB_03_29	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2004		brown	37	0.906	1.1
CSIBUB_03_30	CSIBUB	Jardin Botanique Porrentruy	Papaver Somniferum L. ssp. Somniferum		Basel		2005		brown	39	0.833	1
DG0002			*Papaver somniferum*							30	0.748	0.92
DG0003			*Papaver somniferum*							29	0.629	0.754
DG0004			*Papaver somniferum*							26	0.668	0.83
DG0005			*Papaver somniferum*							33	0.794	0.922
DG0008			*Papaver somniferum*							31	0.722	0.877
DG0009			*Papaver somniferum*							27	0.626	0.751
DG0010			*Papaver somniferum*							27	0.703	0.945
DG0011			*Papaver somniferum*							30	0.681	0.793
DG0014			*Papaver somniferum*							33	0.82	1.051
DG0023			*Papaver somniferum*							29	0.713	0.801
DG0029			*Papaver somniferum*							32	0.499	0.577
DG0038			*Papaver somniferum*							35	0.741	0.951
DG0039			*Papaver somniferum*							29	0.723	0.801
DG0040			*Papaver somniferum*							33	0.704	0.826
DG0041			*Papaver somniferum*							26	0.652	0.833
DG0043			*Papaver somniferum*							25	0.778	0.986
DG0045			*Papaver somniferum*							17	0.616	0.758
DG0047			*Papaver somniferum*							23	0.638	0.822
DG0048			*Papaver somniferum*							33	0.696	0.906
DG0049			*Papaver somniferum*							30	0.774	0.964
DG0051			*Papaver somniferum*							32	0.738	0.835
DG0052			*Papaver somniferum*							30	0.693	0.801
DG0059			*Papaver somniferum*							27	0.636	0.778
DG0062			*Papaver somniferum*							26	0.654	0.759
DG0066			*Papaver somniferum*							31	0.691	0.83
DG0067			*Papaver somniferum*							38	0.657	0.719
DG0068			*Papaver somniferum*							29	0.609	0.713
DG0071			*Papaver somniferum*							33	0.562	0.681
ZHOPE0001			*Papaver somniferum*							47	0.888	1.086

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
ZHOPE0002			*Papaver somniferum*							35	0.873	1.089
ZHOPE0003			*Papaver somniferum*							36	0.815	1.019
ZHOPE0004			*Papaver somniferum*							37	0.745	0.936
ZHOPE0005			*Papaver somniferum*							33	0.875	1.032
ZHOPE0006			*Papaver somniferum*							32	0.767	0.913
ZHOPE0007			*Papaver somniferum*							29	0.832	1.038
ZHOPE0008			*Papaver somniferum*							39	0.746	0.906
ZHOPE0009			*Papaver somniferum*							27	0.874	1.058
ZHOPE0011			*Papaver somniferum*							28	0.8	1.006
ZHOPE0012			*Papaver somniferum*							37	0.732	0.964
ZHOPE0013			*Papaver somniferum*							35	0.88	1.074
ZHOPE0014			*Papaver somniferum*							33	0.841	1.039
ZHOPE0015			*Papaver somniferum*							38	0.784	0.973
ZHOPE0016			*Papaver somniferum*							38	0.817	0.981
ZHOPE0017			*Papaver somniferum*							35	0.817	1.028
ZHOPE0018			*Papaver somniferum*							42	0.761	0.975
ZHOPE0019			*Papaver somniferum*							39	0.836	1.087
ZHOPE0020			*Papaver somniferum*							43	0.812	1.035
ZHOPE0021			*Papaver somniferum*							35	0.717	0.948
ZHOPE0022			*Papaver somniferum*							41	0.857	0.978
ZHOPE0023			*Papaver somniferum*							40	0.693	0.909
ZHOPE0024			*Papaver somniferum*							34	0.735	0.875
ZHOPE0025			*Papaver somniferum*							34	0.687	0.812
ZHOPE0026			*Papaver somniferum*							34	0.772	0.977
ZHOPE0027			*Papaver somniferum*							34	0.78	0.964
ZHOPE0028			*Papaver somniferum*							41	0.778	0.971
ZHOPE0029			*Papaver somniferum*							31	0.78	0.954
ZHOPE0030			*Papaver somniferum*							35	0.762	0.922
ZHOPE0031			*Papaver somniferum*							38	0.804	0.988
ZHOPE0032			*Papaver somniferum*							37	0.775	0.951
ZHOPE0033			*Papaver somniferum*							36	0.69	0.861
ZHOPE0034			*Papaver somniferum*							32	0.72	0.878
GRA001_01	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	38	0.754	0.864
GRA001_02	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	37	0.829	0.961
GRA001_03	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown grey	35	0.842	0.935
GRA001_04	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	37	0.767	0.858
GRA001_05	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	34	0.749	0.859
GRA001_06	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	39	0.825	0.883
GRA001_07	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	40	0.864	1.074
GRA001_08	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				caramel	36	0.797	0.997
GRA001_09	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				grey	35	0.807	0.945
GRA001_10	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown burgandy	25	0.683	0.846
GRA001_11	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown grey	34	0.787	0.893
GRA001_12	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				purple	33	0.799	0.948
GRA001_13	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				caramel	34	0.755	0.888
GRA001_14	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				purple grey	37	0.8	0.959
GRA001_15	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	36	0.715	0.806
GRA001_16	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				caramel	35	0.849	0.98
GRA001_17	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				caramel	35	0.868	1.028
GRA001_18	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	34	0.797	0.942
GRA001_19	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	31	0.755	0.939
GRA001_20	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				blue	30	0.745	0.906
GRA001_21	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	29	0.871	1.046
GRA001_22	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				caramel	36	0.801	1.016
GRA001_23	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				caramel	37	0.803	0.933
GRA001_24	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	39	0.796	0.915
GRA001_25	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				caramel	34	0.854	1.012
GRA001_26	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown	34	0.744	0.894
GRA001_27	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown burgandy	35	0.767	0.881
GRA001_28	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown grey	37	0.732	0.839
GRA001_29	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				brown grey	33	0.674	0.842
GRA001_30	Graneterie (MNHN)		Papaver Setigerum ssp. Setigerum		Paris				caramel	33	0.726	0.846

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
GRA002_01	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	36	0.845	1.048
GRA002_02	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	33	0.775	0.939
GRA002_03	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	33	0.834	1.002
GRA002_04	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	41	0.87	1.033
GRA002_05	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	43	0.806	0.988
GRA002_06	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	38	0.871	1.014
GRA002_07	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	44	0.855	1.09
GRA002_08	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	36	0.909	1.104
GRA002_09	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	39	0.907	1.046
GRA002_10	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	45	0.801	1.054
GRA002_11	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	40	0.887	1.049
GRA002_12	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	38	0.9	1.09
GRA002_13	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	41	0.878	1.141
GRA002_14	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	40	0.803	0.955
GRA002_15	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	40	0.823	1.006
GRA002_16	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	38	0.871	1.012
GRA002_17	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	32	0.858	1.025
GRA002_18	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	37	0.829	0.987
GRA002_19	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	42	0.79	0.994
GRA002_20	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	31	0.803	0.957
GRA002_21	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	34	0.826	0.987
GRA002_22	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	33	0.897	1.035
GRA002_23	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	40	0.894	1.081
GRA002_24	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	34	0.862	1.062
GRA002_25	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	43	0.867	1.081
GRA002_26	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	36	0.857	1.075
GRA002_27	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	35	0.828	1.022
GRA002_28	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	34	0.809	0.986
GRA002_29	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	36	0.891	1.055
GRA002_30	Graneterie (MNHN)		Papaver Somniferum		Paris				brown	35	0.857	1.041
IPNA_001_01	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	48	1.062	1.253
IPNA_001_02	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	51	1.199	1.399
IPNA_001_03	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	43	0.958	1.1
IPNA_001_04	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	40	1.077	1.328
IPNA_001_05	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	48	1.168	1.401
IPNA_001_06	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	50	1.148	1.374
IPNA_001_07	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	43	1.029	1.25
IPNA_001_08	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	46	1.013	1.17
IPNA_001_09	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	44	1.088	1.292
IPNA_001_10	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	44	1.037	1.257
IPNA_001_11	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	43	1.033	1.299
IPNA_001_12	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	49	1.128	1.283
IPNA_001_13	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	52	1.157	1.377
IPNA_001_14	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	55	1.222	1.419
IPNA_001_15	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	47	0.955	1.226
IPNA_001_16	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	50	1.135	1.306
IPNA_001_17	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	46	1.018	1.233
IPNA_001_18	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	54	1.06	1.255
IPNA_001_19	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	41	1.064	1.299
IPNA_001_20	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	60	1.111	1.37
IPNA_001_21	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	45	0.987	1.182
IPNA_001_22	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	55	1.168	1.366
IPNA_001_23	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	54	1.038	1.284
IPNA_001_24	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	54	0.993	1.202
IPNA_001_25	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	58	1.146	1.477
IPNA_001_26	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	48	1.031	1.23
IPNA_001_27	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	45	0.993	1.19
IPNA_001_28	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	43	1.027	1.222
IPNA_001_29	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	47	1.009	1.244
IPNA_001_30	Ungarn Garden	Ungarn	Papaver somniferum		Basel		1988		blue greyish	46	1.006	1.181
IPNA002_01			Papaver setigerum DC wild gesammelt	H. Schlichtgerle	Basel		1983		brown	26	0.676	0.86
IPNA002_02			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	25	0.705	0.805
IPNA002_03			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	28	0.69	0.845
IPNA002_04			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	27	0.668	0.861
IPNA002_05			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	24	0.762	0.918
IPNA002_06			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	20	0.687	0.803
IPNA002_07			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	28	0.658	0.906
IPNA002_08			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	26	0.718	0.87
IPNA002_09			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	28	0.718	0.897
IPNA002_10			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	24	0.658	0.799
IPNA002_11			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	23	0.762	0.96
IPNA002_12			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	23	0.706	0.919

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
IPNA002_13			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	21	0.702	0.852
IPNA002_14			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	29	0.76	0.89
IPNA002_15			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	24	0.726	0.873
IPNA002_16			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	28	0.687	0.873
IPNA002_17			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	19	0.693	0.852
IPNA002_18			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	23	0.749	0.928
IPNA002_19			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	20	0.693	0.797
IPNA002_20			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	23	0.72	0.863
IPNA002_21			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	19	0.673	0.876
IPNA002_22			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	21	0.645	0.791
IPNA002_23			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	29	0.665	0.805
IPNA002_24			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	25	0.655	0.883
IPNA002_25			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	25	0.697	0.863
IPNA002_26			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	28	0.671	0.81
IPNA002_27			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	25	0.67	0.799
IPNA002_28			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	24	0.736	0.886
IPNA002_29			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	29	0.773	0.913
IPNA002_30			Papaver setigerum DC	H. Schlichtgerle	Basel		1983		brown	29	0.67	0.876
CSIBUB05_01			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	50	0.531	0.678
CSIBUB05_02			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	68	0.694	0.862
CSIBUB05_03			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	53	0.561	0.771
CSIBUB05_04			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	46	0.612	0.759
CSIBUB05_05			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	58	0.606	0.8
CSIBUB05_06			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	52	0.677	0.883
CSIBUB05_07			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	51	0.702	0.88
CSIBUB05_08			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	54	0.593	0.78
CSIBUB05_09			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	55	0.667	0.838
CSIBUB05_10			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	51	0.666	0.796
CSIBUB05_11			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	49	0.662	0.824
CSIBUB05_12			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	57	0.691	0.887
CSIBUB05_13			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	56	0.645	0.854
CSIBUB05_14			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	45	0.617	0.785
CSIBUB05_15		Salzburg, Bergheim Tennisplatz ruderal , Kalk 420m	Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	53	0.655	0.793
CSIBUB05_16			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	55	0.603	0.764
CSIBUB05_17			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	61	0.63	0.797
CSIBUB05_18			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	61	0.628	0.804
CSIBUB05_19			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	56	0.632	0.82
CSIBUB05_20			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	59	0.631	0.819
CSIBUB05_21			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	55	0.61	0.785
CSIBUB05_22			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	51	0.577	0.797
CSIBUB05_23			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	48	0.683	0.847
CSIBUB05_24			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	56	0.588	0.788
CSIBUB05_25			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	48	0.607	0.749
CSIBUB05_26			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	55	0.612	0.799
CSIBUB05_27			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	53	0.594	0.795
CSIBUB05_28			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	60	0.603	0.728
CSIBUB05_29			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	52	0.634	0.859
CSIBUB05_30			Papaver rhoeas L.	no info	no info	no info	1982 /550		blue burgundy	47	0.633	0.827
CSIBUB06_1			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	42	0.755	1.035
CSIBUB06_2			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	33	0.764	1.109
CSIBUB06_3			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	40	0.825	1.284
CSIBUB06_4			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	39	0.832	1.194
CSIBUB06_5			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	38	0.894	1.116
CSIBUB06_6			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	30	0.712	0.958
CSIBUB06_7			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	43	0.868	1.244
CSIBUB06_8			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	44	0.787	1.077
CSIBUB06_9			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	33	0.846	1.145
CSIBUB06_10			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	38	0.735	1.019
CSIBUB06_11			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	37	0.765	1.113
CSIBUB06_12			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	36	0.771	1.151
CSIBUB06_13			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	37	0.726	1.033
CSIBUB06_14			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	37	0.684	1.051
CSIBUB06_15			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	33	0.67	1
CSIBUB06_16			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	35	0.787	1.128
CSIBUB06_17			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	44	0.645	1.022
CSIBUB06_18			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	35	0.728	1.035
CSIBUB06_19			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	46	0.748	1.078
CSIBUB06_20			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	38	0.623	0.844
CSIBUB06_21			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	28	0.745	1.007
CSIBUB06_22			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	29	0.668	0.912
CSIBUB06_23			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	34	0.664	0.893
CSIBUB06_24			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	40	0.829	1.204

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
CSIBUB06_25			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	37	0.651	0.978
CSIBUB06_26			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	34	0.73	1.046
CSIBUB06_27			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	45	0.68	1
CSIBUB06_28			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	31	0.641	1.029
CSIBUB06_29			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	34	0.713	1.055
CSIBUB06_30			Papaver hybridum L.	no info	no info	no info	1984		brown purpleish	41	0.696	1.003
CSIBUB08_01			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	62	0.648	1.029
CSIBUB08_02			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	74	0.652	1.052
CSIBUB08_03			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	65	0.639	1.012
CSIBUB08_04			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	71	0.696	1.003
CSIBUB08_05			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	74	0.684	1.077
CSIBUB08_06			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	71	0.729	1.093
CSIBUB08_07			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	74	0.601	1.006
CSIBUB08_08			Papaver argemone L.	no info	no info	no info	1976	There is some visual problem with the cells	brown purpleish	65	0.652	0.994
CSIBUB08_09			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	66	0.712	1.138
CSIBUB08_10			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	78	0.593	0.928
CSIBUB08_11			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	83	0.697	1.122
CSIBUB08_12			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	72	0.697	1.145
CSIBUB08_13			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	62	0.69	1.017
CSIBUB08_14			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	73	0.719	1.161
CSIBUB08_15			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	73	0.665	1.035
CSIBUB08_16			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	60	0.625	0.957
CSIBUB08_17			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	72	0.67	1.067
CSIBUB08_18			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	60	0.668	1.02
CSIBUB08_19			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	70	0.638	1.038
CSIBUB08_20			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	60	0.622	0.948
CSIBUB08_21			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	74	0.649	1.026
CSIBUB08_22			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	66	0.661	1.048
CSIBUB08_23			Papaver argemone L.	no info	no info	no info	1976	There is some visual problem with the cells	brown purpleish	59	0.581	0.936
CSIBUB08_24			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	75	0.648	1.052
CSIBUB08_25			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	70	0.713	1.071
CSIBUB08_26			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	71	0.641	1.01
CSIBUB08_27			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	66	0.744	1.177
CSIBUB08_28			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	70	0.726	1.159
CSIBUB08_29			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	71	0.638	0.987
CSIBUB08_30			Papaver argemone L.	no info	no info	no info	1976		brown purpleish	67	0.636	1.036
CSIBUB07_01		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	45	0.688	0.874
CSIBUB07_02		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	50	0.6	0.778
CSIBUB07_03		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	48	0.677	0.836
CSIBUB07_04		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	46	0.662	0.844
CSIBUB07_05		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	46	0.693	0.92
CSIBUB07_06		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	51	0.659	0.835
CSIBUB07_07		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	42	0.691	0.822
CSIBUB07_08		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	42	0.744	0.968
CSIBUB07_09		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	48	0.671	0.857
CSIBUB07_10		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	55	0.7	0.865
CSIBUB07_11		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	46	0.674	0.809
CSIBUB07_12		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	48	0.604	0.778
CSIBUB07_13		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	53	0.649	0.825
CSIBUB07_14		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	51	0.674	0.844
CSIBUB07_15	CH VS Naters: Mund: Warbflie 1080 m	46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	52	0.575	0.77
CSIBUB07_16		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	48	0.648	0.841
CSIBUB07_17		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	50	0.61	0.799
CSIBUB07_18		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	53	0.644	0.848
CSIBUB07_19		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	48	0.583	0.804
CSIBUB07_20		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	50	0.606	0.793
CSIBUB07_21		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	49	0.604	0.813
CSIBUB07_22		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	49	0.693	0.88
CSIBUB07_23		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	49	0.69	0.862
CSIBUB07_24		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	42	0.635	0.78
CSIBUB07_25		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	42	0.609	0.851
CSIBUB07_26		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	50	0.674	0.865
CSIBUB07_27		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	50	0.616	0.777
CSIBUB07_28		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	43	0.591	0.755
CSIBUB07_29		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	52	0.63	0.836
CSIBUB07_30		46 18'32"N 7 55'51" E	Papaver dubium L. s. str.	Marlu Kühn and Örni Akeret	Basel	2 capsule	20.7.1997		blue purpleish	48	0.657	0.855
ISBA_01_01			*Papaver somniferum*							40	0.561	0.681
ISBA_02_01			*Papaver somniferum*							32	0.638	0.813
ISBA_03_01			*Papaver somniferum*							30	0.729	0.929
ISBA_03_02			*Papaver somniferum*							34	0.552	0.713
ISBA_03_03			*Papaver somniferum*							33	0.561	0.648

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
ISBA_04_01			*Papaver somniferum*							29	0.567	0.761
ISBA_05_01			*Papaver somniferum*							29	0.775	0.915
ISBA_06_01			*Papaver somniferum*							29	0.507	0.697
ISBA_09_01			*Papaver somniferum*							32	0.718	0.916
ISBA_10_01			*Papaver somniferum*							38	0.691	0.864
ISBA_11_01			*Papaver somniferum*							22	0.667	0.841
ISBA_13_07			*Papaver somniferum*							38	0.559	0.791
ISBA_14_01			*Papaver somniferum*							34	0.703	0.928
ISBA_14_04			*Papaver somniferum*							27	0.719	0.828
ISBA_15_01			*Papaver argemone*							35	0.49	0.739
ISBA_16_01			*Papaver somniferum*							30	0.664	0.815
Arb_3803_01			*Papaver somniferum*							41	0.973	1.139
Arb_3803_02			*Papaver somniferum*							39	0.917	1.08
Arb_3803_03			*Papaver somniferum*							34	0.829	0.988
Arb_3803_04			*Papaver somniferum*							39	0.926	1.115
Arb_3803_05			*Papaver somniferum*							41	0.881	1.023
Arb_3803_06			*Papaver somniferum*							35	0.835	1.067
Arb_3803_07			*Papaver somniferum*							32	0.801	1.001
Arb_3803_08			*Papaver somniferum*							36	0.833	1.001
Arb_3803_09			*Papaver somniferum*							38	0.817	1.042
Arb_3803_10			*Papaver somniferum*							33	0.803	1.078
Arb_3803_11			*Papaver somniferum*							37	0.709	0.868
Arb_3803_12			*Papaver somniferum*							44	0.823	1.103
Arb_3803_13			*Papaver somniferum*							35	0.761	0.938
Arb_3803_14			*Papaver somniferum*							39	0.816	1.075
Arb_3803_15			*Papaver somniferum*							35	0.815	0.974
Arb_3803_16			*Papaver somniferum*							35	0.73	0.907
Arb_3803_17			*Papaver somniferum*							44	0.899	1.115
Arb_3803_18			*Papaver somniferum*							38	0.757	0.951
Arb_3803_19			*Papaver somniferum*							35	0.825	1.001
Arb_3803_20			*Papaver somniferum*							26	0.713	0.925
Arb_3803_21			*Papaver somniferum*							35	0.745	0.893
Arb_3803_22			*Papaver somniferum*							37	0.739	0.983
Arb_3803_23			*Papaver somniferum*							30	0.788	0.917
Arb_3803_24			*Papaver somniferum*							44	0.771	0.925
Arb_3803_25			*Papaver somniferum*							33	0.89	1.046
Arb_3803_26			*Papaver somniferum*							33	0.777	0.951
Arb_3803_27			*Papaver somniferum*							31	0.662	0.791
Arb_3803_28			*Papaver somniferum*							34	0.825	1.013
Arb_3803_29			*Papaver somniferum*							34	0.768	0.949
Arb_3803_30			*Papaver somniferum*							35	0.8	1.023
KH_1010_01			*Papaver somniferum*							32	0.862	0.954
KH_1010_02			*Papaver somniferum*							37	0.738	0.868
KH_1010_03			*Papaver somniferum*							44	0.799	1.03
KH_1010_04			*Papaver somniferum*							33	0.806	0.888
KH_1010_05			*Papaver somniferum*							28	0.764	0.99
KH_1010_06			*Papaver somniferum*							28	0.786	0.942
KH_1010_07			*Papaver somniferum*							31	0.772	0.952
KH_1010_08			*Papaver somniferum*							35	0.826	0.993
KH_1010L_09			*Papaver somniferum*							30	0.817	1
KH_1010L_10			*Papaver somniferum*							33	0.686	0.887
KH_1010L_11			*Papaver somniferum*							30	0.815	0.999
KH_1010L_12			*Papaver somniferum*							32	0.696	0.899
KH_1010L_13			*Papaver somniferum*							35	0.815	0.978
KH_1010L_14			*Papaver somniferum*							34	0.732	0.838
KH_1010L_15			*Papaver somniferum*							27	0.758	0.916
KH_1010L_16			*Papaver somniferum*							29	0.733	0.922
KH_1010L_17			*Papaver somniferum*							26	0.704	0.901
KH_1010L_18			*Papaver somniferum*							31	0.772	0.935
KH_1010L_19			*Papaver somniferum*							30	0.807	0.967
KH_1010L_20			*Papaver somniferum*							30	0.793	0.975
KH_1010L_21			*Papaver somniferum*							36	0.71	0.893
KH_1010L_22			*Papaver somniferum*							34	0.728	0.913
KH_1009_23			*Papaver somniferum*							31	0.751	0.926
KH_1009_24			*Papaver somniferum*							35	0.742	0.975
KH_1009_25			*Papaver somniferum*							30	0.746	0.929

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
KH_1009_26			*Papaver somniferum*							31	0.79	0.974
KH_1009_27			*Papaver somniferum*							34	0.733	0.874
KH_1009_28			*Papaver somniferum*							40	0.746	0.964
KH_1009_29			*Papaver somniferum*							27	0.758	0.91
KH_1009_30			*Papaver somniferum*							35	0.687	0.861
E_3_01			*Papaver somniferum*							33	0.671	0.899
E_3_02			*Papaver somniferum*							29	0.752	0.91
E_3_03			*Papaver somniferum*							29	0.844	1.017
E_3_04			*Papaver somniferum*							32	0.752	0.9
E_3_05			*Papaver somniferum*							29	0.765	0.926
E_3_06			*Papaver somniferum*							29	0.725	0.929
E_3_07			*Papaver somniferum*							30	0.851	1.044
E_3_08			*Papaver somniferum*							37	0.787	0.986
E_3_09			*Papaver somniferum*							33	0.768	0.941
E_3_10			*Papaver somniferum*							30	0.677	0.896
E_3_11			*Papaver somniferum*							32	0.774	0.945
E_3_12			*Papaver somniferum*							30	0.725	0.9
E_3_13			*Papaver somniferum*							35	0.772	0.9
E_3_14			*Papaver somniferum*							36	0.762	0.928
E_3_15			*Papaver somniferum*							27	0.742	0.884
E_3_16			*Papaver somniferum*							37	0.758	0.917
E_3_17			*Papaver somniferum*							40	0.72	1.023
E_3_18			*Papaver somniferum*							27	0.815	0.957
E_3_19			*Papaver somniferum*							32	0.822	0.9
E_3_20			*Papaver somniferum*							34	0.873	1.039
E_3_21			*Papaver somniferum*							34	0.771	1.003
E_3_22			*Papaver somniferum*							29	0.681	0.862
E_3_23			*Papaver somniferum*							31	0.722	0.877
E_3_24			*Papaver somniferum*							33	0.741	0.881
E_3_25			*Papaver somniferum*							36	0.781	1.004
E_3_26			*Papaver somniferum*							33	0.754	0.944
E_3_27			*Papaver somniferum*							30	0.842	1.101
E_3_28			*Papaver somniferum*							38	0.796	0.991
E_3_29			*Papaver somniferum*							40	0.858	1.039
E_3_30			*Papaver somniferum*							33	0.696	0.91
ISVA18_B_243_01			*Papaver somniferum*							32	0.678	0.845
ISVA18_B_243_02			*Papaver somniferum*							35	0.775	0.955
ISVA18_B_243_04			*Papaver somniferum*							24	0.816	0.984
ISVA18_B_243_12			*Papaver somniferum*							36	0.767	0.936
ISVA18_B_263_1			*Papaver somniferum*							34	0.886	1.067
ISVA18_B_263_3			*Papaver somniferum*							31	0.668	0.813
ISVA18_B_263_5			*Papaver somniferum*							33	0.841	1.086
ISVA18_B_263_8			*Papaver somniferum*							33	0.655	0.82
ISVA18_B_263_10			*Papaver somniferum*							36	0.797	0.974
ISVA18_B_263_12			*Papaver somniferum*							27	0.719	0.909
ISVA18_B_263_13			*Papaver somniferum*							31	0.706	0.868
ISVA18_B_263_14			*Papaver somniferum*							30	0.828	1.049
ISVA18_B_263_15			*Papaver somniferum*							30	0.7	0.912
ISVA18_B_263_16			*Papaver somniferum*							36	0.654	0.857
ISVA18_B_264_02			*Papaver somniferum*							34	0.833	1.032
ISVA18_B_264_03			*Papaver somniferum*							36	0.772	0.975
ISVA18_B_264_05			*Papaver somniferum*							31	0.841	1.013
ISVA18_B_264_06			*Papaver somniferum*							25	0.706	0.888
ISVA18_B_264_08			*Papaver somniferum*							31	0.79	0.961
ISVA18_B_264_09			*Papaver somniferum*							29	0.799	0.99
ISVA18_B_264_10			*Papaver somniferum*							27	0.713	0.928
ISVA18_B_297_02			*Papaver somniferum*							30	0.855	1.012
ISVA18_B_297_06			*Papaver somniferum*							33	0.772	0.978
ISVA18_B_297_08			*Papaver somniferum*							37	0.891	1.001
ISVA18_B_297_09			*Papaver somniferum*							24	0.683	0.793
ISVA18_B_298_01			*Papaver somniferum*							34	0.787	1.075
ISVA18_B_298_04			*Papaver somniferum*							31	0.761	0.893
ISVA18_B_298_05			*Papaver somniferum*							33	0.803	0.926
ISVA18_B_298_06			*Papaver somniferum*							29	0.719	0.89
ISVA18_B_298_08			*Papaver somniferum*							26	0.793	0.951
ISVA18_B_298_09			*Papaver somniferum*							33	0.803	0.919
ISVA18_B_298_10			*Papaver somniferum*							28	0.765	0.919

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
ISVA18_B_298_11			*Papaver somniferum*							26	0.742	0.903
ISVA18_B_298_12			*Papaver somniferum*							27	0.709	0.896
ISVA18_B_298_14			*Papaver somniferum*							22	0.542	0.654
ISVA18_B_298_15			*Papaver somniferum*							29	0.686	0.864
ISVA18_B_298_16			*Papaver somniferum*							28	0.615	0.791
ISVA18_B_300_01			*Papaver somniferum*							28	0.819	1.042
ISVA18_B_300_02			*Papaver somniferum*							27	0.729	0.915
ISVA18_B_300_03			*Papaver somniferum*							35	0.738	1.023
ISVA18_B_300_04			*Papaver somniferum*							26	0.713	0.91
ISVA18_B_300_05			*Papaver somniferum*							29	0.675	0.841
KSZ9_1401_001			*Papaver somniferum*							37	0.784	0.919
KSZ9_1401_002			*Papaver somniferum*							34	0.772	0.978
KSZ9_1401_003			*Papaver somniferum*							30	0.79	0.92
KSZ9_1401_004			*Papaver somniferum*							34	0.793	0.954
KSZ9_1401_005			*Papaver somniferum*							35	0.754	0.919
KSZ9_1401_006			*Papaver somniferum*							32	0.738	0.896
KSZ9_1401_007			*Papaver somniferum*							39	0.725	0.952
KSZ9_1401_008			*Papaver somniferum*							32	0.799	0.994
KSZ9_1401_009			*Papaver somniferum*							34	0.722	0.93
KSZ9_1401_010			*Papaver somniferum*							34	0.812	0.957
KSZ9_1401_011			*Papaver somniferum*							37	0.801	1
KSZ9_1401_012			*Papaver somniferum*							32	0.749	0.951
KSZ9_1401_013			*Papaver somniferum*							38	0.771	0.952
KSZ9_1401_014			*Papaver somniferum*							34	0.732	0.855
KSZ9_1401_015			*Papaver somniferum*							35	0.816	0.955
KSZ9_1401_016			*Papaver somniferum*							28	0.725	0.916
KSZ9_1401_017			*Papaver somniferum*							35	0.867	1.001
KSZ9_1401_018			*Papaver somniferum*							31	0.751	0.994
KSZ9_1401_019			*Papaver somniferum*							32	0.665	0.896
KSZ9_1401_020			*Papaver somniferum*							30	0.664	0.825
KSZ9_1341_021			*Papaver somniferum*							40	0.841	1.049
KSZ9_1341_022			*Papaver somniferum*							31	0.867	1.109
KSZ9_1341_023			*Papaver somniferum*							35	0.829	1.02
KSZ9_1341_024			*Papaver somniferum*							39	0.767	0.981
KSZ9_1341_025			*Papaver somniferum*							36	0.749	0.954
KSZ9_1341_026			*Papaver somniferum*							32	0.79	0.964
KSZ9_1341_027			*Papaver somniferum*							39	0.784	0.954
KSZ9_1341_028			*Papaver somniferum*							35	0.765	1.032
KSZ9_1341_029			*Papaver somniferum*							36	0.806	0.93
KSZ9_1341_030			*Papaver somniferum*							35	0.752	0.916
ZGRI_73.7.01			*Papaver somniferum*							35	0.87	1.026
ZGRI_73.7.02			*Papaver somniferum*							37	0.816	1.038
ZGRI_73.7.03			*Papaver somniferum*							32	0.833	0.98
ZGRI_73.7.04			*Papaver somniferum*							38	0.841	1.083
ZGRI_73.7.05			*Papaver somniferum*							33	0.787	0.973
ZGRI_73.7.06			*Papaver somniferum*							42	0.813	1.022
ZGRI_73.7.07			*Papaver somniferum*							33	0.745	0.988
ZGRI_73.7.08			*Papaver somniferum*							38	0.77	0.971
ZGRI_73.7.09			*Papaver somniferum*							32	0.667	0.835
ZGRI_73.7.10			*Papaver somniferum*							40	0.841	1.052
ZGRI_73.7.11			*Papaver somniferum*							34	0.723	0.939
ZGRI_73.7.12			*Papaver somniferum*							29	0.861	1.065
ZGRI_73.7.13			*Papaver somniferum*							44	0.762	0.939
ZGRI_73.7.14			*Papaver somniferum*							31	0.768	0.941
ZGRI_73.7.15			*Papaver somniferum*							33	0.791	0.967
ZGRI_73.7.16			*Papaver somniferum*							49	0.854	1.094
ZGRI_73.7.17			*Papaver somniferum*							34	0.767	0.971
ZGRI_73.7.18			*Papaver somniferum*							37	0.761	0.978
ZGRI_73.7.19			*Papaver somniferum*							32	0.806	1.026
ZGRI_73.7.20			*Papaver somniferum*							34	0.801	1.003
ZGRI_73.7.21			*Papaver somniferum*							40	0.822	0.983
ZGRI_73.7.22			*Papaver somniferum*							37	0.813	0.926
ZGRI_73.7.23			*Papaver somniferum*							46	0.804	1.009
ZGRI_73.7.24			*Papaver somniferum*							33	0.716	0.945
ZGRI_73.7.25			*Papaver somniferum*							38	0.754	0.962
ZGRI_73.7.26			*Papaver somniferum*							32	0.729	0.909
ZGRI_73.7.27			*Papaver somniferum*							44	0.828	0.993

Codes	Botanical Info								Seed info			
Label	Institution	Locus	Prior identification	LEGIT	HORTUS BOTANICUS	Same capsule	Year	Observations	Colour	Number of cells	Width	Length
ZGRI_73.7.28			*Papaver somniferum*							37	0.755	0.901
ZGRI_73.7.29			*Papaver somniferum*							40	0.712	0.862
ZGRI_73.7.30			*Papaver somniferum*							35	0.757	0.923
ZUS_1430_01			*Papaver somniferum*							44	0.904	1.013
ZUS_1430_02			*Papaver somniferum*							38	0.89	1.158
ZUS_1430_03			*Papaver somniferum*							35	0.971	1.167
ZUS_1430_04			*Papaver somniferum*							39	0.959	1.188
ZUS_1430_05			*Papaver somniferum*							39	0.933	1.104
ZUS_1430_06			*Papaver somniferum*							32	0.81	1.049
ZUS_1430_07			*Papaver somniferum*							36	1.035	1.157
ZUS_1430_08			*Papaver somniferum*							45	0.877	1.054
ZUS_1430_09			*Papaver somniferum*							39	0.923	1.206
ZUS_1430_10			*Papaver somniferum*							46	0.958	1.19
ZUS_1430_11			*Papaver somniferum*							40	0.949	1.139
ZUS_1430_12			*Papaver somniferum*							39	0.851	1.091
ZUS_1430_13			*Papaver somniferum*							46	0.9	1.075
ZUS_1430_14			*Papaver somniferum*							41	1.023	1.215
ZUS_1430_15			*Papaver somniferum*							41	0.926	1.109
ZUS_1430_16			*Papaver somniferum*							44	0.832	1.044
ZUS_1430_17			*Papaver somniferum*							44	0.89	1.096
ZUS_1430_18			*Papaver somniferum*							38	0.881	1.042
ZUS_1430_19			*Papaver somniferum*							38	0.851	1
ZUS_1430_20			*Papaver somniferum*							39	0.893	1.071
ZUS_1430_21			*Papaver somniferum*							41	0.861	1.07
ZUS_1430_22			*Papaver somniferum*							44	0.896	1.067
ZUS_1430_23			*Papaver somniferum*							44	0.797	0.944
ZUS_1430_24			*Papaver somniferum*							38	0.993	1.139
ZUS_1430_25			*Papaver somniferum*							39	0.988	1.202
ZUS_1430_26			*Papaver somniferum*							35	0.771	0.873
ZUS_1430_27			*Papaver somniferum*							33	0.906	1.09
ZUS_1430_28			*Papaver somniferum*							39	0.913	1.094
ZUS_1430_29			*Papaver somniferum*							29	0.897	1.029
ZUS_1430_30			*Papaver somniferum*							39	0.983	1.138

Appendix G: Collecting poppy seeds

Table G1 – Details of each poppy plant sampled from the Herbaria in Paris and Geneve that could be used for GMM in the future.

Code	Number of seeds	GMM	Observations	Species	Pays étiq.	year	Localité étiq.
MNHN_B4	85 possible	maybe	20 not mature very small immature	*Papaver setigerum* DC.	Spain	1878	Ténériffe : Funchal
MNHN_C9	~60	yes	several underdeveloped	*Papaver setigerum* DC.	France	1961	France (dép. Var) - Agay
JBG_G2	<50 DNC	yes	some are immature	*Papaver somniferum* L. *setigerum*	Portugal	1868	Porto-Santo, Madeira
JBG_G7	>100 DNC	yes	good violet and good red babies	*Papaver somniferum* L. *setigerum*		1981	information missing in the picture
MNHN_A8	~35immature and 45 ~fully	yes	texture wrinkle does not look like P som	*Papaver somniferum* L.	China	1897	Environs Tong-tchuan
MNHN_B5	~81 immature squashed seeds	maybe	some could be they have the typical purple skin	*Papaver somniferum* L.	Portugal	1865	Porto-Santo, passim in cultis.
MNHN_C2	578	yes	good	*Papaver somniferum* L.	France	1957	Jardin, Plaine des Monts, près de Cognac-le-Froid (Haute-Vienne)
MNHN_C5	231	yes	some have a sticky liquid	*Papaver somniferum* L.	France	1858	A Nans, arrondissement de Baume-les-Dames (Doubs)
JBG_E8	~432	yes	yellow like E6 but 1 yellow pale and 1 yellow humid immature very hard for pics	*Papaver somniferum* L. *somniferum*		1897	
JBG_F3	~100 DNC	yes	Multi-coloured very odd. Mix poppies?	*Papaver somniferum* L. *somniferum*	Tunis	1944	spontaneous in a garden
JBG_F7	~108	yes		*Papaver somniferum* L. *somniferum*	France	1858	Nans, Baume-les-Dames (Doubs), dans les vignes, abondant et subspontané
JBG_E6	~195	yes	cell very faintly, some kind of liquid some are glue together hard for pics. They do not look very mature	*Papaver somniferum* L. *somniferum* var. *album*		1897	Cultivated in his garden
JBG_E7	~97	yes	yellow like E6	*Papaver somniferum* L. *somniferum* var. *album*			
JBG_F5	>300	yes	Pinkish violet; some are not good for GMM	*Papaver somniferum* L. *somniferum* (var. *nigrum* subvar. Hortense)	France	1976	Fabrègues (dep. Hérault), petit massif de la Gardiole, Alt: ca. 200m, subspontané au bord des chemins forestiers
JBG_F8	~200 DNC	yes	Good like F7	*Papaver somniferum* L. *somniferum* (hortense)	France	1858	Nans, Baume-les-Dames (Doubs), dans les vignes, abondant et subspontané
JBG_F2	~300	yes	but not all are suitable for GMM	*Papaver somniferum* L. *somniferum* subsp. *songaricum*	Portugal	1986	Sintra. Praia da Adraga, Alt.: 10 m
MNHN_D9	~207	yes	mature yellow and pinkish, but the cells are too fainting bad for pics	*Papaver somniferum* L *opiiferum*			
MNHN_E1	62	yes	14 immature, mature but tiny yellow	*Papaver somniferum* L *opiiferum*	Portugal	1879	Sables - Presqu'ile de Troïa

<u>Notes of the poppy-growing balcony experiment</u>

In the first year, seeds were sown on 19th March 2018 after the last frost (Figure G1A, G1B and G1C). The seeds started to sprout at different paces starting on April 3rd (Figure G1D). In order to have better success in growing poppy, several poppies were sown in one put, and when they were growing slowly, some plants were removed to let the others grow (Figure G1E). The first plant to flower was the variety of Rehetobel, at June 11th,. The biggest flower apperead on June 25th from the poppy Dornach himberrot variety. The petals fall very quickly, sometimes in a matter of one day. The flowering also happens at a different pace for each variety (Figure G1F). On the 28th of June, Dornach violet died probably because of spider mites. Later, slowly the other plants died from the exact cause (Figure G1G). The treatment of soup and water was not enough and needed to be performed several times.

When the capsules were dried, they were cut and sampled separately to compare seed size from different capsules from the same plant (Figure G1H, G1I and G1J). All samples were kept in a paper bag and then kept inside of a freezer for two weeks. Some of the capsules were examined, and seeds were counted. Around 40 capsules were collected, and only nine were analysed. The results of these nine capsules were that the seeds were immature and had some sort of viscous liquid, some capsules had no seed, and only two capsules had some seeds that could be used for GMM.

Figure G1 – Photographs of the experience of growing six varieties of opium poppy in the balcony of IPNA. Photos by: Raül Soteras

Second-year, poppy seeds were sown on the 19th of March 2019. This time, the seeds were selected under the microscope, and only 20 seeds per specimen were used. On April 2nd, all specimens had sprouted, except the variety of Plan-les-Quates. The temperatures were very low at the end of April and during May. The plants continue to grow slowly. On the 14th of June, the plants had black aphids, which were removed manually with cloth and water. On the 24th - 28th of June, it was a hot week, some plants flowered. Then the plants had spider mites, like the previous year. The plants were again cleaned with water and soup. They dried out in July 2019, and only six capsules were collected.