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A Fruity Subject: Fruit Availability and their Uses in the Mesolithic of Northwest Europe

Cornucopia – Symbolic for fruit and its great abundance within the Mesolithic of Northwest Europe
(Source: www.sprouls.com/blog/2012/01/food-and-drink/cornucopia-detail)

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Submitted for the Qualification: Masters by Research (MRes)

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Abstract

This thesis combines archaeological, palynological and ethnographic approaches to the study of fruit in the Mesolithic period of Northwest Europe. This is to better understand the role that different fruits played in the lives of the hunter-gatherer communities at that time. The specific focus on fruit is a new approach to the study of Mesolithic Archaeology, where previously research has been focused on plant remains as a whole, within much more confined geographical areas. This research combines archaeological evidence and pollen core data highlighting what fruits were available, which of those fruits were used, and whether there may be a discrepancy between species available and found in the archaeological record. Ethnographic evidence is also examined in order to identify the possible uses for fruit species beyond simply fresh consumption. The research includes a compendium of fruit pollen evidence from the Fossil Pollen Database, a catalogue of published finds of fruit species evidence from archaeological excavation, a seasonality/availability calendar highlighting species biomes, and a comprehensive collection of ethnographic and historical uses of the fruits. The research identifies that fruit are an essential part of the hunter-gatherer diet, but also from which a number of products with significant economic value can be produced, particularly oil extracted from seeds and preserved foodstuffs containing periodically unavailable vital nutrients. It also uncovers and suggests reasons for a number of discrepancies between species present in the palynology and species for which there is archaeological evidence for, assisted by a comparison of ethnographic uses. Furthermore, the research indicates the value of fruit macro-fossils in contributing to our understanding of seasonal movement patterns of the Mesolithic communities of Northwest Europe and interpreting seasonal occupation on archaeological sites.

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List of Abbreviations

Aggr.: Aggregate

cal BP: Calibrated years Before Present

EPD: European Pollen Database

FPD: Fossil Pollen Database

GDA: Guideline Daily Amount

Sp.: Species

Spp.: Species plural

Declaration

This thesis is a presentation of my original research work.

Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature, and acknowledgement of collaborative research and discussions.

The work was conducted under the guidance of Prof. P. Rowley-Conwy and Dr. M. Church at Durham University, Durham, United Kingdom.

Candidate's name (Print):

Candidate's signature:

Statement of copyright

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I am grateful to my supervisors Prof. Peter Rowley-Conwy and Dr. Mike Church for their support and direction in this work. I am honoured to have had the opportunity to work with you both. I am also appreciative for the significant role you have both played in my university education and the positive impact you have had on my life during this formative period.

Dedication

This Research Master's Thesis is dedicated to Mr. Frank Newport whose 'green-fingers' and love of the botanical world has been an inspiration to every successive generation.

Chapter 1: Introduction

1.1 Introducing the research

Research into fruit in the Mesolithic of Northwest Europe has slowly been increasing in scale over the last 60 years. Moving from rudimentary environmental sampling on a site by site basis (Troels-Smith, 1959; Larsson 1983; Goransson 1983) to more recent approaches that combine sites on a regional or country-wide analysis of plant remains in more recent times (Zvelebil, 1994; Regnell *et al*. 1995; Warren *et al*. 2014; Bishop *et al*. 2014). It does seem however that there is still a relative scarcity of published archaeobotanical data, particularly pertaining to fruit macro-fossil on Mesolithic sites, which in turn may account for the lack of research and analysis of larger regional areas such as Northwest Europe or Europe as a whole. Given the large potential range of mobile hunter-gatherers throughout Northwest Europe during the Mesolithic, it is perhaps surprising that this level of investigation has not been done in the past. Furthermore, due to this scarcity of evidence, particularly relating to fruit remains, a larger study area is required in order to examine the possible trends more effectively.

The reasons behind the lack of this published material and the narrow subject focus are noted as 'the relative infancy of the discipline' and the bias toward one section of the potential archaeological assemblage: Domesticated seeds (Mason & Hather, 2002). Archaeobotany as a discipline has a large amount of published material on domesticates and weeds of crops, largely focussed on the agrarian relationships between plants and people (ibid.). It seems the excuse that archaeobotany is a new discipline is actually now an old one. It may be true that environmental archaeology is perhaps not prioritised on excavations on account of its time consuming nature (Kenward *et al*. 1980). Floatation tanks and graded sieving is of course the primary approach that does indeed take a long time (ibid.). Thus, this lack of evidence may be more to do with the constraints of time and funding, coupled with the comparably fewer number of recently excavated Mesolithic sites compared to later sites.

It can be without question that archaeobotany is an important tool for developing our understanding of the people of the Mesolithic. As a hunter-gatherer, the primary activity is food procurement (Bailey, 1983; Harris & Hillman, 1989; Cordain *et al*. 2000). Whilst a lot of research has been done into analysing faunal remains and developing understandings of hunting practise (Noe-Nygaard, 1974; Churchill, 1993; Rowley-Conwy, 1995; Magnell, 2005), as well as comprehensive research into lithics from the period (and their relation to hunting practise) (Care, 1982; Jensen, 1988; Fischer, 1990; Churchill, 1993; Straus, 2006), hunter-gatherer archaeobotany appears to have gone malnourished. Floral remains, such as plant macrofossils are artefacts of great significance, as they give insight into the use of one of the most significant resources during the Mesolithic. The small population density throughout the period and relatively few recently excavated sites mean, that when and where such significant artefacts are available, they should not simply be discarded on the spoil heap.

Where plant macro-fossil analysis from the Mesolithic has been published successfully, the broad focus on all plant macrofossils and the glut of nut species (Kubiak-Martens, 1999; Mithen, 2001; Regnell, 2012), particularly *Corylus avelana*, has severely limited the potential for effective analysis of the soft fruit remains in those articles. This nut focus has produced a number of interesting finds, however nuts are a notably storable crop, once dried they can keep almost indefinitely. The same may be true for macro-fossils from fruit, however once the soft fruit flesh has been consumed or perished, the seeds alone are of much less calorific value and thus are more likely to be simply deposited. The shorter lifespan of the resource makes it a potentially useful indicator of factors such as site seasonality.

The study of palynology is a valuable resource to the Mesolithic period. The use of boreholes in pollen reservoirs in order to establish an understanding of plant populations across many periods, has not neglected the Mesolithic (see Appendix 1 - List of the sites, countries and sources references compiled in the palynological study). This makes it a useful indicator of species presence in archaeobotanical studies. Palynology can only tell us so much and is not without its inherent limitations and biases. It also does not clearly inform us about plant-human interaction beyond general trends such as highlighting possible periods of anthropogenic deforestation or propagation.

Similarly, understanding how these fruit were used and to what extent they were processed or preserved is difficult to ascertain using only the evidence that the archaeology and palynology provide. Using modern historical and ethnographic research to understand how fruits are used, processed and preserved may give us an insight into the possible uses that fruits and fruit plants had during the Mesolithic period. Particularly useful are ethnographic reports on how pre-industrial and hunter-gatherer communities are using, processing and preserving fruits with traditional methods and resources in similar living conditions to the people of the Mesolithic in Northwest Europe.

It is only by combining palynological research with the published fruit macro-fossil data and modern-historical and ethnographic reports, that a comprehensive understanding of fruits and their uses in the Mesolithic of Northwest Europe, can be made. By using these three approaches together, this research seeks to highlight potential discrepancies in the datasets, and bridge possible gaps in our understanding of humans' interaction with this extremely significant resource to the hunter-gatherers of the Mesolithic.

1.2. Research Objectives:

1. Why is fruit significant in understanding the lives of the hunter-gatherers in the Mesolithic of Northwest Europe and in understanding the people of the Mesolithic in their wider context?
2. Which edible species of fruit were available throughout the Mesolithic of Northwest Europe and what does palynology suggest about their relative abundance?
3. Which edible fruit species do we have archaeological evidence for from the Mesolithic period?
4. Is there any discrepancy between the fruits that were available and the fruits for which there is archaeological evidence for?
5. How are the fruits, considered native to the research area processed, preserved and used in the present, in recorded history and ethnography? What evidence would we expect to find in the Mesolithic?

Chapter 2: Research Background

2.1. Definition of 'fruit' for the purposes of this research

In order to effectively answer the research questions, a clear definition of fruit must be established and any omissions be noted. Throughout this research paper, Murray's definition of fruit (2012:127) will be applicable: "A fruit is the mature gynoecium; the ripened ovary including the seeds". From a botanical perspective, fruit can be categorised accordingly (Illustration 2.1):

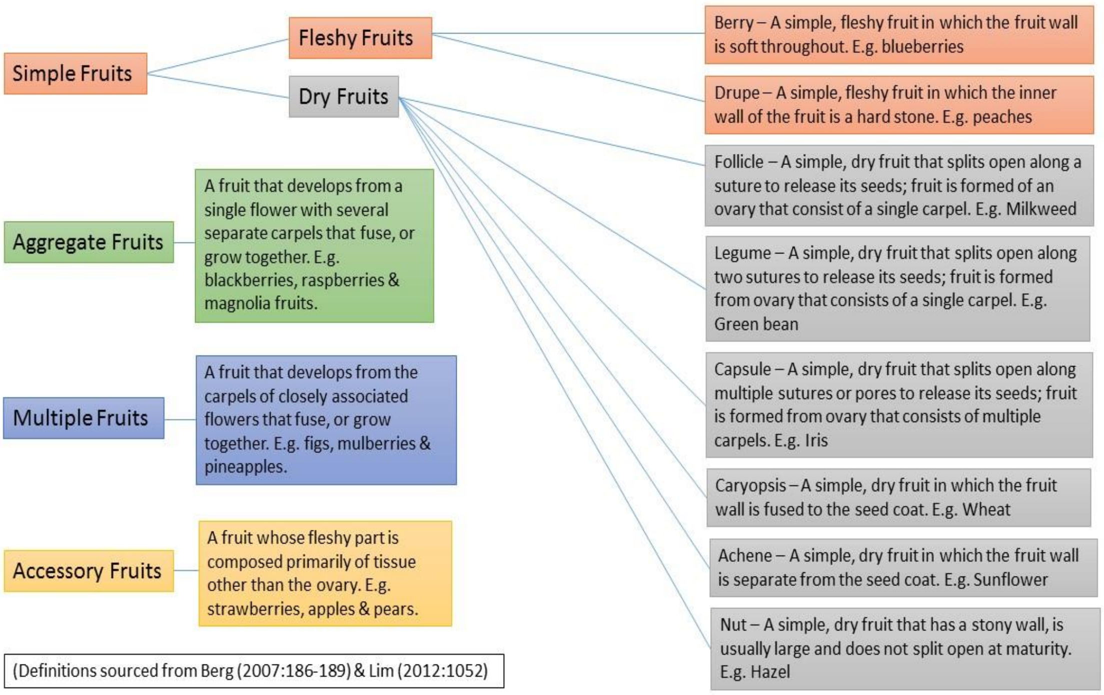
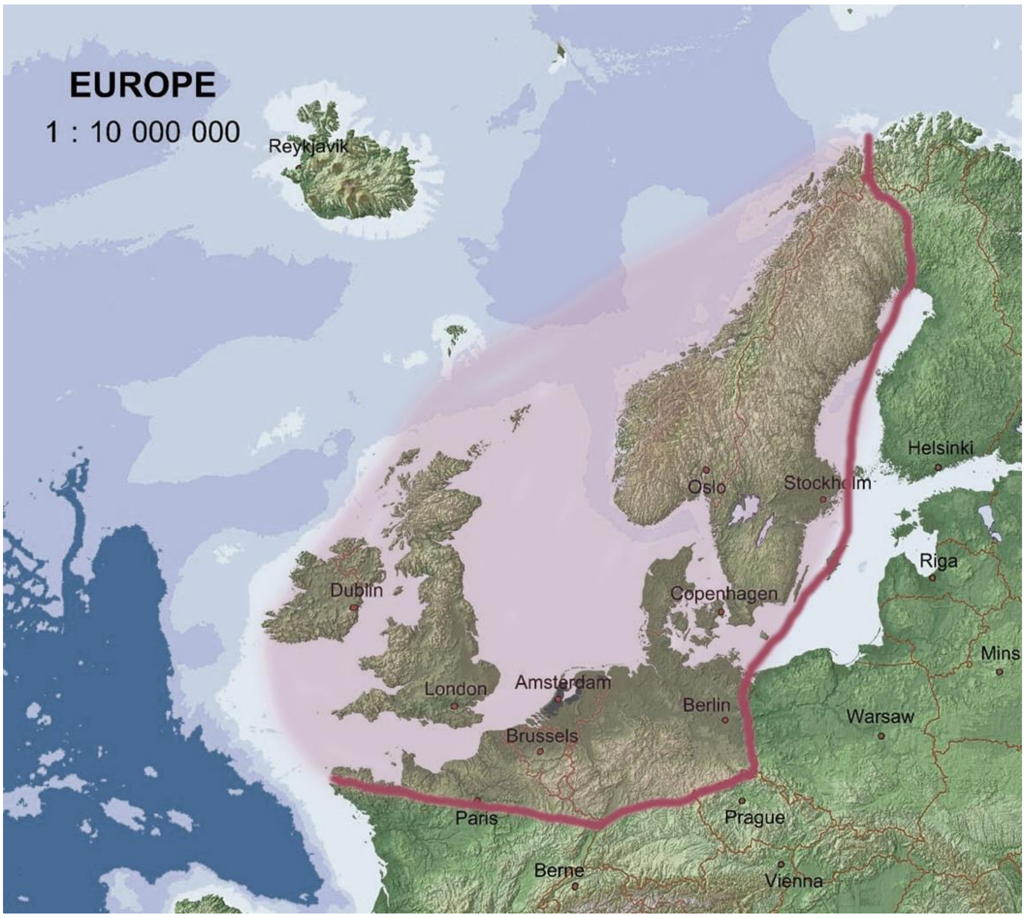


Illustration 2.1: Different categories of fruit according to Berg (2007) and Lim (2012).

This research will focus on the 'fleshy fruits' and the 'dry fruits' shall be omitted as research into dry fruits such as hazelnuts has already been covered in a lot of detail by previous research (Kubiak-Martens, 1999; Mithen *et al*. 2001; Holst, 2010; Bishop *et al*. 2014). Therefore, the fruit types covered in this survey will be: Berry, Drupe, Aggregate fruits, Multiple fruits and Accessory fruits.

2.2. Research area

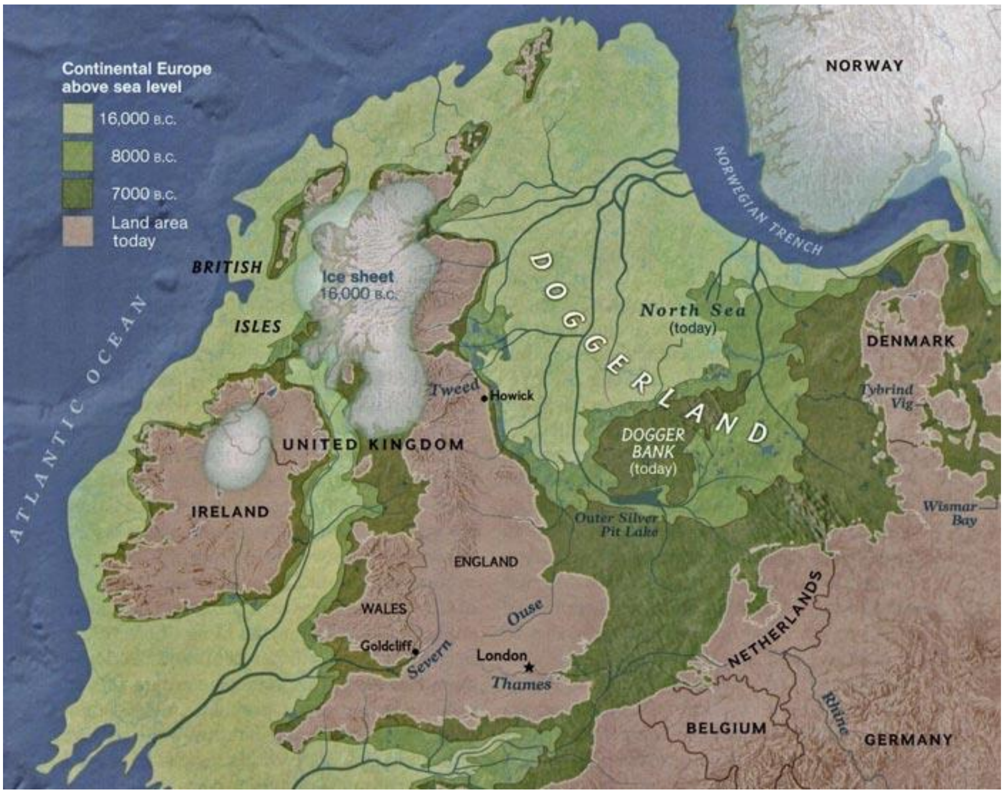
The area that is covered in this research covers the modern countries Ireland, United Kingdom, Northern France, Belgium, the Netherlands, Luxembourg, Northern Germany, Denmark, Norway (excluding Finnmark) and Sweden (Map 2.1). This area was selected for a number of reasons. Despite the research covering the whole period of the Mesolithic, the research area roughly pertaining to the Maglemosian culture has been selected. The Maglemosian culture (ca. 11,600-8,400 cal BP) takes its name from excavated bog called "Maglemosen" at the site of Mullerup in Zealand (Sarauw, 1903). The culture, unlike its preceding Palaeolithic period, is characterised by microlith technology and big game hunting (Brinch Petersen, 1993; Jessen *et al*. 2015).



Map 2.1: Research area marked in red by author.
(Source: chainimages.com – Weltatlas)

It is incredibly difficult to infer tribal boundaries that are likely very fluid throughout the duration of the Mesolithic (Coles, 1998). Therefore, the similarity to these cultural areas is not by design, but instead the area has been selected because of its similar climatological zone. This climatological zone, a cold-temperate coastal/peri-coastal climate, combined with stabilising conditions brought by the prevailing south-westerly winds of the Gulf Stream, provide an area where specific assortment of flora varieties flourish. It has also been selected because of its geographical location being the furthest northwest area of mainland Eurasia and something of terminus to species migration, both for flora and for the Mesolithic hunter-gatherer communities.

Due to sea-level changes the coastline of this area has varied since the early Mesolithic. Coles (1998) implies that the low-lying wetlands of Doggerland would have been ideal territory for Hunter-gatherer's and states the North Sea now hides the area of greatest Maglemosian occupation (Map 2.2). The research area should not be seen as simply following modern geographical boundaries but aims to cover the whole region of Northwest Europe in the period of the Mesolithic. However, it is no mistake that the research areas eastern boundary follows Germany's and Sweden's eastern borders. This choice was made on the basis of the author's language restrictions in compiling data from Polish and Finnish literature, for sites just across the border that may still be considered Northwest Europe.



Map 2.2: Landscape changes – Map of Doggerland (Source: disassociated.com/images/posts/doggerland.jpg)

Chapter 3: Research Objective One

Why is fruit significant in understanding the lives of the hunter-gatherers in the Mesolithic of Northwest Europe and in understanding the people of the Mesolithic in their wider context?

3.1. The importance of fruit as a food source in the diet of Mesolithic Hunter-gatherers in Northwest Europe

Vitamin C is essential to human life and is required, alongside other antioxidants, to maintain good health (and prevent scurvy) (Naidu, 2003). Humans cannot synthesize vitamin C like other carnivores and omnivores. They must obtain all their vitamin C through dietary nutrition which can be done by consuming a number of foodstuffs (Benzie, 2003; Stinson *et al.* 2012). In ethnography, the Evenki of Siberia or Inuit of Canada consume raw meat, blood and offal as environmental conditions limit their access to plant-foods, sometimes to almost nil (Shephard, 2015). Whilst vitamins are present in vegetable matter such as pine needles, the most abundant source of vitamins (such as vitamin C) as well as sugars during the Mesolithic, would likely be fruits. Fruit must therefore be considered an essential commodity, not a luxury.

Figure 3.1 from Eaton and Eaton (2000) compares approximate intakes for micronutrients in the Palaeolithic and modern day. It quite clearly shows, that what is an essential part of modern diets was of even greater significance in the Palaeolithic diet. The data suggests a much more nutrient rich diet and thus a much higher fruit intake during the Palaeolithic.

Estimated daily intake of selected nutrients in Paleolithic and modern diets

Micronutrient	Paleolithic diet	Modern diet	Current day average requirement or recommended allowance
Vitamin C (mg)	604	59–115	30 (UK) 75–100 (women); 90 (men) (US)
Vitamin E (mg)	33	5.2–6.0	7 (UK); 15 (US)
Folate (µg)	357	208–317	140
Carotenoids (µg)	5560	1846–2048	Currently no recommended allowance
Iron (mg)	87	9.5–17.2	7–10
Copper (mg)	?	1–1.3	0.8
Zinc (mg)	43	7.1–13.6	5.5–7.5

Data from Eaton et al. (1997), Carr and Frei (1999), Kiely et al. (2001) and Levine et al. (2001).

Fig. 3.1: Estimated daily intake of nutrients during the Palaeolithic and in modern diets. (Source: Eaton and Eaton, 2000)

Fruit (and therefore sugars and vitamins) are a seasonal resource, therefore making them somewhat dependable. So, whilst vitamins could be attained through raw meat eating, like Inuit and Evenki (Smil, 2002; Leonard, 2002), the lack of seasonally migrating large herds in the densely wooded environment Mesolithic Northwest Europe reduces the dependability of this resource significantly. When one compares the hunting and gathering industries, whilst both skilled disciplines, gathering has the advantages of: seasonal and regional dependability, the foodstuff is immobile and often highly visible (from blossom to fruit), children can do it and can be collected in large numbers with relatively little exertion (Clark, 1936; Zvelebil, 1995). Fruit, unlike wild salads are a storable foodstuff and if correctly preserved maintain a great deal of their vitamin content. Preserved fruits can be carried with relative ease making them an important commodity when journeying or during times of known absence.

Cordain *et al.* (2000) have made a comprehensive mathematical assessment of modern hunter-gatherer diets from across the world. Using the “Ethnographic Atlas”[1] they were able to compare the proportions of dietary foodstuffs (meat, fish and plant-foods). They found that 73% of the groups surveyed in the “Ethnographic Atlas” derived > 50% (^{3}56–65%) of their foodstuffs from animal products (hunted or fished). By comparison 13.5% derived > 50% (^{3}56–65%) from plant foods. They continue stating that:

“Of the 229 hunter-gatherer societies listed in the Ethnographic Atlas, 58% (n = 133) obtained ^{3}66% of their subsistence from animal foods in contrast with 4% (n = 8) of societies that obtain ^{3}66% of their subsistence from gathered plant foods. No hunter-gatherer population is entirely or largely dependent (86–100% subsistence) on gathered plant foods, whereas 20% (n = 46) are highly or solely dependent (86–100%) on fished and hunted animal foods” (Cordain et al. 2000:689).

Taking a mean of hunter-gatherers worldwide covers up regional anomalies, however Cordain *et al.* (2000) also state hunted foodstuffs stay relatively constant with latitude (26–35% subsistence) whereas plant-food significance decreases. Despite this evidence, it may be that temperate Northwest Europe is in the 4% as stated in the quote above. If we look at the main dietary constituents by prime living environment (separated into biomes), in “temperate forest” plant-foods and fished animal foods are equally important with hunted animal foods the least important. However, plant-foods are least significant in the Northern coniferous forest (Cordain

[1] The Ethnographic Atlas is a database on 1167 societies coded by George P. Murdock and published in 29 successive instalments in the journal ETHNOLOGY, 1962-1980” (Source: Fischer, M. http://eclectic.ss.uci.edu/~drwhite/worldcul/atlas.htm)

et al. 2000). Plant-foods may not be the most significant foodstuff but certainly play a crucial role in both regions/biomes that could be considered as being covered in the research area (Fig. 3.2).

Mean economic subsistence dependence in worldwide hunter-gatherer societies (n = 63) by primary living environment

Environment	Dependence on gathered plant foods	Dependence on hunted animal foods	Dependence on fished animal foods
		%	
Tundra, northern areas (n = 6)	6–15	36–45	46–55
Northern coniferous forest (n = 14)	16–25	26–35	46–55
Temperate forest, mostly mountainous (n = 6)	36–45	16–25	36–45
Desert grasses and shrubs (n = 11)	46–55	36–45	6–15
Temperate grasslands (n = 11)	26–35	56–65	6–15
Subtropical bush (n = 2)	36–45	26–35	26–35
Subtropical rain forest (n = 4)	36–45	46–55	6–15
Tropical grassland (n = 4)	46–55	26–35	16–25
Monsoon forest (n = 2)	36–45	26–35	26–35
Tropical rain forest (n = 3)	26–35	26–35	36–45

Fig. 3.2: Mean economic subsistence dependence in world-wide hunter-gatherer societies (Source: Cordain *et al.* 2000)

It is true however that fruit do not make up all plant-foods but are only one type. Of all the wild plant-foods covered in the “wild-plant-food database”, fruits are by far the most numerous at 41.3% of all plant-foods, tubers second most at only 11.2% (Cordain *et al*. 2000). So fruits may not be the largest contributing food-stuff to hunter-gatherer subsistence, nor is it the most energy dense. However, it still represents a significant part of the diet and unlike the other elements of hunter-gatherer subsistence, cannot be easily substituted (Fig. 3.3).

Relative contribution of plant-food type to the wild-plant-food database[1]

Rank	Plant-food type	n	Percentage of total number	Energy density
			%	*kJ/g*
1	Fruit	317	41.3	3.97
2	Tubers	86	11.2	4.06
3	Other seeds	74	9.6	12.38
4	Nuts	74	9.6	12.80
5	Roots	51	8.5	3.93
6	Acacia seeds	55	7.2	14.73
7	Bulbs	30	3.9	6.78
8	Leaves	28	3.6	2.55
9	Flowers	16	2.1	3.56
10	Miscellaneous	14	1.8	3.81
11	Dried fruit	7	0.9	12.18
12	Gums	2	0.3	9.96

[1] n = 768. From reference 17.

Fig. 3.3: Relative contribution of plant food type towards the wild-plant-food database (Source: Cordain *et al.* 2000)

Fruits are an integral part of the diet, being some of our only known sources of certain vitamins and minerals as well as being high in sugars, antioxidants and other nutrients that are essential in human health. However, the importance of fruit as a resource is not limited to its culinary/dietary value. Fruits are an important ingredient in herbal medicine, aesthetics (paints, inks & dyes) and are valued by other animals and so can be used as a bait (Grieve, 1971; Darwin, 1996). In some cases it is chemicals within the fruit that are valued such as certain oils (for light and preservation), acids (for preservation) or chemicals like saponins that are used as soaps and fish poisons (Sale, 1981; Francis *et al*. 2002).

Some fruits ferment readily (such as *R. fruticosus*) and therefore may be used in the production of alcohol. This is incredibly significant in our understanding of the period, as high carbohydrate alcohol not only encourages the accumulation of adipose tissue and can be used as an energy source (Stinson *et al.* 2012), but has several other effect. It increases the longevity of and access to certain fruits, makes others palatable and more easily digestible, produces vinegars that can in turn be used in preservation and has significant implications to our understanding of Mesolithic social practise (James, 2003; Srivastava *et al*. 2015).

It seems part of human nature, to wish to control, to develop and to improve ones resources, particularly those of significant importance. If fruit are such a significant social, dietary, medicinal and aesthetic primary resource, their value and cultural significance cannot be understated. Whilst the implications of territoriality that develop with such are suggestion are notable, perhaps more interesting are the possibilities of an early form of agriculture (encouraging seed distribution) or propagation. Unfortunately, evidence of such activities would unlikely make it into the archaeological record as planted seeds would either germinate or appear as naturally scattered (Rafferty, 1985). Un-germinated seeds that had been deliberately scattered would be more diffuse and appear as insignificant accumulations. Uncharred/uncarbonised seeds are also less persistent in the soil (Miksicek, 1987; Minnis, 1981).

The importance of fruit to humans is therefore without question and for archaeologists, it seems surprising that something of such value and significance, especially for this period, has not been previously researched in detail.

Chapter 4: Research Objective Two

Which edible species of fruit were available throughout the Mesolithic of Northwest Europe and what does palynology suggest about their relative abundance?

4.1. Introduction

This chapter uses palynological data extracted from the "European Pollen Database"[2] to produce a series of tables that show the changes in fruiting species pollen levels and thus infer their relative abundance. To start with, it discusses the use of the database, the issues of using pollen evidence to infer fruiting species populations, the accuracy and limitations of the database, and the way in which the data will be processed and presented.

4.2. Using the Fossil Pollen Database to ascertain the fruit species available during the Mesolithic and track the changes in relative abundance.

4.2.1. The European Pollen Database: usage, accuracy and limitations

The European Pollen Database (EPD) is an online digital database that is publicly accessible. This data is accessed using the *Fossil Pollen Database Viewer* (FPD) on their website. [3]This tool allows the user to find pollen data by species, site name, country, specific researcher and by map locations. This data is made up of individual samples. Each 'sample' represents the identification of a species (or genera/family where species cannot be identified) at a year (cal BP). As well as age and species, included with each sample is the location it was taken (site, country, latitude and longitude), the sum of pollen grains relating to the specific year, and a reference for where the data is published. Samples were omitted where the accompanying dataset was incomplete. In the case of this research the data was accessed on 2nd March 2015 and the complete dataset is accessible in appendix 5.

Specific parameters were selected to isolate the data pertaining to fruit species, genera, and families, within the research area. The date ranges selected cover 15,000 cal BP - 12,000 cal BP (Late Upper Palaeolithic), 12,000 cal BP – 10,500 cal BP (Early Mesolithic), 10,500 cal BP – 9,000 cal BP (Middle Mesolithic), 9,000 cal BP – 7,500 cal BP (Late Mesolithic), 7,500 cal BP – 5,700 cal BP (Mesolithic to Neolithic transition, into Early Neolithic). This data (based on some 5077 samples) has then been presented in tables for the clear comparison of the percentage ubiquity

[2] "The **European Pollen Database** (EPD) is a freely available database of pollen frequencies, past and present, in the larger European area" (Source: http://www.europeanpollendatabase.net/index.php).

[3] Cf: http://www.europeanpollendatabase.net/fpd-epd/

(number of samples pertaining to a single year) and percentage total (total of pollen grains recorded) of each fruit species, genera or family across the research area and period. Whilst the data is not new, the relative infancy of the FPD allows for this data to be analysed in ways that have never previously been done, incorporating more samples across a larger research area.

4.2.2. Fruit pollination and its impact on palynology

The European fruit tree species are noted as not being able to fruit if self-pollinated. As fruit species they require cross-pollination via a carrier and are unable to wind pollinate, a process that requires specialised pollen (Di-Giovanni *et al*. 1991; Brush and Brush, 1972). This carrier transfer of pollen is sometimes referred to as insect pollination however the action of transferring pollen is not exclusive to insects. Successful fruiting occurs when pollen from one fruit tree's stamen is transferred to another tree's stigma and fertilises the ovule (Cummings, 2014). It is because this process works through manual transfer and not through wind pollination, that the fruit pollen that makes it into pollen reservoirs will be vastly smaller in quantity and variable (Brush and Brush, 1972). For this pollen to reach a reservoir it must have undergone the following process:

- The pollen falls from the tree and may be blown a short distance.
- Assuming the pollen has not fallen into reservoir in the first instance, surface run-off washes the pollen grains into a larger water body.
- Ultimately, to successfully accumulate in the record, the pollen must reach a reservoir which may take the form of a lake or bog.

The volume of accumulated pollen therefore is not necessarily reliant on the number of species but instead the number of species whose pollen is able to accumulate effectively in a reservoir. Ergo, the data may be seen instead to represent the number of species that are located in areas that expose their pollen to the optimal conditions for accumulation in a secure reservoir (Di-Giovanni *et al.* 1991).

This process of pollen moving into a reservoir will also have differential lag times depending on the distance a plant is from the reservoir and the duration of the route to reservoir (which may also be variable dependent on regional weather conditions). There is therefore likely to be bias in frequency and quantity towards species that favour the environmental conditions found at the site of a pollen reservoir or toward species that naturally produce more pollen (Di-Giovanni *et al.* 1991). It is also possible that changes in environmental conditions, such as increases in volume of water through a system, move pollen from one reservoir to another at a later date. It would be impossible to track the time pollen had spent in transit or in any potential previous temporary reservoirs before its final accumulation. This huge possible variation in lag times of pollen reaching its final reservoir as well as the possibility of large amounts of pollen never reaching a reservoir (and therefore not represented) raises questions about the reliability of the dataset in its use for modelling past environments and of stratigraphic dating (Di-Giovanni *et al*. 1991; Brush and Brush, 1972).

4.2.3. The database and its use in this research

With regards to the fidelity, the accuracy and precision of the results of this research are twinned with that of the Fossil Pollen Database. The database is formed by independent submissions from researchers across Europe and during this research, poorly entered/incomplete datasets were found. This raises questions about further errors within the database that are less noticeable.

One might also struggle with the interpretation of the absence of evidence because of a possible incomplete dataset. For example, it appears that during the Late Palaeolithic, Early Mesolithic in Denmark there is no fruit pollen evidence recorded. It is impossible to tell from the dataset whether this is because of a lack of evidence submitted to the FPD, lack of available reservoir that corresponds to this period from which to extract a core, or whether this is a naturally occurring phenomenon. It certainly seems beyond imagination that from 15,000-10,500 BP that there was a complete absence of fruit species, where in neighbouring countries, such species proliferate.

The FPD does in some cases identify pollen at species level, however, Kershaw *et al.* 1994 state that this is rarely an accurate identification and accuracy can usually only be attributed to identification at family level. For this research the data has been used as it is presented. To allow for comparative analysis, where a sample is only identified to family level it has been labelled "*Family name, Undifferentiated, undifferentiated.* Where a sample is identified to a genus level, it has been labelled "*Family name, Genus name, undifferentiated".* Naturally these categories represent a varying number of species that is impossible to ascertain. It is therefore difficult to make clear comparisons between these categories and those with a specific species labelled. With regards to this, pollen genera and families that also contain non-fruiting species do occur and adjustments cannot be made to account for this. For example, the family *Ericaceae* contains many species yet only six from the research area bear useable fruits. This should be a consideration when interpreting the results, particularly at genus and family level.

4.3. Analysis of the Fossil Pollen Database evidence

The data has been analysed to find the % ubiquity and % total. In the case of this research, the % ubiquity is the percentage of times that a species identified as present throughout a time period. The % total uses the "sum" category from the FPD that represents the number of pollen grains found attributed to a specific year sample. Both are useful in interpreting the prevalence of a particular fruit species, family or genus during the research periods. Below is an example of the possible scenarios and the inferences that could be made from such results:

1. **Low ubiquity – Low total pollen**

Species occurs infrequently in low numbers by comparison with other species.

2. **Low ubiquity – High total pollen**

Species occurs infrequently but is prevalent/successful during growth periods by comparison with other species.

3. **High ubiquity – Low total pollen**

Species occurs throughout the period in low numbers by comparison with other species.

4. **High ubiquity – High total pollen**

Species occurs throughout period and is prevalent/successful during growth periods by comparison with other species.

For the purposes of this research, the species groups present and their respective percentage ubiquity and percentage total will be compared for the region defined previously as Northwest Europe (See section 2.2) across the time periods: 15,000 – 12,000 BP, 11,999 – 10,500 BP, 10,499 – 9,000 BP, 8,999 – 7500 BP and 7,499 – 5700 BP. These categories have been defined for ease of reference as Late Upper Palaeolithic, Early Mesolithic, Middle Mesolithic, Late Mesolithic and Mesolithic to Neolithic transition. These dates are quite arbitrary due to the differing date ranges of periods across the large research area, and are used merely to illustrate the general trend with easy reference. Pollen data is used from the period referred to as "Late Upper Palaeolithic" and "Mesolithic to Neolithic transition" despite being outside the main research period set out in the research objectives. This is used to form a baseline for which the later periods can be compared and to track changes that are occurring as the Mesolithic period begins and ends, which would not otherwise be noticed.

Data was collected from 157 sites in Belgium, Denmark, France, Germany, Ireland, The Netherlands, Norway, Sweden and the United Kingdom. The data was retrieved from 121 papers submitted to the FPD (see Appendix 1 for complete list of sites, countries and papers), creating some 5076 data entries.

The tables provided in the appendix 2 (palynology study pollen tables and graphs) include the data for this analysis over time. Included is a breakdown of the data along modern geographical boundaries, more clearly defining the changes in pollen ubiquity and total throughout Northwest Europe into smaller regions. The data in the country specific tables can be used by the reader to further understand the regional differentiation behind the Northwest Europe dataset, if required. This data, if analysed, could provide a more detailed understanding of the changes in frequency and density of fruit species across the period. The data has not been analysed at this level of detail for this research, as it is not required to address the research objectives. However, this may provide the basis for future research with a more palynologically focussed research objectives.

This data has been condensed below into tables that include the species ubiquity and is ranked by highest value to lowest for ease of comparison and analysis. The same has been provided for percentage total. This is in contrast to the tables presented in the appendix that are categorised by Family, genus and species alphabetically. The data is first broken down into the aforementioned arbitrary period groupings and then presented for the whole research period 15,000 – 5,700 BP. This is done to provide a clearer understanding of the changes in prevalence of species groups and their distribution throughout the Mesolithic period. Following the ubiquity and percentage total tables, is a ‘period overview’ section analysing the data and comparing it with the preceding period. This chapter is concluded with a section that discusses the trends of the different fruit species across the period.

The terms prevalence and dominance are used to describe two distinct facets of a species group during the period. A prevalent species is frequently present throughout the period. A dominant species is one that appears successful during a period on account of the large volumes of pollen recovered pertaining to said period.

4.3.1. Analysis of percentage ubiquity and percentage total of the data from the Fossil Pollen Database

Late Upper Palaeolithic - 15,000 cal BP - 12,000 cal BP

Percentage Ubiquity

Family/Genus/Species	Total times presence detected	% ubiquity
Rosaceae Undifferentiated	265	46.17
Empetrum nigrum	193	33.62
Hippophae rhamnoides	83	14.46
Crataegus undifferentiated	14	2.44
Prunus undifferentiated	5	0.87
Vaccinium undifferentiated	3	0.52
Cornus undifferentiated	2	0.35
Arctostaphylos undifferentiated	2	0.35
Ribes undifferentiated	2	0.35
Rosa undifferentiated	2	0.35
Rubus chamaemorus	2	0.35
Sorbus undifferentiated	1	0.17
Total	574	

Table 4.1: Percentage Ubiquity of fruit species in the research area (15,000-12,000 cal BP).

Percentage Total

Family/Genus/Species	Total pollen samples detected	% total
Rosaceae Undifferentiated	703857	40.46
Empetrum nigrum	579965	33.34
Rosa undifferentiated	206476	11.87
Hippophae rhamnoides	106194	6.10
Vaccinium undifferentiated	71153	4.09
Arctostaphylos undifferentiated	47026	2.70
Prunus undifferentiated	10010	0.58
Crataegus undifferentiated	9265	0.53
Rubus chamaemorus	3075	0.18
Ribes undifferentiated	1070	0.06
Sorbus undifferentiated	1066	0.06
Cornus undifferentiated	483	0.03
Total	1739640	

Table 4.2: Percentage Total of fruit species in the research area (15,000-12,000 cal BP).

Period Overview

Rosaceae Undifferentiated appears most prevalent and dominant throughout the period with 46.17% ubiquity and 40.46% total. Suggestive that the category was pollinating throughout the period and in high volumes. However, unlike the other categories representing species or genera groupings, *Rosaceae Undifferentiated* is a large family category. It is therefore likely that this category represents a relatively large conglomeration of species, and many of which may not be fruit-bearing.

Empetrum nigrum (the crowberry) is the most prevalent and dominant species level category with 33.62% ubiquity and 33.34% total. This is a significant, high result, especially considering the next highest species specific result is *Hippophae rhamnoides* (Sea Buckthorn) with 14.46% ubiquity and 6.1% total. *H. rhamnoides'* higher ubiquity and lower total percentages would suggest a species that is present during the period but one that is not very dominant. When considering *H. rhamnoides* coastal biome is coastal and peri-coastal, a common yet comparably small biome in Northwest Europe, the difference in percentage ubiquity and percentage total is more understandable.

Rosa undifferentiated (the Dog Roses) has a peculiar result. It occurs only twice in this period (0.35% ubiquity) but when it occurs it is responsible for 11.87% of the total pollen from this period (Cf. Tables 4.1 + 4.2). If one divides the ubiquity from the pollen total in order to get an average of the pollen released per occurrence, Rosa undifferentiated heavily skews the result because of its very few occurrences with high pollen volumes. It is difficult to interpret this as it could be the result of a number of factors including taphonomic and accumulation changes such as a sudden change in hydrology. For example, changes in the watercourse result in a former pollen reservoir being scoured and redeposited as a large accumulation in another pollen reservoir. This could be understood in a late glacial to postglacial period when hydrological pathways carrying pollen are far less stable. The results could also be erroneous on account of insufficient data from the FPD or simply represent two brief periods of optimal climate where the species prospered and pollinated heavily.

Crataegus undifferentiated is third most ubiquitous of the species/genera categories, however only having 2.44% (occurring 14 times throughout the period). It also makes up only 0.53% of the total pollen during this period. Likewise, *Vaccinium undifferentiated* and *Arctostaphylos undifferentiated* make up 4.09% and 2.7% of the percentage total pollen respectively, but only have 0.52% (*V. undifferentiated*) and 0.35% (*A. undifferentiated*) ubiquity, its presence only being detected three and two times throughout the whole period. Such results raise questions to the accuracy of the FPD or the way it presents the results.

The total number of times the presence was detected of all fruit family/genus/species categories during this period grouping is 574. This is 11.3% of the total number of times the presence was detected of all fruit family/genus/species categories during all periods covered in this research. The total pollen samples detected for this period is 1,739,640, only 3.3% of the total pollen samples detected across all periods. There were twelve fruit family/genus/species categories detected during this period, the lowest diversity of any of the research periods.

The species/genera categories that are present have quite specific soil requirements (see chapter 7 for species requirements). For example, the presence of *Vaccinium undifferentiated*, *Arctostaphylos undifferentiated, Empetrum nigrum, Cornus undifferentiated* and *Rubus chamaemorus* is suggestive of poor, acidic, stony, moist soils. These species typically found in Scandinavia in the Boreal forests on podsol soils. Both *Craetagus* and *Prunus undifferentiated* would also tolerate poor soils and damp conditions but require more light (Clapham *et al*. 1962; Beckett & Beckett 1979; Launert, 1989). The relatively low diversity of present fruit species would therefore be coherent with existing interpretations of the post-glacial environment in Northwest Europe (Riede *et al.* 2014; Cummings, 2014).

Early Mesolithic - 12,000 cal BP - 10,500 cal BP

Percentage ubiquity

Family/Genus/Species	**Total times presence detected**	**% ubiquity**
Empetrum nigrum	650	54.99
Rosaceae Undifferentiated	358	30.29
Hippophae rhamnoides	49	4.15
Vaccinium undifferentiated	41	3.47
Viburnum undifferentiated	16	1.35
Ericaceae Undifferentiated	15	1.27
Prunus undifferentiated	14	1.18
Sorbus undifferentiated	11	0.93
Crataegus undifferentiated	9	0.76
Arctostaphylos undifferentiated	8	0.68
Sambucus undifferentiated	2	0.17
Viburnum opulus	2	0.17
Rubus undifferentiated	2	0.17
Sorbus aucuparia	2	0.17
Arctostaphylos alpinus	1	0.08
Rosa undifferentiated	1	0.08
Rubus chamaemorus	1	0.08
Total	1182	

Table 4.3: Percentage Ubiquity of fruit species in the research area (12,000-10,500 cal BP).

Percentage Total

Family/Genus/Species	Total pollen samples detected	% total
Empetrum nigrum	4181035	54.65
Vaccinium undifferentiated	1359309	17.77
Rosaceae Undifferentiated	1129123	14.76
Sorbus undifferentiated	252196	3.30
Arctostaphylos undfferentiated	147787	1.93
Hippophae rhamnoides	144964	1.89
Viburnum undifferentiated	117937	1.54
Rosa undifferentiated	101846	1.33
Prunus undifferentiated	69443	0.91
Ericaceae Undifferentiated	63082	0.82
Sambucus undifferentiated	57214	0.75
Sorbus aucuparia	11574	0.15
Rubus chamaemorus	4233	0.06
Crataegus undifferentiated	3574	0.05
Viburnum opulus	3139	0.04
Rubus undifferentiated	2537	0.03
Arctostaphylos alpinus	1611	0.02
Total	7650602	

Table 4.4: Percentage Total of fruit species in the research area (12,000-10,500 cal BP).

Period Overview

Whilst half as long as the Late Upper Palaeolithic period (1,500 years as opposed to 3,000 years), the Early Mesolithic has 2.06 times more species ubiquity and 4.4 times more pollen. This would likely be caused by improvements in climate stability, soil conditions and an upward spiral in environmental conditions created by pioneer species. For example, the creation of shelter belts that would allow for the establishment of more diverse niches.

The data would suggest that the Early Mesolithic appears to be a period characterised by an abundance of *Empetrum nigrum*, both in prevalence (54.99%) and dominance (54.65%). Even the large family group *Rosaceae Undifferentiated*, previously most abundant during the Late Upper Palaeolithic, is significantly less ubiquitous and a notably lower % total, 30.29% and 14.76% respectively. The increase in dominance (17.77%) and prevalence (3.47%) in *Vaccinium undifferentiated* coupled with the aforementioned success of *E. nigrum* during this period might suggest a period of wet, cold weather with poor soils, conditions similar to modern day Scandinavia.

The appearance of *Arctostaphylos alpinus* and *Ericaceae Undifferentiated,* during this period, might be further suggestive of cold and inclement weather conditions. However, this could simply be caused by pollen that would normally be attributed to Arctostaphylos undifferentiated being categorised more (*Arctostaphylos alpinus*) or less (*Ericaceae Undifferentiated*) accurately.

The appearance of *Sorbus aucuparia, Rubus undifferentiated, Viburnum opulus, Viburnum undifferentiated* and *Sambucus undifferentiated*, and the general increase in biodiversity (17 species groups) might be suggestive of the contrary. That instead, the environmental conditions generally improve. The radical increase in pollen levels and prosperity of these "useful" species might be suggestive of human intervention in their propagation (Cf. Tables 4.3 + 4.4).

Similar to *Rosaceae Undifferentiated*, *Ericaceae Undifferentiated* is a family category where pollen could not be differentiated on species or genera level. The family has many non-fruit related genera, such as Rhododendron, Erica and Daboecia and should be understood within this context (Chittendon, 1951; Clapham *et al.* 1962).

Middle Mesolithic - 10,500 cal BP - 9,000 cal BP

Percentage Ubiquity

Family/Genus/Species	Total times presence detected	% ubiquity
Empetrum nigrum	656	47.33
Rosaceae Undifferentiated	352	25.40
Hippophae rhamnoides	91	6.57
Sorbus aucuparia	70	5.05
Ericaceae Undifferentiated	44	3.17
Viburnum undifferentiated	38	2.74
Sorbus undifferentiated	31	2.24
Viburnum opulus	22	1.59
Vaccinium undifferentiated	19	1.37
Crataegus undifferentiated	19	1.37
Sambucus undifferentiated	13	0.94
Prunus undifferentiated	10	0.72
Sambucus nigra	3	0.22
Arctostaphylos undifferentiated	3	0.22
Arctostaphylos uva-ursi	3	0.22
Rosa undifferentiated	3	0.22
Rubus chamaemorus	3	0.22
Cornus undifferentiated	2	0.14
Prunus padus	2	0.14
Arctostaphylos alpinus	1	0.07
Rubus undifferentiated	1	0.07
Total	1386	

Table 4.5: Percentage Ubiquity of fruit species in the research area (10,500-9,000 cal BP).

Percentage Total

Family/Genus/Species	Total pollen samples detected	% total

Rosaceae Undifferentiated	3808038	19.90
Sorbus aucuparia	3336041	17.43
Empetrum nigrum	3052163	15.95
Viburnum opulus	2292943	11.98
Sorbus undifferentiated	1577728	8.24
Viburnum undifferentiated	1542618	8.06
Crataegus undifferentiated	789077	4.12
Vaccinium undifferentiated	639798	3.34
Rosa undifferentiated	552021	2.88
Prunus undifferentiated	543272	2.84
Sambucus undifferentiated	437419	2.29
Hippophae rhamnoides	360186	1.88
Ericaceae Undifferentiated	110690	0.58
Arctostaphylos undifferentiated	69078	0.36
Rubus chamaemorus	6463	0.03
Sambucus nigra	4151	0.02
Arctostaphylos uva-ursi	3856	0.02
Prunus padus	3380	0.02
Arctostaphylos alpinus	3075	0.02
Cornus undifferentiated	2028	0.01
Rubus undifferentiated	1875	0.01
Total	19135897	

Table 4.6: Percentage Total of fruit species in the research area (10,500-9,000 cal BP).

Period Overview

The Middle Mesolithic represents a fruit pollen zenith. Whilst the species ubiquity is only 1.17 times more than the Early Mesolithic, the total pollen samples detected is 19,135,897 (Cf. Tables 4.5 + 4.6). This is 2.5 times larger than the Early Mesolithic and is the highest total of any of the periods examined. The species diversity increases during this period to 21 species categories.

Notably, *Empetrum nigrum* remains most ubiquitous but descends in the share of total pollen in this period to 3rd place (Table 4.6). This might have been easily explained were it 2nd to *Rosaceae Undifferentiated* as this category represents a large unknown number of species, however it is 3rd to *Sorbus aucuparia* which is a single species group. The amount of *Empetrum nigrum* pollen samples detected in this period is actually a decrease on the Early Mesolithic, despite sizeable increase in total samples detected.

Interestingly, whilst the rise in fruit species during this period could be attributed to human propagation, the two of the most insipid and fowl tasting fruits, *Sorbus aucuparia* and *Viburnum opulus* appear among the most dominant categories. To better understand if this increase could be due to human intervention, a comparison would need to be made against a baseline of similar non-fruiting species categories. This would be a valuable avenue of enquiry for future research.

During this period, *Rosa undifferentiated* (the Dog Roses) appears only 3 times but has a total pollen samples detected as 552,021. If one divides the total pollen samples by the number of occurrences one finds the average number of pollen samples detected per pollen event. This sum shows *Rosa undifferentiated* as the highest across all periods, at an average 184,007 pollen samples to a single event, some 180,000 more than what might be expected from similar fruiting species category.

Late Mesolithic - 9,000 cal BP - 7,500 cal BP

Percentage Ubiquity

Family/Genus/Species	Total times presence detected	% ubiquity
Rosaceae Undifferentiated	269	29.11
Empetrum nigrum	260	28.14
Sorbus aucuparia	106	11.47
Viburnum opulus	59	6.39
Ericaceae Undifferentiated	56	6.06
Sorbus undifferentiated	51	5.52
Viburnum undifferentiated	47	5.09
Sambucus undifferentiated	16	1.73
Hippophae rhamnoides	15	1.62
Prunus undifferentiated	10	1.08
Cornus undifferentiated	8	0.87
Crataegus undifferentiated	8	0.87
Vaccinium undifferentiated	6	0.65
Rubus undifferentiated	4	0.43
Sambucus nigra	2	0.22
Arctostaphylos uva-ursi	2	0.22
Prunus padus	2	0.22
Sambucus racemosa	1	0.11
Ribes undifferentiated	1	0.11
Rubus chamaemorus	1	0.11
Total	924	

Table 4.7 Percentage Ubiquity of fruit species in the research area (9,000 – 7,500 cal BP).

Percentage Total

Family/Genus/Species	Total pollen samples detected	% total
Sorbus undifferentiated	2767982	19.27
Viburnum opulus	2670310	18.59

Sorbus aucuparia	2490782	17.34
Rosaceae Undifferentiated	2224491	15.49
Empetrum nigrum	2194313	15.28
Viburnum undifferentiated	744547	5.18
Sambucus undifferentiated	665119	4.63
Prunus undifferentiated	268720	1.87
Hippophae rhamnoides	142263	0.99
Ericaceae Undifferentiated	81534	0.57
Vaccinium undifferentiated	41256	0.29
Cornus undifferentiated	38725	0.27
Crataegus undifferentiated	11623	0.08
Rubus undifferentiated	5908	0.04
Prunus padus	4300	0.03
Rubus chamaemorus	2898	0.02
Sambucus nigra	2568	0.02
Arctostaphylos uva-ursi	2186	0.02
Ribes undifferentiated	1204	0.01
Sambucus racemosa	240	0.002
Total	14360969	

Table 4.8: Percentage Total of fruit species in the research area (9,000 – 7,500 cal BP).

Period Overview

The Late Mesolithic shows a decrease in the species diversity (20 species categories, down from 21), the total ubiquity (924 occurrences detected, down from 1386) and the total pollen samples detected (14,360,969, down from 19,135,897). Whilst the drop in diversity is very small, the total ubiquity and total pollen samples decrease is substantial.

There is a distinct change in the top species categories of the percentage total category (Table 4.8). Whilst there is an increase in the species categories *Sorbus undifferentiated* and *Viburnum opulus*, there is a significant decrease in the categories *Rosaceae Undifferentiated*, *Sorbus aucuparia* and *Empetrum nigrum*. Also notable is the fall of *Hippophae rhamnoides* by over half, from 360,186 (1.88%) to 142,263 (0.99%).

This change could be occurring in the Late Mesolithic for a number of reasons. An initial assumption might be changes in climatic conditions that are more preferable to *Sorbus undifferentiated* and *Viburnum opulus*. If food source species were being in propagated in the Middle Mesolithic period, this general decrease in certain previously dominant species, could be an indication of changes in resource choice or a decrease in this practice.

By comparison the ubiquity suggests that *Empetrum nigrum*, *Rosaceae Undifferentiated*, *Sorbus aucuparia* and *Ericaceae Undiffferentiated* remain in the top five most prevalent fruit species

(Table 4.7). This might suggest the species remain present but are producing notably less pollen. *Hippophae rhamnoides* decreases in prevalence during this period from 91 occurrences to 15, and is supplanted in the top five by *Viburnum opulus*. This decrease is more suggestive of a reduction in the species population rather than simply a reduction in pollen production.

The appearance of *Sambucus racemosa* is small in quantity. This could be attributed to a more accurate identification of some *Sambucus undifferentiated* pollen. As a species that is usually attributed to central southern Europe, it could also be the result of warmer climate or wind dispersal by a strong southerly wind.

Mesolithic to Neolithic transition - 7,500 cal BP - 5,700 cal BP

Percentage Ubiquity

Family/Genus/Species	Total times presence detected	% ubiquity
Rosaceae Undifferentiated	319	31.21
Empetrum nigrum	269	26.32
Sorbus aucuparia	86	8.41
Viburnum undifferentiated	65	6.36
Sorbus undifferentiated	61	5.97
Viburnum opulus	45	4.40
Ericaceae Undifferentiated	39	3.82
Sambucus undifferentiated	35	3.42
Prunus undifferentiated	22	2.15
Hippophae rhamnoides	20	1.96
Vaccinium undifferentiated	17	1.66
Crataegus undifferentiated	13	1.27
Rubus undifferentiated	10	0.98
Prunus padus	6	0.59
Rosa undifferentiated	6	0.59
Rubus chamaemorus	4	0.39
Sambucus nigra	3	0.29
Cornus undifferentiated	1	0.10
Arctostaphylos uva-ursi	1	0.10
Total	1022	

Table 4.9: Percentage Ubiquity of fruit species in the research area (7,500 – 5,700 cal BP).

Percentage Total

Family/Genus/Species	Total pollen samples detected	% total
Empetrum nigrum	2178887	22.54
Rosaceae Undifferentiated	1877945	19.43

Viburnum opulus	1818218	18.81
Sorbus undifferentiated	1453477	15.04
Sorbus aucuparia	789120	8.16
Crataegus undifferentiated	564960	5.84
Sambucus undifferentiated	335479	3.47
Prunus undifferentiated	246869	2.55
Viburnum undifferentiated	146614	1.52
Hippophae rhamnoides	128850	1.33
Ericaceae Undifferentiated	68035	0.70
Vaccinium undifferentiated	21605	0.22
Rubus undifferentiated	17978	0.19
Prunus padus	7819	0.08
Rosa undifferentiated	3499	0.04
Rubus chamaemorus	3343	0.03
Sambucus nigra	2797	0.03
Arctostaphylos uva-ursi	1338	0.01
Cornus undifferentiated	356	0.004
Total	9667189	

Table 4.10: Percentage Total of fruit species in the research area (7,500 – 5,700 cal BP).

Period Overview

Similarly, to the Late Upper Palaeolithic, the Neolithic falls outside of the research period. However, using information from the preceding and proceeding periods allows changes across the entire research period to be more easily tracked and compared. This period grouping, the 'Mesolithic to Neolithic transition - 7,500 cal BP - 5,700 cal BP' covers the period of time that the Neolithic progressively occurred across Europe (Pinhasi *et al.* 2005; Larson *et al.* 2007). One might think this change from a hunter-gatherer economy to an agricultural one may have a visible impact on fruit pollen during this time, however as is evident from the proceeding overview, this period shows little dissimilarity to previous periods.

Perhaps the most significant changes during this period is in fact a sizeable decrease in pollen total, from 14,360,969 to 9,667,189. This could be attributed to the shorter period length from 1,500 years to 800 years. The species diversity also decreases in this period from 20 to 19, however this is due to the disappearance of *Ribes undifferentiated* which is occurs rarely and sporadically throughout all periods in this study with distinctly low dominance and persistence. The ubiquity increases in this period actually increases from 924 to 1,022 despite the shorter period length.

Regarding the top five most prevalent species (ubiquity) there appears to be only minor change (Table 4.9). There is an increase in percentage ubiquity and 'times presence detected' by *Rosaceae Undifferentiated*. *Empetrum nigrum* also increases in 'times presence detected' despite a decrease in percentage ubiquity. *Sorbus aucuparia* remains third most prevalent despite a decrease in ubiquity. There is a notable decrease in *Ericaceae Undifferentiated*, which permits *Sorbus undifferentiated* into the top 5 with only a minor increase in prevalence. *Viburnum opulus* drops to sixth most prevalent but is supplanted by *Viburnum undifferentiated* which could be account for by less specific identification of pollen previously attributed to *Viburnum opulus* at a species level.

The Total Pollen, by comparison, shows a more interesting pattern occurring over multiple periods (Table 4.10). In the Mesolithic to Neolithic transition the occurrences of *Empetrum nigrum* and *Rosaceae Undifferentiated* become the most dominant again, returning to a distribution more similar to the Middle Mesolithic than the Late Mesolithic periods. This rearrangement of the top five species seems to be more the result of a relative decrease (with consideration of the shorter period) in *Sorbus undifferentiated* and *Sorbus aucuparia*, than an increase in *Empetrum nigrum* and *Rosaceae Undifferentiated*. There is very little change in Percentage Total of *Viburnum opulus*. The changes in *Sorbus undifferentiated* and *S. aucuparia* across these periods will be discussed further in the discussion section of this chapter.

All samples spanning late Palaeolithic - early Neolithic - 15,000 cal BP - 5,700 cal BP

Percentage Ubiquity

Family/Genus/Species	Total times presence detected	% ubiquity
Empetrum nigrum	2021	39.81
Rosaceae Undifferentiated	1559	30.71
Sorbus aucuparia	264	5.20
Hippophae rhamnoides	258	5.08
Viburnum undifferentiated	166	3.27
Sorbus undifferentiated	155	3.05
Ericaceae Undifferentiated	154	3.03
Viburnum opulus	128	2.52
Vaccinium undifferentiated	85	1.67
Sambucus undifferentiated	66	1.30
Crataegus undifferentiated	63	1.24
Prunus undifferentiated	61	1.20
Rubus undifferentiated	17	0.33
Cornus undifferentiated	13	0.26
Arctostaphylos undifferentiated	13	0.26
Rosa undifferentiated	12	0.24
Rubus chamaemorus	11	0.22
Prunus padus	10	0.20

Sambucus nigra	8	0.16
Arctostaphylos uva-ursi	6	0.12
Ribes undifferentiated	3	0.06
Arctostaphylos alpinus	2	0.04
Sambucus racemosa	1	0.02
Total	5076	

Table 4.11: Percentage Ubiquity of all samples in the research area (15,000 – 5,700 cal BP).

Percentage

Total

Family/Genus/Species	Total pollen samples detected	% total
Empetrum nigrum	12178876	23.23
Rosaceae Undifferentiated	9637758	18.38
Viburnum opulus	6784610	12.94
Sorbus aucuparia	6627517	12.64
Sorbus undifferentiated	6052449	11.54
Viburnum undifferentiated	2551716	4.87
Vaccinium undifferentiated	2130397	4.06
Sambucus undifferentiated	1495230	2.85
Crataegus undifferentiated	1378498	2.63
Prunus undifferentiated	1138314	2.17
Hippophae rhamnoides	882457	1.68
Rosa undifferentiated	863841	1.65
Ericaceae Undifferentiated	323341	0.62
Arctostaphylos undifferentiated	263891	0.50
Cornus undifferentiated	41592	0.08
Rubus undifferentiated	28298	0.05
Rubus chamaemorus	20012	0.04
Prunus padus	15499	0.03
Sambucus nigra	9516	0.02
Arctostaphylos uva-ursi	7380	0.01
Arctostaphylos alpinus	4686	0.01
Ribes undifferentiated	2274	0.004
Sambucus racemosa	240	0.0005
Total	52438393	

Table 4.12: Percentage Total of all samples in the research area (15,000 – 5,700 cal BP).

Period Overview

When viewed as a whole the prevalence and dominance, and therefore the relative abundance of different species can be clearly examined in order to answer the research question.

By examining the species ubiquity across all periods (Table 4.11), four distinct groups become apparent: Group D = 0 – 17 times (0.02 to 0.33% ubiquity), Group C = 61 – 85 times (1.2 to 1.67% ubiquity), Group B = 128 – 264 times (2.52 to 5.2% ubiquity), and Group A = 1559 – 2021 (30.71

to 39.87% ubiquity). The two species groups that are most prevalent (the entirety of group A), and therefore most frequently available, are *Empetrum nigrum* and *Rosaceae Undifferentiated*, by a large margin.

In group B are less frequently available species although still common: *Sorbus aucuparia*, *Hippophae rhamnoides*, *Viburnum undifferentiated*, *Sorbus undifferentiated*, *Ericaceae Undifferentiated* and *Viburnum opulus*. It is notable however that the fruits of *Sorbus aucuparia*, *Viburnum undifferentiated* and *Viburnum opulus* are distinctly unpalatable (discussed later in chapter 7).

Group C and D are least frequently available with 85 occurrences or less over the 9,300 years covered in this study. This evidence would suggest they were rarely available throughout the period. However, this research assumes that identification many of the *Rosaceae* species such as *Rubus undifferentiated* at species or genera level may not have been possible and are represented under *Rosaceae Undifferentiated*.

If we examine the results spanning all period at a family level, although lacking detail on a species and genus level, the dominance and persistence between differing family groups is more easily compared.

Family/Genus/Species	**Total times presence detected**	**% ubiquity**
Adoxaceae	369	7.27
Cornaceae	13	0.26
Elaegnaceae	258	5.08
Ericaceae	2281	44.94

Grossulariaceae	3	0.06
Rosaceae	2152	42.40
Total	5076	

Family/Genus/Species	**Total pollen samples detected**	**% total**
Adoxaceae	10841311	20.67
Cornaceae	41592	0.08
Elaegnaceae	882457	1.68
Ericaceae	14908571	28.43
Grossulariaceae	2274	0.00 (0.004336517)
Rosaceae	25762187	49.13
Total	52438393	

Table 4.13 + 4.14: Species and genus level examination (15,000 – 5,700 cal BP).

These tables (4.13 + 4.14) show more clearly that the *Ericaceae* family is most consistently available. However, it also has a lower % Total pollen which may suggest that whilst consistently available throughout the period, they are not as populace as the *Rosaceae* family. The *Rosaceae* family is second most persistent and the most dominant, suggesting this family was the most readily available fruit species. Interestingly, whilst the *Adoxaceae* family seems more intermittently available, when it is available it appears to produce an above average volume of pollen. This may be due to the large flowering heads of many *Adoxaceae* family members that could produce larger volumes of pollen by comparison.

These results would suggest *Cornaceae* and *Grossulariaceae* are both rarely available and in minute quantity. It is likely that species of fruit in this family would therefore be a rare delicacy rather than a staple fruit source. *Elaegnaceae* seems to represent a relatively small proportion of the pollen produced with a low relative persistence. However, as discussed later in chapter 7 the fruit of the Sea Buckthorn (*Hippophae rhamnoides*) are extremely high in vital vitamins and minerals and have a mostly coastal distribution. One must also bear in mind the relative numbers of the fruit-bearing members of these families. All three of these families represent around only one to three fruiting species whereas *Rosaceae* and *Ericaceae* represent a much larger number.

To try and create a more balanced overview of these results, the data was divided by the total number of fruiting species in each family considered native to the research area in modern literature (discussed in chapter 7). This is used as a simple indicator and awareness of the lack of evidence to exact species present during this period must be maintained during analysis.

Family/Genus/Species	Total times presence detected/number of members	% ubiquity per member
Adoxaceae *4 members*	92.25	1.82
Cornaceae *2 members*	6.5	0.13
Elaegnaceae *1 member*	258	5.082
Ericaceae *5 members*	456.2	8.99
Grossulariacaeae *5 members*	0.6	0.01
Rosaceae *23+ members*	93.57	1.84
Total times detected	5076	

Family/Genus/Species	Total pollen samples detected/number of members	% total per member
Adoxaceae *4 members*	2710327.75	5.17
Cornaceae *2 members*	20796	0.04
Elaegnaceae *1 member*	882457	1.68
Ericaceae *5 members*	2981714.2	5.69
Grossulariacaeae *5 members*	454.8	0.00 (0.000867303)
Rosaceae *23+ members*	1120095.09	2.14
Total	52438393	

Table 4.15 + 4.16: Research data divided by the total number of fruiting species in each family area (15,000 – 5,700 cal BP).

Interestingly these tables (4.15 + 4.16) show a more balanced spread of results. Per member, *Ericaceae* remains the most persistent with the highest ubiquity. However, *Rosaceae* seems to represent a similar ubiquity per member to *Adoxaceae. Elegnaceae*, as it has only one member, is a notably more persistent species. The data further confirms *Grossulariacaeae* and *Cornaceae* as infrequently available. With regards to % Total, a different pattern emerges. This shows *Adoxaceae* and *Ericaceae* representing the largest percentages of per-member pollen. *Rosaceae* species seeming much less significant than previous data would suggest.

Discussion

It is clear that using palynology is a useful tool in giving a general picture of the species available and their relative abundance during the research period. The inherent limitations of this dataset have been discussed briefly throughout this chapter but include:

- The accuracy of the dataset from the European Pollen Database cannot be easily verified. The database is made up of a large number of contributors who may have different approaches to handling their data and in their approach to submitting/uploading this to the FPD.
- The FPD is in relative infancy and may only represent a small amount of the pollen recovered from this period from sites throughout the research area.
- Changes in fluvial conditions or taphonomy would likely have an impact on pollen accumulation within differing pollen reservoirs. This may be of particular note during post-glacial conditions where the hydrology and topography of the landscape were unstable (Cummings, 2014).
- The fruiting species examined in this study are insect pollinated varieties, as opposed to wind pollenated. This means that pollen fall from the plants will likely have a much shorter travel by comparison. This can create a bias in pollen cores towards species that have a preference for the conditions around pollen reservoirs, such as lakes and rivers. Long rivers could also contribute to a considerable dislocation of pollen from its source.
- The species groupings used in this study are based on categories used on the FPD. Included were groupings at family, genus and species level, which provides a difficulty for effective comparisons to be made below a species level.
- It is difficult to compare species availability throughout the period based on pollen evidence alone. Large volumes of pollen do not guarantee a successfully fruiting species. Furthermore, comparisons between family groups based on pollen volumes are difficult due to the varying numbers of possible fruiting and non-fruiting members within said family groups. Even if all the members of the family groups could be directly attributed to fruiting species, it is impossible to guarantee the number of species and therefore distinguish which species or family groups are most successful. The attempt to divide the family groups' results by the number of fruiting species considered native to the research area (discussed in chapter 7) provides little more than an indication and cannot be seen as accurate. It also does not eliminate the issue of Rosaceae Undifferentiated

and Ericaceae Undifferentiated possible representing other, non-fruiting species (see below).

- As previously mentioned *Rosaceae Undifferentiated* represents a family group rather than a genera or species group. This means that whilst it could represent some significant fruit species not represented by any listed species or genera group, such as *Malus sylvestris* or *Pyrus pyraster*, it also includes fruit species that may belong to a species or genera grouping but were unable to be identified with that level of accuracy. Furthermore, the *Rosaceae* family also includes many non-fruiting varieties from whom this pollen could have come. The presence of the *Rosaceae* family cannot even be used to infer a particular seral community, in the same way that the Ericaceae family may be able to, on account of the diversity of environments *Rosaceae* family members grow. For example, *Potentilla erecta,* a member of the *Rosaceae* family, can be found alongside *Empetrum nigrum* on upland environments with poor, acidic, waterlogged soils.

Whilst it may be true that this dataset has some inherent flaws, it does bring to light some interesting patterns, helps to answer the research question and highlights interesting avenues for potential future research.

The first obvious observation within these results is the prevalence and dominance of *Empetrum nigrum*. The results suggest *Empetrum nigrum* is consistently available and in large numbers across all periods, with a decrease during the Late Mesolithic that recovers by the Mesolithic-Neolithic transition. If *Empetrum nigrum* was such a successful species as the data might suggest, it would have likely been an unmissable resource for the Mesolithic inhabitants of Northwest Europe.

As previously mentioned the species groups *Viburnum opulus*, *Viburnum undifferentiated* and *Sorbus aucuparia* appear regularly in the top five for % Total and % Ubiquity. These species are noted later (in chapter 7) for their insipid, unpalatable, bitter and highly astringent taste which cannot easily be removed via processing. If the Mesolithic inhabitants of Northwest Europe were practicing propagation for food, one might expect to see more calorific or delicious species being more successful. Whilst we cannot rule out propagation on these grounds as they could have been used for a more practical application. It is likely these inhabitants also had a very different palette to our own, however, given the emetic properties of these fruits, it is not likely the unprocessed fruits were a staple.

During the Late Mesolithic there is an interesting change that occurs. Whilst *Empetrum nigrum* and *Rosaceae Undifferentiated* remain the most ubiquitous, their total pollen decrease so much so that *Sorbus undifferentiated*, *Viburnum opulus* and *Sorbus aucuparia* because most dominant. *Sorbus undifferentiated* also increases markedly on the previous period. Many of the fruiting *Sorbus* genus members such as *Sorbus aria* and *Sorbus torminalis* produce palatable fruits, improved by bletting (this is discussed later in chapter 7, section 6.3.20) (Johnson, 1862; Hedrick, 1972; Tanaka, 1976; Facciola, 1990; Mabey, 2007). This increase in *Sorbus* and decrease in *Rosaceae undifferentiated* and *Empetrum nigrum* could be caused by a number of different factors. Assuming the dataset is accurate, it could be the result of climatic or environmental changes that are more preferable to *Sorbus*, it might also be indicative of propagation of *Sorbus* species. Over consumption is an unlikely cause as the collection of fruit does not impact the blossom and pollen production of a plant unless done very carelessly. Harvesting of the fruit woods for fuel or materials is a possibility.

There is an interesting pattern in fruit species diversity that occurs throughout the whole research period. From Late Upper Palaeolithic to the Mesolithic to Neolithic transition, the number of different species categories present is as follows: 12, 17, 21, 20 and 19. This pattern shows a steady increase to the Middle Mesolithic and then a slight decline towards the Mesolithic to Neolithic transition. The increase in diversity is likely attributed to the stabilising of conditions following the last glacial as conditions become more temperate. However, the decrease may be on account of the changes in the accuracy of pollen identification. For example, during one period there may be two categories *Viburnum undifferentiated* and *Viburnum opulus*, in a following period the pollen from *Viburnum opulus* may be categorised under Viburnum undifferentiated. Thus appearing like there is one less category. The use of undifferentiated categories makes exact assessment of species diversity somewhat impossible.

Despite the difficulty in comparing direct species diversity, a similar pattern is modelled when we compare total number of times all species are present and the total pollen samples across the periods:

Period group	Total times presence detected	% of total
Late Upper Palaeolithic	574	11.31
Early Mesolithic	1182	23.29
Middle Mesolithic	1386	27.30

Table 4.17 + 4.18: Comparison of total number of times all species are present and the total pollen samples across 15,000 – 5,700 cal BP.

Late Mesolithic	924	18.20
Mesolithic to Neolithic transition	1022	20.13
Total	5076	

Period group	Total pollen samples detected	% total
Late Upper Palaeolithic	1739640	3.317
Early Mesolithic	7650602	14.59
Middle Mesolithic	19135897	36.49
Late Mesolithic	14360969	27.39
Mesolithic to Neolithic transition	9667189	18.44
Total	52438393	

Interestingly, these results (Tables 4.17 + 4.18) follow a strikingly similar pattern to species diversity. They show an increase to the Middle Mesolithic, followed by a decrease in the Late Mesolithic and Mesolithic to Neolithic transition. With the exception of a more marked decrease in 'total times presence detected' during the Late Mesolithic, followed by something of a recovery during the Mesolithic to Neolithic transition. There is a single explosion event of *Rosa undifferentiated* that occurs in the Middle Mesolithic. On face value the pollen quantity does not appear significant but when compared with the ubiquity (three occurrences), it makes *Rosa undifferentiated* the highest total pollen per presence detected, of any species. This is especially noteworthy given the otherwise relative scarcity of the species throughout the whole research period. This evidence would suggest the species may require very specific conditions to pollinate heavily. However, more likely is that this anomaly is the result in an error in the dataset or the cause of an unusual taphonomic occurrence or an exceptional accumulation event.

It is clear that the fruiting species of the *Ericaceae* family are consistently available. Whilst this may be the result of these fruiting species' having a preference for wetland environments and therefore having a greater potential for accumulation, the results suggest the species' are both dominant and persistent by comparison with other species. If accurate, the implications of this on the hunter-gatherer communities of the Mesolithic are noteworthy. During times of food and fruit scarcity, the upland environments that are the principle niche for fruiting *Ericaceae* could be depended upon for a persistent and dominant source of nutrition.

Chapter 5: Research Objective Three

Which edible fruit species do we have archaeological evidence for from the Mesolithic period?

5.1. Introduction

The compilation of archaeobotanical data in this section is integral for the reader to gain an understanding of which fruits are found on the Mesolithic sites from across the research area. This data was collated from all available published Mesolithic sites that could be retrieved from the Durham University Library, both in the offline, book and journal collections, as well as in available e-resources and e-journal repositories (accessible through University subscription). Nationally focussed surveys of archaeobotanical finds such as Bishop *et al.* (2014) and Regnell (2011) helped to create a baseline in several of the regions that could be added to in order to include more recent or previously overlooked entries. The value of these resources for establishing this broader database was significant, particularly where there were restrictions in the linguistic ability of the author.

This chapter looks specifically at which edible fruit species are found in the archaeological record, during excavation, pertaining to the Mesolithic, within the research area. The data from all published material found during the study, has been compiled and presented in the table below. This chapter does not include finds from grey-literature and similar unpublished material. Material published in other languages from outside the research area has not been used. The data compiled relates to archaeological evidence which may include: pollen recovered on an archaeological excavation, plant charcoal, fruit stones (fresh and charred), and other plant macro-fossils. For continuity purposes the species are listed in the same order as the species in chapter 7 which discusses “plant food and lore descriptions, ethnographic and modern historical uses” and includes species considered ‘native’ to Northwest Europe. Species that there is no archaeological evidence for, but that are deemed present in the previous chapter, or that are considered native and discussed later in chapter 7, are also included in order to provide a clear comparison.

5.2. Tables of archaeological evidence recovered from excavation

Tables 5.1 and 5.2 below show all the Mesolithic sites for which there was mentioned to be archaeobotanical remains of fruit species, from within the research area, retrieved from the aforementioned data sources. There were, in total, 40 archaeological sites throughout the research area that retrieved archaeobotanical finds. The two tables have been created from the same dataset. The first (5.1) represents the full dataset under the categories species, country, site, type of evidence, date and reference. The second (5.2) uses the number of sites and countries from which the data has been recovered in order to try and infer which species of edible fruits are most commonly occurring and therefore may be of significance to the Mesolithic inhabitants of said sites. This approach is somewhat problematic in its dependence on a number of assumptions. These inherent limitations will be conferred in the discussion section of this chapter.

The results are also limited to factors including where the publication does not give quantifiable yields in finds, citing only terms like 'some seeds'. Where an accurate radiocarbon date could not be given pertaining to the macrofossil find-layers, the terms cited in the literature such as 'Mesolithic' or 'Late Mesolithic' was used. Where no date was given, the term 'Mesolithic' was used. The table below (5.1) includes all species considered native, even those where no archaeobotanical evidence for them has been retrieved. Where no data is present, the term 'N/A' is included within the 'Country Found' column.

Included in this table (5.1) were references to pollen recovered from archaeological site. This is distinct from data used in the analysis of the European Pollen Database in Chapter four, as it is recorded from archaeological excavation and not from pollen cores. Furthermore, this is included to provide a complete table of archaeobotanical overview of the sites and cannot be considered macro-fossil remains. Comparing finds to possible contemporary local fruit species may seem attractive prospect, but the issues with pollen travel are well documented in chapter four and thus this approach is not pursued. Originally it was the aim of this research to create a third table with quantifiable values for the number of macro-fossils found at sites during excavation. This approach would have given more reliable dataset on which to base our conclusions on the use of fruits available during the research period and potentially their relative significance. Unfortunately, due to the distinctly vague descriptions, referring to finds in a non-quantitative fashion, such as "Wild berries of" (Bos, 2003), "Present in macrofossil assemblage" (Out *et al.* 2014) or simply terms such as "seeds" (Regnell, 1998) or "present" (Regnell, 1995), this information has been included as a direct quotation in the 'Type of evidence' sections of the tables below and therefore cannot be easily compared between different species.

Table of Archaeological evidence (including pollen, plant charcoal, fruit stones and other macro-fossils) found during excavation by family groups

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
Ericaceae						
Vaccinium myrtillus	Bilberry	Sweden	Bökeberg III	Pollen in Gyttja	5250-6770 BP	Regnell, M. et al. 1995
Vaccinium vitis-idaea	Lingonberry	Sweden	Dumpokjauratj/Ipmatisjaurat	Mentioned to be in field layer	8630±85 BP	Hörnberg, G. et al. 2005
Vaccinium uliginosum	Alpine Bilberry or Bog Whortleberry	N/A				
Arctostaphylos uva-ursi	Bearberry	N/A				
Arctostaphylos alpine	Alpine Bearberry	N/A				

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
Empetrum nigrum	Crowberry	Sweden	Tågerup	Pollen in Gyttja	6700-6000 BC (Kongermose)	Regnell, M. 2011
		Germany	Bedburg-Königshoven	Pollen data	Preboreal period from 9780 - 9600±100 uncal BP	Behling, H. & Street, M 1999
		Germany	Lahntal Hessen	Wild berries of "*"	Early Mesolithic (9271±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
		England	Esklets, North York Moors	Pollen data	8150±50 - 7670±60	
General Ericaceae		Sweden	Bökeberg III	Pollen in Gyttja	5250-6770 BP	Regnell, M. et al. 1995
Ericaceae type		Sweden	Dumpokjauratj/Ipmatisjaurat	Pollen in Gyttja	8630±85 BP	Hörnberg, G. et al. 2005
<u>Rosaceae</u>						
Fragaria vesca	Wild Strawberry	Denmark	Tybrind Vig	Seed, "achenes 2"	Ertøbolle	Robinson, D. E. 2007; Kubiak-Martens 1999

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
		Sweden	Balltorp	1 uncarbonised seed	7130 - 6315 BC	Larsson, E. 2000
		Germany	Lahntal Hessen	Wild berries of "*"	Early Mesolithic (9271±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
Rubus idaeus	Wild Raspberry	Northern Ireland	Newferry	Seeds	5500 - 3500BC	Zvelebil, M. 1994, Warren et al. 2014
		Sweden	Ageröd 5	raspberry	4910-4500 BC	Larsson 1983; Goransson 1983
		Sweden	Bökeberg III	(a) "Achene" (b) fruitlets	5560-4680 cal. BC	(a) Robinson, D. E. 2007; (b) Regnell, M. et al. 1995
		Sweden	Tågerup	78 Diaspoers from processed soil samples	6700-6000 BC (Kongermose)	Regnell, M. 2011
		Sweden	Holmegaards Mose	seeds	Mesolithic	Regnell 1998

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
		Sweden	Ronneholms Mosse	very large deposit of seeds - crescent shaped	Mesolithic	Regnell 1998; Larsson, L. & Sjöström, A. 2013
		Denmark	Angus Bank, Småland Bight	Black or Raspberry	4900 BC	Zvelebil, M. 1994
		Denmark	Muldbjerg	Rasberries	Mesolithic	Troels-Smith 1959; Renfrew 1973
		Denmark	Halsskov	"Achene"	Ertøbolle	Robinson, D. E. 2007
		Denmark	Tybrind Vig	"Achene","fruit-stones 9"	Ertøbolle	Robinson, D. E. 2007; Kubiak-Martens 1999
		Wales	Goldcliff East A	2 seeds, 1 thorn	Mesolithic	Bell *et al.* 2002
		Wales	Goldcliff East B	1 seed	Mesolithic	Bell *et al.* 2002
		Wales	Goldcliff East J	2 seeds	Mesolithic	Bell *et al.* 2002
Rubus spp.		England	Thatcham, Berkshire	Mentioned	9100±80 BP	Healey, F. et al. 1992

Fruit Species	**Common Name**	**Country found**	**Sites**	**Type of evidence**	**Date**	**Reference**
		Netherlands	Zutphen	"Half Rubus seed"	11110-11230 BP	Bos, J. et al. 2005
		Norway	Rognelien	seeds	Mesolithic	Regnell 1998
Rubus fruticosus aggregate	Blackberry	Denmark	Angus Bank, Småland Bight	Black or Raspberry	4900 BC	Fisher 1993
		England	Westward Ho!	1 Fruitstone	Mesolithic	Churchill, D. M. et al. 1965
		Sweden	Balltorp	1 carbonised seed	7130 - 6315 BC	a) Larsson, E. 2000 b) Larsson, L. 1993
Rubus fruticosus/idaeus		Wales	Llandevenny	151 charred seeds	3704-3656 cal BC	Brown, A. 2005
		North Sea	Argus Bank Lol.	1 carbonised fruitstone from marine deposit	Late Mesolithic	Fischer 1993

Fruit Species	**Common Name**	**Country found**	**Sites**	**Type of evidence**	**Date**	**Reference**
Rubus caesius	Dewberry	Denmark	Tybrind Vig	"Achene", "fruit-stones 14"	Ertøbolle	Robinson, D. E. 2007; Kubiak-Martens 1999
		Germany	Lahntal Hessen	Fruitstones / Macrofossil data	Early Mesolithic (9271±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
Rubus chamaemorus	Cloudberry	N/A				
Rubus saxatilis	Stone Bramble	Germany	Lahntal Hessen	Wild berries of "*"	Early Mesolithic (9271±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
		Sweden	Sarauws Holm, sjaell	Fruitstone in refuse layer	Early Mesolithic	Jessen 1935
Rosa spp.	Rose hips	Denmark	Tybrind Vig	(a)"Achene" (b)"Seeds 19"	Ertøbolle	(a) Robinson, D. E. 2007; (b)Kubiak-Martens 1999

Fruit Species	**Common Name**	**Country found**	**Sites**	**Type of evidence**	**Date**	**Reference**
		Sweden	Huseby Klev	Mentioned	Mesolithic	(a) Larsson, E. 2000
		Germany	Lahntal Hessen	fruitstones/ Macrofossil data	Early Mesolithic (9116±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
Prunus spinosa	Blackthorn or Sloe berry	Sweden	Bökeberg III	(a) "Fruitstone"	5560-4680 cal. BC	(a) Robinson, D. E. 2007 (b) Regnell et al. 1995
		England	Westward Ho!	3 Fruitstones	Mesolithic	Churchill, D. M. et al. 1965
		Germany	Lahntal Hessen	fruitstones/ Macrofossil data/ drupes of	Early Mesolithic (9116±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
		Sweden	Huseby Klev	Mentioned (b) to be 3	Mesolithic	(a) Larsson, E. 2000 (b) Nordqvist, B. 2005
		Wales	Goldcliff East A	1 charred stone	Mesolithic	Bell *et al.* 2002

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
Prunus padus	Bird Cherry	Germany	Lahntal Hessen	Fruitstones / Macrofossil data	Early Mesolithic (9271±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
		Netherlands	Hardinxveld-Giessendam De Bruin	Present in macrofossil assemblage	Mesolithic/Neolithic transition	Out, W. & Verhoeven, K. 2014
Prunus avium	Wild Cherry	Sweden	Bökeberg III	Present	5560-4680 cal. BC	Regnell, M. et al. 1995
		Sweden	Tågerup	2 Diaspoers from processed soil samples (possibly *P. cerasus*)	6700-6000 BC (Kongermose)	Regnell, M. 2011
Prunus cerasus	Sour Cherry	Sweden	Tågerup	2 Diaspoers from processed soil samples	6700-6000 BC (Kongermose)	Regnell, M. 2011

Fruit Species	**Common Name**	**Country found**	**Sites**	**Type of evidence**	**Date**	**Reference**
Prunus fruticosa	European Dwarf Cherry	N/A				
Prunus cerasifera	Cherry Plum	N/A				
Prunoideae (P. avium, padus, spinosa)		England	Streat Lane, Streat	3 Charcoal fragments, 10 hand-picked charc. Fragm.	Mesolithic	Butler, C. 2007
Prunus undiff.		England	Bluewath Beck Head	Pollen	Late Mesolithic (6950-6475 cal BP)	Innes, J. et al. 2010
Malus sylvestris	Crab apple	Sweden	Huseby Klev	(a) apple (b) "carbonised and relatively abundant"	6400-6650 BC	(a) Nordquist pers. comm. - Through Zvelebil 1994; (b) mentioned in Larsson, E. 2000
		Sweden	Bökeberg III	Present	5560-4680 cal. BC	Regnell, M. et al. 1995

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
		Sweden	Tågerup	1 uncarbonised diaspore from processed soil samples	6700-6000 BC (Kongermose)	Regnell, M. 2011
		Sweden	Balltorp	4 carbonised seed	7130 - 6315 BC	Larsson, E. 2000
		Denmark	Tybrind Vig	"Seeds" "pips 17"	Ertøbolle	Robinson, D. E. 2007; Kubiak-Martens 1999
		Northern Ireland	Mount Sandel	"wild pear/apple"	6845±135 BC	Zvelebil, M. 1994, Warren et al. 2014, Wijngaarden-Bakker, L. van 1985, Woodman, P. 1985
		Scotland	Staosnaig F24	21 Crab apple seeds / Fruit fragment	Mesolithic	Bishop, R. et al. 2014

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
		Netherlands	Hardinxveld-Giessendam De Bruin	Present in macrofossil ass. Carb.and uncarb.	Mesolithic/Neolithic transition	Out, W. et al. 2014
		Wales	Goldcliff East A	1 charred seed	Mesolithic	Bell *et al.* 2002
		Wales	Goldcliff East J	1 charred seed	Mesolithic	Bell *et al.* 2002
Pyrus pyraster	Wild Pear	Scotland	Carn Southern	(a) Pip (b) 1 pip?	3000BC	(a) Zvelebil, M. 1994; (b) Bishop, R. et al. 2014
Pyrus cordata	Plymouth Pear	N/A				
Malus/Pyrus group		Germany	Lahntal Hessen	seeds/ Macrofossil data	Early Mesolithic (9116±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
Crataegus monogyna	Hawthorn	Denmark	Aərø Mollegabet I & II	hawthorn	3960±75	Grøn & Skaarup 1992 - through Zvelebil

Fruit Species	**Common Name**	**Country found**	**Sites**	**Type of evidence**	**Date**	**Reference**
		Denmark	Møllegabet	"Fruitstones" & "Fruitstones & epidermis"	Ertøbolle	Robinson, D. E. 2007
		Denmark	Ringkloster	"Fruitstones" some charred	Ertøbolle	Robinson, D. E. 2007
		Denmark	Tybrind Vig	"Fruitstones", "fruitstones 20"	Ertøbolle	Robinson, D. E. 2007; Kubiak-Martens 1999
		Scotland	Ailsa View	"Hawthorn Stone" Single Stone	Later Mesolithic I	Bishop, R. et al. 2014
		Scotland	Chapelfield Pit 5	"Hawthorn Stone" Single Stone	Mesolithic	Bishop, R. et al. 2014
		England	Westward Ho!	4 Fruitstones	Mesolithic	Churchill, D. M. et al. 1965

Fruit Species	**Common Name**	**Country found**	**Sites**	**Type of evidence**	**Date**	**Reference**
		Netherlands	Hardinxveld-Giessendam De Bruin	Present in macrofossil ass. Carb.and uncarb.	Mesolithic/Neolithic transition	Out, W. et al. 2014
Crataegus laevigata	Midland Hawthorn	N/A				
Crataegus undiff.		Germany	Lahntal Hessen	pyrenes / Macrofossil data	Early Mesolithic (9116±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
		Denmark	Ringkloster jyll	Fruitstone in refuse layer	Late Mesolithic	Andersen 1975
Sorbus aucuparia	Rowan berry or Mountain Ash	Sweden	Balltorp	Rowan Berries	7130 - 6315 BC	Larsson, L. 1993, Zvelebil, M. 1994, Warren et al. 2014

Fruit Species	**Common Name**	**Country found**	**Sites**	**Type of evidence**	**Date**	**Reference**
		Sweden	Tågerup	2 Diaspoers from processed soil samples	6700-6000 BC (Kongermose)	Regnell, M. 2011
		Sweden	Bökeberg III	"Achene"	5560-4680 cal. BC	Regnell, M. et al. 1995, Robinson, D. E. 2007
		Denmark	Tybrind Vig	"Achene", "seeds 3"	Ertøbolle	Robinson, D. E. 2007; Kubiak-Martens 1999
Sorbus aria	Whitebeam	N/A				
Sorbus devoniensis	Devon Whitebeam	N/A				
Sorbus intermedia	Swedish Whitebeam	N/A				
Sorbus torminalis	Wild Service Berry or Chequer	N/A				

Fruit Species	**Common Name**	**Country found**	**Sites**	**Type of evidence**	**Date**	**Reference**
General Sorbus		Sweden	Tågerup	Pollen in Gyttja	6700-6000 BC (Kongermose)	Regnell, M. 2011
Sorbus type		Germany	Bedburg-Königshoven	Pollen data	Preboreal period from 9780 - 9600±100 uncal BP	Behling, H. & Street, M 1999
		Germany	Lahntal Hessen	Pollen data	Early Mesolithic (9270-8700 uncal BP)	Bos, J. A. A., & Urz, R. 2003
		Sweden	Huseby Klev	Mentioned to be 1	6400-6650 BC	Nordqvist, B. 2005
Sorbus spec.		Germany	Lahntal Hessen	seeds/ Macrofossil data	Early Mesolithic (9116±50 - 8704±55 uncal BP)	Bos, J. A. A., & Urz, R. 2003
Rosaceae undifferentiated		Sweden	Tågerup	Pollen in Gyttja	6700-6000 BC (Kongermose)	Regnell, M. 2011

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
		Sweden	Dumpokjauratj/Ipmatisjaurat	Pollen in Gyttja	8630±85 BP	Hörnberg, G. et al. 2005
General Rosaceae		Sweden	Bökeberg III	Pollen in Gyttja	5250-6770 BP	Regnell, M. et al. 1995
		England	Bluewath Beck Head	Pollen	Late Mesolithic (6950-6475 cal BP)	Innes, J. et al. 2010
Rubus/Sorbus		England	Howick	Pollen	10000-9000 cal BP	Boomer, I. et al. 2007
Pomoideae (Crataegus, Malus, Pyrus, Sorbus)		England	Streat Lane, Streat	17 Charcoal fragments, 6 hand picked charc. Fragm.	Mesolithic	Butler, C. 2007
		Netherlands	Hardinxveld-Giessendam De Bruin	Present in macrofossil assemblage	Mesolithic/Neolithic transition	Out, W. et al. 2014
Adoxaceae						

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
Viburnum opulus	Guelder Rose	Denmark	Tybrind Vig	"Seed", "seeds 2"	Ertøbolle	Robinson, D. E. 2007
		Sweden	Tågerup	Pollen in Gyttja	6700-6000 BC (Kongermose)	Regnell, M. 2011
		Netherlands	Hardinxveld-Giessendam De Bruin	Present	Mesolithic/Neolithic transition	Out, W. et al. 2014
		Germany	Lahntal Hessen	seeds / Macrofossil data	Early Mesolithic (9271±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003
Sambucus nigra	Elder	England	Thatcham, Berkshire	Present	9100±80 BP	Allen, M. et al. 1992
		Wales	Llandevenny	Present	3770-3030 cal BC	Brown, A. 2007
		Netherlands	Hardinxveld-Giessendam De Bruin	Present	Mesolithic/Neolithic transition	Out, W. et al. 2014

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
		Germany	Lahntal Hessen	Pollen data	Early Mesolithic (9270-8700 uncal BP)	Bos, J. A. A., & Urz, R. 2003
		Wales	Goldcliff East A	513 seeds + 2 charred seeds	Mesolithic	Bell *et al.* 2002
		Wales	Goldcliff East B	1 charred seed	Mesolithic	Bell *et al.* 2002
		Wales	Goldcliff East J	97 seeds + 1 charred seed+ 1 charred berry	Mesolithic	Bell *et al.* 2002
Sambucus ebulus	Dwarf Elderberry	N/A				
Sambucus racemosa var. racemosa	European Red Elder	N/A				
Grossulariaceae						

Fruit Species	**Common Name**	**Country found**	**Sites**	**Type of evidence**	**Date**	**Reference**
Ribes rubrum	Wild Redcurrant	N/A				
Ribes nigrum	Wild Blackcurrant	N/A				
Ribes uva-crispa	Wild Gooseberry	N/A				
Ribes alpinum	Alpine Currant	N/A				
Ribes spicatum	Nordic Currant	N/A				
Elaegnaceae						
Hippophae rhamnoides	Sea Buckthorn	Sweden	Tågerup	Pollen in Gyttja	6700-6000 BC (Kongermose)	Regnell, M. 2011
		Sweden	Dumpokjauratj/Ipmatisjaurat	Pollen in Gyttja	8630±85 BP	Hörnberg, G. et al. 2005

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
		Sweden	Huseby Klev	Mentioned to be 2	6400-6650 BC	Nordqvist, B. 2005
<u>Cornaceae</u>						
Cornus sanguinea	Common Dogwood	Denmark	Møllegabet	"Fruitstones"	Ertøbolle	Robinson, D. E. 2007
		Denmark	Ringkloster	(a) "Fruitstones" (b) 1 Fruitsone in refuse layer	(a) Ertøbolle (b) Late Mesolithic	(a) Robinson, D. E. 2007 (b) Andersen 1975
		Sweden	Bökeberg III	(a) "Fruitstones" (b) cracked (c) 2 Fruitstones in refuse layer	5560-4680 cal. BC (c) Late Mesolithic	(a) Robinson, D. E. 2007; (b) Regnell, M. et al. 1995 & 2011 (c) Regnell et al. 1982

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
		Denmark	Tybrind Vig	"Fruit-stones 96"	Ertøbolle	
		Sweden	Tågerup	(a) 9 Diaspoers from processed soil samples (b) 300+ fruit stones cracked & fractured: possible oil production	6700-6000 BC (Kongermose)	Regnell, M. 2011
		England	Westward Ho!	13 Fruitstones	Mesolithic	Churchill, D. M. et al. 1965
		Netherlands	Hardinxveld-Giessendam De Bruin	Present	Mesolithic/Neolithic transition	Out, W. et al. 2014
		Germany	Lahntal Hessen	fruitstones/ Macrofossil data	Early Mesolithic (9116±50 - 8525±35 uncal BP)	Bos, J. A. A., & Urz, R. 2003

Fruit Species	Common Name	Country found	Sites	Type of evidence	Date	Reference
		Wales	Goldcliff East A	2 charred seeds	Mesolithic	Bell *et al.* 2002
		Denmark	Ulkestrup sjaell	1 Fruitstone in cultural layer	Early Mesolithic	Andersen et al. 1982
Cornus suecica	Dwarf Cornel	N/A				

Table 5.1: Archaeological evidence (including pollen, plant charcoal, fruit stones and other macro-fossils) found during excavation by family groups.

The following table (5.2) highlights the number of sites at which macrofossil remains were discovered and across how many countries the sites were spread within the research area. Included are the types of evidence found and, where possible, the quantities. Where species are not included in this second table, no finds, and therefore no sites and/or countries are recorded.

Table of Archaeological evidence (including pollen, plant charcoal, fruit stones and other macro-fossils) found during excavation by number of sites

Fruit Species	Common Name	Number of Sites	Number of Countries	Type of evidence
Rubus idaeus	Wild Raspberry	13	4	Raspberry, "Achene", fruitlets, 78 Diaspoers from processed soil samples, seeds, very large deposit of seeds - crescent shaped, Black or Raspberry, Rasberries,"fruit-stones 9", 2 seeds, 1 thorn, 1 seed, 2 seeds
Malus sylvestris	Crab apple	10	6	Apple,"carbonised and relatively abundant", Present, 1 uncarbonised diaspore from processed soil samples, 4 carbonised seed, "Seeds", "pips 17", "wild pear/apple", 21 Crab apple seeds / Fruit fragment, Present in macrofossil ass. Carb.and uncarb., 1 charred seed, 1 charred seed.
Cornus sanguinea	Common Dogwood	10	6	Large quantity of "Fruitstones", cracked fruit stones, diaspoers, charred seeds
Crataegus monogyna	Hawthorn	8	4	some Fruitstones, charred fruitstones, macrofossil
Sambucus nigra	Elder	7	4	Very large number of seeds, charred seeds, single charred berry, pollen

Fruit Species	**Common Name**	**Number of Sites**	**Number of Countries**	**Type of evidence**
Prunus spinosa	Blackthorn or Sloe berry	5	4	"Fruitstone", 3 Fruitstones, fruitstones/ Macrofossil data/ drupes of, Mentioned to be 3, 1 charred stone
Viburnum opulus	Guelder Rose	4	4	Seeds, macrofossil data and pollen
Empetrum nigrum	Crowberry	4	3	Pollen, wild berries of,
Sorbus aucuparia	Rowan berry or Mountain Ash	4	2	Rowan Berries, 3 seeds, 2 achene, 2 diaspoers
General Sorbus		4	2	single seed and pollen
Fragaria vesca	Wild Strawberry	3	3	Seeds, achenes, wild berries of
Rubus spp.		3	3	Mentioned
Rubus fruticosus aggregate	Blackberry	3	3	Black or Raspberry
Rosa spp.	Rose hips	3	3	(a)"Achene" (b)"Seeds 19"
Hippophae rhamnoides	Sea Buckthorn	3	1	Pollen and 2 seeds
Rubus caesius	Dewberry	2	2	"Achene", "fruit-stones 14"

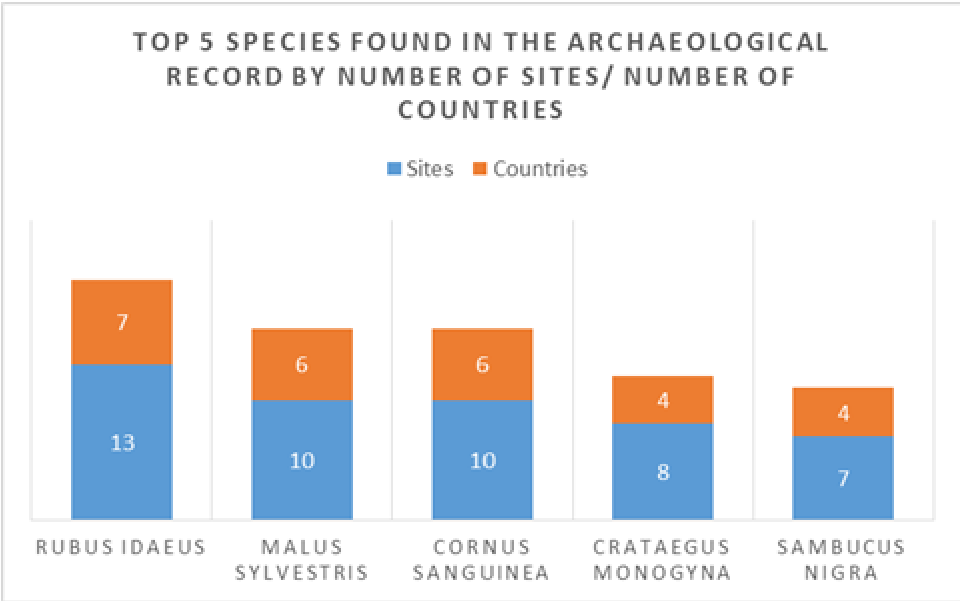
Fruit Species	Common Name	Number of Sites	Number of Countries	Type of evidence
Rubus saxatilis	Stone Bramble	2	2	Wild berries of "*"
Prunus padus	Bird Cherry	2	2	Fruitstones / Macrofossil data
Crataegus undiff.		2	2	pyrenes / Macrofossil data, Fruitstone in refuse layer
General Rosaceae		2	2	Pollen only
Pomoideae (Crataegus, Malus, Pyrus, Sorbus)		2	2	17 Charcoal fragments, 6 hand picked charc. Fragm.; macro fossil assemblage
Rubus fruticosus/idaeus		2	1	151 charred seeds
Prunus avium	Wild Cherry	2	1	Present
Rosaceae undifferentiated		2	1	Pollen only
Vaccinium myrtillus	Bilberry	1	1	Pollen in Gyttja
Vaccinium vitis-idaea	Lingonberry	1	1	Mentioned to be in field layer
General Ericaceae		1	1	Pollen in Gyttja
Ericaceae type		1	1	Pollen in Gyttja

Fruit Species	Common Name	Number of Sites	Number of Countries	Type of evidence
Prunus cerasus	Sour Cherry	1	1	2 Diaspoers from processed soil samples (possibly *P. avium*)
Prunoideae (P. avium, padus, spinosa)		1	1	3 Charcoal fragments, 10 hand-picked charc. Fragm.
Prunus undiff.		1	1	Pollen
Pyrus pyraster	Wild Pear	1	1	(a) Pip (b) 1 pip?
Malus/Pyrus group		1	1	seeds/ Macrofossil data
Sorbus spec.		1	1	seeds/ Macrofossil data
Rubus/Sorbus		1	1	Pollen only

Table 5.2: Archaeological evidence (including pollen, plant charcoal, fruit stones and other macro-fossils) found during excavation by number of sites.

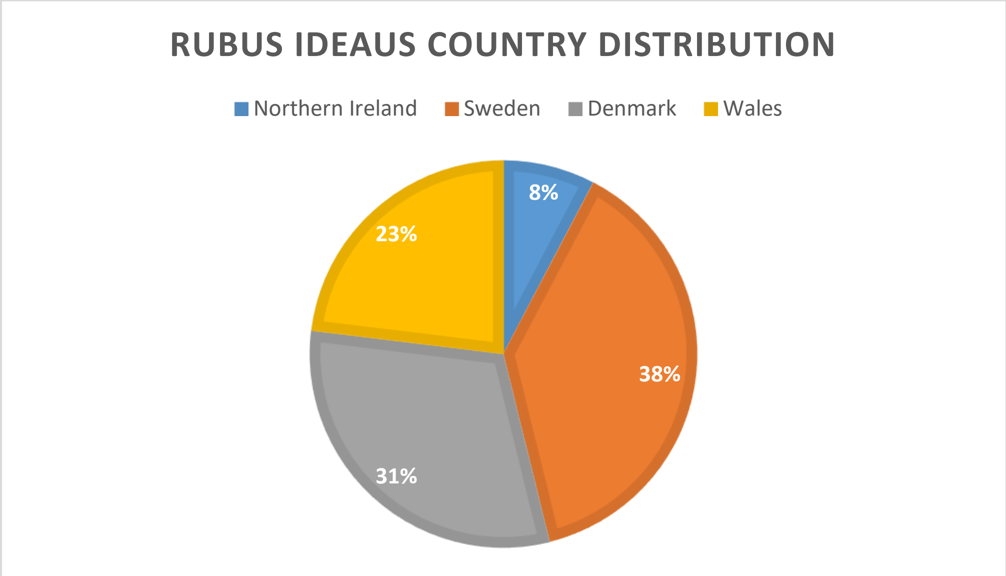
5.3. Discussion of findings

The top five species found according to number of sites is notable and is consistent with the authors initial assumptions with fruits used during this period. All five show a similarly diverse use across a large number of countries, implying that where available, the fruits were brought to sites across Europe. The value and uses of these species are understandably important and thus it does not appear anomalous for any of these species to be present in the top five. Fruit uses are discussed later in more detail in chapter 7.

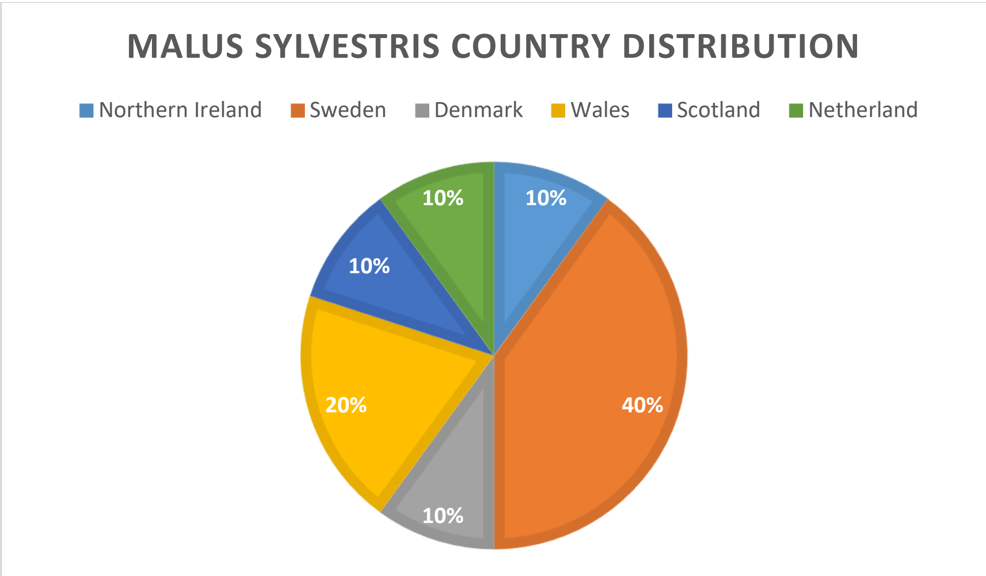


Graph 5.1: Top 5 Species found in the archaeological record by number of sites/number of countries.

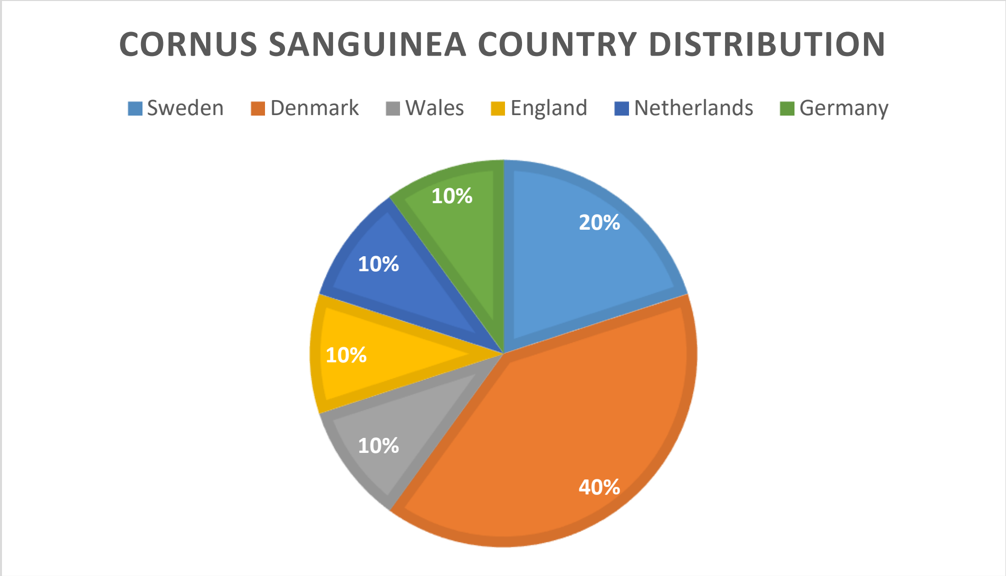
The top five species by number of sites:



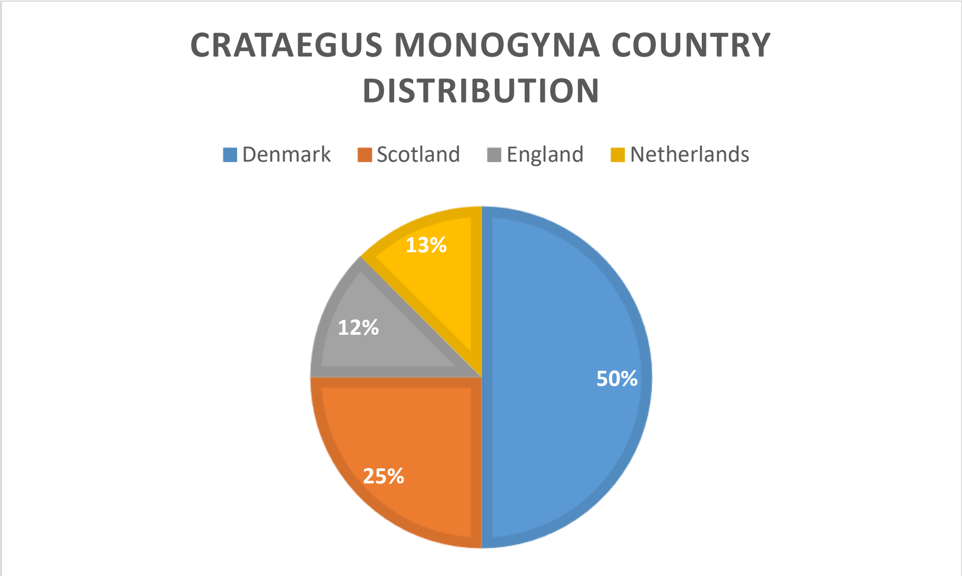
Graph 5.2: *Rubus ideaus* country distribution



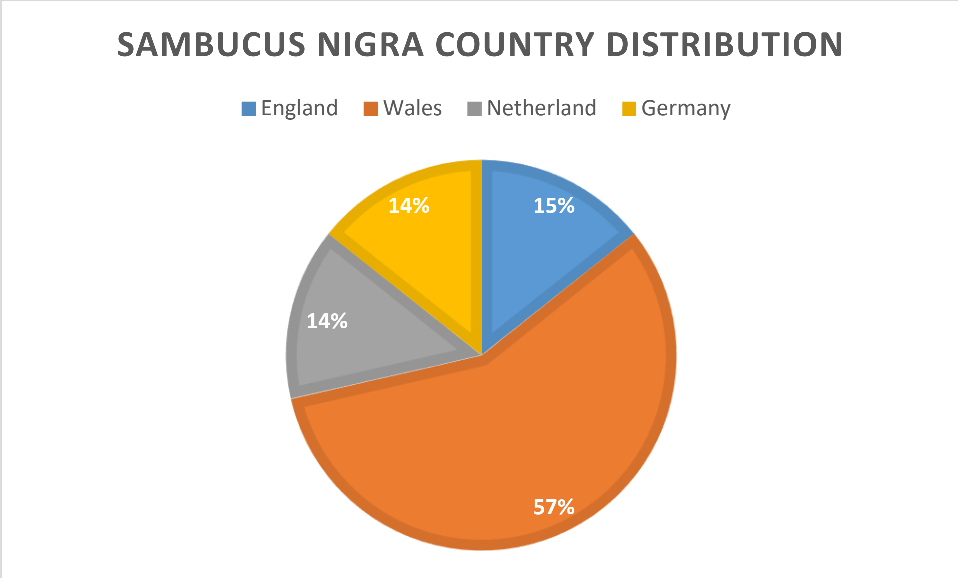
Graph 5.3: *Malus sylvestris* country distribution



Graph 5.4: *Cornus sanguinea* country distribution



Graph 5.5: *Crataegus monogyna* country distribution



Graph 5.6: *Sambucus nigra* country distribution

- *Rubus ideaus* (Graph 5.2) is found on 13 sites across four countries. It is the most commonly found species by number of sites suggesting a fairly ubiquitous use in the countries where is found; Wales, Northern Ireland, Denmark and Sweden. The majority of the finds were found in Sweden (38%) and Denmark (31%), with the other finds being located within the UK (31% combined).

- *Malus sylvestris* (Graph 5.3) is found across 10 sites in six countries. The large number of countries suggests the use of this fruit is widespread across the research area and coupled with the large number of sites suggest this was one of the more commonly exploited fruit resources throughout the countries. The majority of find sites are in Sweden (40%) with two find sites in Wales and single find sites in the Netherlands, Denmark, Northern Ireland and Scotland.

- *Cornus sanguinea* (Graph 5.4) finds are perhaps the most interesting on account of their find state. The large number of cracked seeds is attributed to oil production at the site of Tågerup (Regnell, 2011). The fact that the finds of *C. sanguinea* are in the top five further impresses upon the importance of the oil as a resource. *C. sanguinea* is found on ten sites across six countries, with 40% of finds occurring on sites in Denmark, 20% in Sweden and single find sites Wales, England, Germany and the Netherlands. This wide ranging occurrence on archaeological sites throughout Europe suggests that its value as a resource was well known and utilised extensively, where available.

- *Crataegus monogyna* (Graph 5.5) has multiple seed finds (20 at Tybrind Vig and four at Westward Ho!), on eight sites across four countries. Their hard single seed has been found on four sites within Denmark dating to the Ertøbolle period. The seeds have also been recovered at two sites in Scotland (one dating to the Late Mesolithic), one site in England (Westward Ho!), and one site in the Netherlands (Hardinxveld-Giessendam De Bruin) dating to the Mesolithic to Neolithic transition. The fact that the finds pertain exclusively to the later Mesolithic period could be on account of an increase in prominence as the period progresses, however it is noteworthy that the seeds can be homogenised and used within a food stuff. The seeds are typically removed if processing 'fruit leather' which is a preserveable food stuff with a long longevity (up to a year) and has a sweet pleasant texture. This could indicate either an increase in the importance of having preserveable fruit and nutrient sources toward the end of the Mesolithic period. It could also represent a shift toward food decadence, where taste and texture is more important than calorific value.

- *Sambucus nigra* (Graph 5.6) is found on seven sites across four countries, the majority of which (57%) is found in Wales at Llandevenny and Goldcliff East A, B & J; with single find sites in England, the Netherlands and Germany. The fruit is found in the highest number of any specified in the literature at 513 seeds plus two charred, at Goldcliffe A; with 97 seeds, 1 charred seed and 1 charred berry at Goldcliffe J (Bell *et al*. 2000) (Cf. Subchapter 5.2). The few charred remains might hint at the fruits cooking treatment, as an emetic if not first cooked (Cooper & Johnson, 1984; Frohne & Pfänder, 1984; Mears & Hillman, 2007), however they could also be pulped and strained to remove the seeds, which exacerbate the nauseating potential of these fruits (ibid). The seed finds dates span the period suggesting that this was a valuable resource from the Early Mesolithic to Mesolithic to Neolithic transition.

Other species

Prunus spinosa falls just outside of the top five but is still worth noting as a significant result of five sites across five countries. As discussed later in chapter 7, *P. spinosa* could represent a valuable food source, especially if homogenised with the seeds after a frost, so much so that Mears & Hillman (2007) refer to this as a "seasonal staple".

Viburnum opulus and *Sorbus aucuparia* are in the top ten, 7th and 9th respectively, which appears to be consistent with the results of the palynological study in chapter 4. However, the fruits of these species are considered distinctly insipid, unpalatable and in some cases referred to as inedible. Mears and Hillman (2007) state that they had tried in vain to process *Sorbus aucuparia* to make it palatable. There does not appear to be any charred seeds of these species which suggests if they are being processed in order to be edible, the technique does not involve cooking or fire.

Empetrum nigrum appears 8th (4 sites 3 countries) despite being so prolific in the palynological study in chapter 4. The types of evidence are mostly 'Pollen in gyttja' with only 'wild berries of' being mentioned as present at Lahntal Hessen (Bos, 2003). This reinforces the aforementioned point that large volumes of pollen do not imply that there is human interaction with the species. Furthermore, the distinct lack of seeds recovered from the *Ericaceae* family could be suggestive of two notable points. The seeds of the *Ericaceae* fruits may be too small to be easily recovered during excavation. Hunter-gatherers are not harvesting upland/moorland *Ericaceae* fruits. The latter point will be discussed further in chapter 6.

It is also notable, despite being present in many of the countries within the research area for the palynological study (chapter 4), there are only *Hippophae rhamnoides* finds from Sweden recovered during excavation. Furthermore, only two actual seed finds from Huseby Klev. This could be due to the harvesting technique employed to extract the fruit. The process involves grasping the branches closely laden with the berries and protected by large thorns. The harvester then pulls down on the branch in a fashion similar to milking a cow in order to collect the fruit pulp whilst simultaneously combing the thorns safely away from the hand (Mears and Hillman 2007, also noted in Chapter 7). This technique collects the fruit pulp and thus the seeds are not collected. Alternatively, this could be due to the coastal habitat of the species becoming submerged by sea-level rise since the Mesolithic. Harvesting, processing and consumption sites may well have since been inundated and is implied in Map 2.2.

Rubus fruticosus is notably low (12th with 3 sites and 3 countries) however this is where the inability to compare the number of finds effectively, is problematic. 151 charred seeds were found at Llandevenny attributed to *Rubus fruticosus/ideaus*, the second largest single accumulation of seeds found during this study. This however may not be as significant as it sounds, on account of some reports using unquantifiable metrics to describe seed accumulations, such as "carbonised and relatively abundant" (Larsson, 2000).

The *Prunoideae* genus, more specifically, *P. padus*, *P. avium*, are relatively low by number of sites and when inspected, the finds are also low in quantity by comparison with the pollen evidence in chapter 4. This could be on account of only bearing a single seed and thus fewer of them in the archaeological record. However, its larger size might suggest it would be easier to recover. Another possibility for their low number of finds, is the difficulty in harvesting these small fruits from high in trees.

Many of the species with one or no sites are also particularly uncommon and specific regional variants. It may be that these species variants have too small a habitat to be detectable, may have not even existed at this time, or simply that their pollen and macro-fossil remains are too similar to differentiate from their more ubiquitous relatives. Examples include: C*rataegus levigata, Pyrus cordata* and *Sorbus intermedia.* The regionality of these species is discussed further in chapter 7.

These discussion points highlight a number of limitations and biases that were alluded to in the introduction of this chapter:

- A fruit seeds presence on an archaeological site does not directly imply the fruit or the plant was used, this could be a natural accumulation. Even when fruit seeds are charred, this could equally be caused by burning rubbish or by cooking or by deliberate processing for food.
- The table is created from the data provided from published work, in which many papers do not refer to the number of finds in a quantifiable amount (Troels-Smith, 1959; Larsson, 2000; Hörnberg *et al.* 2006).
- There is a large variety in the size, quantity and persistence of a seed in the soil, for these fruit species. A direct comparison is difficult as whilst a stone fruit bears a single large stone and implies the use of a single fruit, other species such as *Rubus ideaus* have a large and somewhat variable number of seeds. Equally a comparison between number of seeds and the calorific value of a fruit is very difficult. An experiment was carried out in order to ascertain the average number of seeds in a *Rubus ideaus* berry (see experiment in appendix 3). Due to the limitations of the study, modern domesticated raspberries were used, whilst this in itself may not accurately reflect *Rubus ideaus* in the Mesolithic, the number of seeds per fruit was notable (mean n = 65). Thus, the 'large' accumulation of 151 charred seeds found at Llandevenny likely represents one or two berries of modern *Rubus ideaus* (Brown, 2005).
- There is an inherent bias towards countries that practice environmental sampling during excavation and also toward countries with more permitting preservation conditions. The data also has a bias towards information that has been extracted from papers written in English and German. This is on account of the difficulties encountered by the author in retrieving information from literature published in a language with which they were less familiar.

Chapter 6: Research Objective Four

Is there any discrepancy between the fruits that were available and the fruits for which there is archaeological evidence for?

6.1. Introduction

By combining the presence absence data from the previous two chapters, as well as the list of species considered 'native' to the research area from the later chapter 7, a table has been created. This first table is presented by family groups (Table 6.1). This table clearly compares whether each species considered native is either present, identified at a genus level, identified at a family level or absent. Where pollen has been recovered on a site but no macro-fossil remains, there have been classified as 'absent'. This is in order to compare species that have evidence implying human interaction and those without, against species for which there is pollen evidence. Thus, the aim is to create a better understanding of which fruits were used and which were not and ergo, speculate on the possible reasons for the difference.

A second table (Table 6.2) has been derived from the first by ranking the species presence/absence by attributing a value to "Macro-fossils Present in Archaeology" and "Identified in Pollen Cores". On account of macro-fossil remains on a site suggesting human interaction, the finds have been ranked first by "Macro-fossils Present in Archaeology" and second by "Identified in Pollen Cores". This has been achieved by assigning the following values to each category as follows:

Macro-fossils Present in Archaeology

Yes - present/identified	3
Identified at a genus level only	2
Identified at a family level only	1
No - not present/identified	0

Identified in Pollen Cores

Yes - present/identified	0.9
Identified at a genus level only	0.6
Identified at a family level only	0.3
No - not present/identified	0

6.2. Comparing archaeological and palynological data

Species Considered Native	Macro-fossils Present in Archaeology	Identified in Pollen Cores
Ericaceae		
Vaccinium myrtillus	N	Genus level
Vaccinium vitis-idaea	Y	Genus level
Vaccinium uliginosum	N	Genus level
Arctostaphylos uva-ursi	N	Y
Arctostaphylos alpine	N	Y
Empetrum nigrum	Y	Y
Rosaceae		
Fragaria vesca	Y	Family level
Rubus idaeus	Y	Genus level
Rubus fruticosus aggregate	Y	Genus level
Rubus caesius	Y	Genus level
Rubus chamaemorus	Genus level	Y
Rubus saxatilis	Y	Genus level
Rosa spp.	Y	Y
Prunus spinosa	Y	Genus level
Prunus padus	Y	Y
Prunus avium	Y	Genus level
Prunus cerasus	Y	Genus level
Prunus fruticosa	Genus level	Genus level
Prunus cerasifera	Genus level	Genus level
Malus sylvestris	Y	Family level
Pyrus pyraster	Y	Family level
Pyrus cordata	Genus level	Family level
Crataegus monogyna	Y	Genus level
Crataegus laevigata	Genus level	Genus level
Sorbus aucuparia	Y	Y
Sorbus aria	Genus level	Genus level
Sorbus devoniensis	Genus level	Genus level
Sorbus intermedia	Genus level	Genus level
Sorbus torminalis	Genus level	Genus level
Adoxaceae		

Viburnum opulus	Y	Y
Sambucus nigra	Y	Y
Sambucus ebulus	N	Genus level
Sambucus racemosa	N	Y
<u>Grossulariacaeae</u>		
Ribes nigrum	N	Genus level
Ribes rubrum	N	Genus level
Ribes uva-crispa	N	Genus level
Ribes alpinum	N	Genus level
Ribes spicatum	N	Genus level
<u>Elaegnaceae</u>		
Hippophae rhamnoides	Y	Y
<u>Cornaceae</u>		
Cornus sanguinea	Y	Genus level
Cornus suecica	N	Genus level

Table 6.1: Comparison of species considered native, present in the archaeology and present in palynology

Species Considered Native	Macro-fossils Present in Archaeology	Identified in Pollen Cores	
Empetrum nigrum	Y	Y	
Rosa spp.	Y	Y	
Prunus padus	Y	Y	
Sorbus aucuparia	Y	Y	Category one
Viburnum opulus	Y	Y	
Sambucus nigra	Y	Y	
Hippophae rhamnoides	Y	Y	
Vaccinium vitis-idaea	Y	Genus level	
Rubus idaeus	Y	Genus level	
Rubus fruticosus aggregate	Y	Genus level	
Rubus caesius	Y	Genus level	
Rubus saxatilis	Y	Genus level	Category two
Prunus spinosa	Y	Genus level	
Prunus avium	Y	Genus level	
Prunus cerasus	Y	Genus level	
Cornus sanguinea	Y	Genus level	
Crataegus monogyna	Y	Genus level	
Fragaria vesca	Y	Family level	
Malus sylvestris	Y	Family level	Category three
Pyrus pyraster	Y	Family level	

Rubus chamaemorus	Genus level	Y	Category four
Prunus fruticosa	Genus level	Genus level	Category five
Prunus cerasifera	Genus level	Genus level	
Crataegus laevigata	Genus level	Genus level	
Sorbus aria	Genus level	Genus level	
Sorbus devoniensis	Genus level	Genus level	
Sorbus intermedia	Genus level	Genus level	
Sorbus torminalis	Genus level	Genus level	
Pyrus cordata	Genus level	Family level	Category six
Arctostaphylos uva-ursi	N	Y	Category seven
Arctostaphylos alpine	N	Y	
Sambucus racemosa	N	Y	
Vaccinium myrtillus	N	Genus level	Category eight
Vaccinium uliginosum	N	Genus level	
Sambucus ebulus	N	Genus level	
Ribes nigrum	N	Genus level	
Ribes rubrum	N	Genus level	
Ribes uva-crispa	N	Genus level	
Ribes alpinum	N	Genus level	
Ribes spicatum	N	Genus level	
Cornus suecica	N	Genus level	

Key	
Yes - present/identified	Y
Identified at a genus level only	Genus level
Identified at a family level only	Family level
No - absent/not identified	N

Table 6.2: Comparison of species considered native, present in the archaeology and present in palynology. Firstly weighed by archaeological oresence and then by palynological presence.

6.3. Discussion of findings

The second table in this chapter highlights eight distinct categories useful in compartmentalising different fruits in the Mesolithic, and better understanding their relative significance as a resource to the people of the Mesolithic.

Category one

Category one includes species present in the palynological study and has macro-fossil remains in the archaeological record. This category contains a number of species that appear to be regularly present with high volumes of pollen (within the top five) throughout the palynological study. The exception in this category is *Rosa spp*. that is normally relatively low ranking, however as previously mentioned has some of the highest pollen volumes per single occurrence of any species. This would suggest that the hunter-gatherers are harvesting opportunistically as we might imagine. Gathering fruit from the most abundant species that they would have encountered regularly. *Sambucus nigra's* presence in this group affirms this idea given its large, confirmed number of macro-fossil remains found at Goldcliffe A, B and J. It is noteworthy that both *Sorbus aucuparia* and *Viburnum opulus* occur in this category despite it being noted in previous chapters as well as in detail later in chapter 7, that these fruit are insipid and unpalatable.

Despite its seemingly omnipotent pollen data, *Empetrum nigrum's* macro-fossil evidence is a single occurrence at Lahntal Hessen, where the author simply mentions that there are "wild berries of" and thus *E. nigrums* presence in category one is somewhat dubious.

Category two

Category two combines the species of fruit that are present in macro-fossil assemblages but only identified to genus level in the palynological study. This highlights the fact that it is difficult to identify pollen to a species level and is sometimes done so erroneously (Lowe *et al*. 2014). The species macro-fossil presence in the archaeology proves their existence at that time, and also connects them to genus and family level pollen that could not be identified to species level. Similarly to *Empetrum nigrum* in category one, *Vaccinium vitis-ideae* only appears in this category on account of a single occurrence where it is "mentioned to be in field layer" at the sites Dumpokjauratj/Ipmatisjauratj, Sweden. Thus its presence in this category is also somewhat dubious.

Category three

Like category two, these species are found in the archaeology, however their pollen can only be identified to a family level. Interestingly this category contains *Malus sylvestris* that ranked second in the table comparing number of sites archaeological remains were recovered from (Table 5.2.). The prevalence of macro-fossil remains from this species, spread across such a large area, would suggests it is widespread and abundant. Therefore, the fact that it is not present in palynological data, suggest that Malus species pollen is not identifiable or at least not differentiatable from other *Rosaceae* family members. This therefore highlights the same phenomena in both *Fragaria vesca* and *Pyrus pyraster*.

Category four

Category four contains only *Rubus chamaemorus*, a species with a particularly northern and colder region distribution today (see chapter 7). Category four represents species that are found in the palynological study but only at genus level in the archaeological macro-fossil analysis. Although Mears and Hillman (2007) state that this berry was likely more common during the Mesolithic than it is today (thanks to habitat destruction), similar to today it was likely less common than other members of the *Rubus genus.* Combined with difficulties in identifying macro-fossils to a species level, it may be that this less common fruit is overlooked when identifying finds in favour of the more common *Rubus fruticosus aggr*. Or *R. ideaus* species.

Category five & six

Category five and six include fruit species identified to both genus level in the macro-fossil study and genus level in the palynological study, and genus level in the macro-fossil study with family level in the palynological. These categories include a range of very regionally specific species, such as the Midland hawthorn (*Crataegus laevigata)*, Swedish whitebeam (*Sorbus intermedia*), Plymouth pear (*Pyrus cordata*) and Devon whitebeam (*Sorbus devoniensis*). Species habitats are discussed in more detail later in chapter 7. These species are very similar to their more common genus members and may explain why they are only accredited to genus level. If their seeds and pollen are similarly familiar, an identification at species level would be unlikely. Similarly, these more unusual varieties may be overlooked on account of their specific regional habitats. It is also unknown when these regional varieties became distinct from other genus members. It may be that at this time these species did not exist in their current form and thus can only be identified at genus level.

It should be noted that *P. cordata* pollen can only be identified to family level which adds credence to the idea that *Malus*, *Fragaria* and *Pyrus* genera pollen are either not present or difficult to identify.

Category seven & eight

Category seven represents species that are not present from archaeological evidence but are present in the palynological study. The *Arcotphylos* fruits (as well as *Cornus suecica* from category eight) are circumboreal residing species, in habitats likely only pioneered in the Mesolithic following the last glacial. Coupled with their small single seeds it makes their presence in the archaeological record seem unlikely. *Vaccinium myrtillus* and *V. uliginosum* have similar peripheral upland orientations and have similarly small achenes. The small size of the plants and their few small fruits mean that this species is unlikely part of a staple fruit crop (section 7.4.1.1 and 7.4.1.3 in chapter 7). However, *Vaccinium vitis-ideae* can be found in similar habitats but is found in the archaeological record.

Sambucus racemosa and *Sambucus ebulus* are noted in modern descriptions as having a central European orientation. Their absence from the archaeological record is likely as a result of their infrequent occurrence within the research area. This is further exemplified by *S. racemosa's* single occurrence and very low pollen totals (240 pollen samples, some 0.002% of the total pollen in that period) in the palynological data for the Late Mesolithic.

Likewise, the absence of *Ribes spp*. from the archaeological record and only very brief appearance with a low total in the palynological study suggests these species were not a commonly available food source, if available at all.

Based on the 'dubious' inclusion of certain species and their macrofossil evidence within the initial tables, which was highlighted in the discussion, a revised table of availability is proposed to account for this:

Species Considered Native	Evidence for gathering (macro-fossil on archaeological site)	Available (Identified in Pollen Cores)
Rosa spp.	Y	Y
Prunus padus	Y	Y
Sorbus aucuparia	Y	Y
Viburnum opulus	Y	Y
Sambucus nigra	Y	Y
Hippophae rhamnoides	Y	Y
Rubus idaeus	Y	Genus level
Rubus fruticosus aggregate	Y	Genus level
Rubus caesius	Y	Genus level
Rubus saxatilis	Y	Genus level
Prunus spinosa	Y	Genus level
Prunus avium	Y	Genus level
Prunus cerasus	Y	Genus level
Cornus sanguinea	Y	Genus level
Crataegus monogyna	Y	Genus level
Fragaria vesca	Y	Family level
Malus sylvestris	Y	Family level
Pyrus pyraster	Y	Family level
Empetrum nigrum	Y - dubious	Y
Vaccinium vitis-idaea	Y - dubious	Genus level
Rubus chamaemorus	Genus level	Y
Prunus fruticosa	Genus level	Genus level
Prunus cerasifera	Genus level	Genus level
Crataegus laevigata	Genus level	Genus level
Sorbus aria	Genus level	Genus level
Sorbus devoniensis	Genus level	Genus level
Sorbus intermedia	Genus level	Genus level
Sorbus torminalis	Genus level	Genus level
Pyrus cordata	Genus level	Family level

Arctostaphylos uva-ursi	N	Y
Arctostaphylos alpine	N	Y
Sambucus racemosa	N	Y - dubious
Vaccinium myrtillus	N	Genus level
Vaccinium uliginosum	N	Genus level
Sambucus ebulus	N	Genus level
Ribes nigrum	N	Genus level
Ribes rubrum	N	Genus level
Ribes uva-crispa	N	Genus level
Ribes alpinum	N	Genus level
Ribes spicatum	N	Genus level
Cornus suecica	N	Genus level

Key:

Green	Present/identified
Purple	Present/identified - single or dubious occurrence
Yellow	Identified at a genus level
Red	Not present/identified

Table 6.3: Comparison of species considered native, present in the archaeology and present in palynology. Firstly weighed by archaeological presence and then by palynological presence. WIth adjustments for dubious data entries.

Other possible reasons for discrepancies.

- Macro-fossil evidence (seed remains) is processed or consumed thus either discarded away from a site or only present in a coprolite.
- Macro-fossil evidence is too delicate/too small and therefore is not persistent enough to be found. It has been suggested previously in this chapter that this could account for the lack of *Ericaceae* macro-fossils.
- Fruit exists in a biome that humans are not present in during the time of harvest. Should it not be the case that *Ericaceae* macro-fossils are too small to persist, the calendar of availability (Appendix 4) suggests that hunter-gatherers are more lowland/woodland orientated than upland and moorlands.
- Fruit not processed with heat and so never exposed to charring and therefore less likely to persist. There may therefore be a bias to fruits that require cooking as a processing technique to make them edible or palatable. This idea is reinforced by the large number of finds pertaining to *Sambucus nigra*, a fruit that should be cooked before consumption (see chapter 7).
- Fruit not consumed due to unknown cultural reasons including personal taste.

- Tree present but not fruiting. A similar point is made in the palynological study of this thesis toward plants being present but not pollinating. Climatically sensitive fruit species may be present and pollinating, but cease producing fruits (or in some cases never start) if the conditions are not optimal (Badenes & Byrne, 2012).

- Fruit not consumed or rarely consumed due to practical reasons. Basic cost benefit analyses of calorie and nutrient value versus time taken to collect and energy expended, may have been a part of gathering behaviours. Thus species where gathering is time-consuming and risky may have been less preferable. Large tree genera such as *Sorbus* and *Prunus* with small fruit that need to be picked may have therefore been less attractive, especially the fruits higher in the canopy. Unlike apples that can be collected from the ground, these fruits are often consumed by birds before they have a chance to fall from the tree. This might explain the comparatively smaller (and in some cases non-existent) macro-fossil assemblages of these species.

6.4. Reasons that some fruits may appear to be present when they were never consumed:

Whilst there are many reasons why fruit may have been present but are not found in macro-fossil assemblages, there are also a number of reasons why these species may appear present but were never consumed.

- Deposited as a by-product of plant's other uses. An example of this could be stripping the plants foliage in order to utilise the wood. The straight stems of the young shoots of Guelder Rose/ The Wayfaring Tree (*V. opulus*) were used to make the arrows found in Ötzi's quiver (Drenth, 2003). Fruit woods like Applewood make a superior burning wood and thus may lead to charred apple seeds entering the record where the whole plant is burnt. This is however quite unlikely as the wood requires seasoning first in order to burn efficiently. Therefore, would only be ready to burn once all the fruit and foliage had long since fallen from it and decayed.

- Natural accumulations. Un-carbonised macro-fossil remains may simply be the result of accumulations of over ripe treefall fruits that have decayed but never germinated. Whilst it would seem implausible that such fruit might go unused on an active Mesolithic site, large sprawling thorny species such as *Rubus fruticosus* and *Hippophae rhamnoides* can fruit in parts of the bush that are quite inaccessible. These fruit, if not consumed by other species, when over ripe, will fall from the bush and accumulate under the bush. Year on year this would create a significant accumulation under the plant, so much so that it may appear like a hoard if in close proximity to a site. The experiment in appendix

3 suggests that this is not the case, that the large number of seeds for aggregate fruit such as *Rubus spp.* represents actually a very small number of whole fruit.

- Slash and burn, for site clearance and hunting. There are references to Hunter-gatherer communities have used fire to clear sites for hunting and habitation in both historical and ethnographic literature (Hall, 1984; Brown, 1997; Hörnberg *et al*. 2006). The purpose of this is to create space, either for occupation or for improving the quality of hunting grounds. When hunting, burnt areas provide a clear shot as well as light and nutrient rich conditions that encourage the growth of young shoots, which is a preferred food source of many cervid's.

  The burning of sites, coupled with the previous point of treefall macro-fossils, could create conditions that would suggest fruits had been used and charred during the site occupation where actually no such activity had occurred. The Palaeolithic site of Beeches Pit is suggested as one of the earliest uses of fire in Europe (Gowlett *et al*. 2005), in human evolutionary history. However, it is argued that root bowls that burnt during natural forest fires may appear in the archaeological record as a fire-pit depression (Preece *et al*. 2006). This highlights the possibility that slash and burn could produce charred fruit seeds, burnt in the woodlands humus layer around the base of a plant, as well as a burnt root bowl that could appear like a hearth. The experiment in appendix 3 highlights that over the life of a fruit bush of *Rubus spp.* a natural accumulation would look like hundreds of thousands or millions of seeds. This suggests that charred accumulations are more likely the result of the few that may fall into a hearth. However, it is unknown how many seeds from a natural accumulation in a humus layer around the plant would likely survive a forest fire or clearance fire and persist as charred fruit-stones. Therefore, this remains a contentious point.

- Warfare. Similar to slash and burn, laying waste to areas of a rival tribes fruit gathering grounds by starting a bushfire could be used as an effective method of warfare. In heterarchical cultures, where the most resource-rich tribes are considered the most powerful (Hayden, 2001; Harris, 2012; H. Daly, 2014), sacking your competitors' resources through the strategic use of fire, could be an effective way to remain a dominant tribe.

- Ritual burning/sacrifice/other cultural traditions. Whilst it is impossible to infer from the archaeological evidence, ritual burning/sacrifice is reported in ethnography and from historical sources (Van Baal, 1976; Bowie, 1995; Saraswat & Pokharia, 1998; Robinson, 2002). The burning of fruit which could create charred macro-fossils may be as a result of such ritual behaviours.

6.5. Seasonality and movement

Table 6.2 highlights that where species are definitely available, they appear on archaeological sites, with the exception of *Rubus chamaeomorus*, *Arctostaphylos uva-ursi* and *Arctostaphylos alpine*. Thus, suggesting an opportunistic gathering strategy but comprehensive across most environments. Whilst the absence of these species from archaeological excavations could be the result of misidentification or perhaps not persisting in the soil, it highlights the possibility that the hunter-gatherer communities present in the research area were not active during the fruiting season in the biome where *R. chamaemorus, A. uva-ursi* and *A. alpine* exist. *Empetrum nigrum* and *Sambucus racemosa* have been omitted from this comparison on account of contention in their datasets, however *E. nigrum* would likely be present in a similar biome to *R. chamaemorus, A. uva-ursi and A. alpine.*

In order to cross examine this idea, a table combining: the information from table 6.3, data on the seasonal availability of fruits, and their general habitats has been created (Appendix 4). The aim of this table is to try and better understand where hunter-gatherer communities may be inhabiting at different times of the year. Furthermore, the tables seek to highlight reasons as to why some species are found in the archaeological record where others are not. Where a fruiting season could not be cited, these species have been left blank. The reader should also be aware that fruiting seasons vary slightly year on year depending on the climate and modern day fruiting seasons may not actually correlate with those during the Mesolithic period.

6.6 Calendar of availability

The calendar of availability can be referred to in Appendix 4.

6.6.1 Fruit seasonality as an indicator of site seasonality and hunter-gatherer movements

It is notable that the species for which there is macro-fossil evidence from the archaeology, are of woodland/lowland or coastal habitats. This is with the exception of *Vaccinium vitis-idea* and *Empetrum nigrum* for which the evidence for their presence is somewhat dubious, and *Sorbus aucuparia* whose biome as a pioneer species ranges from the lowlands to upland and moorland conditions. This pattern suggests that from mid-June to early December hunter-gatherer communities were occupying the woodland and lowland biomes, perhaps moving to the coast over winter in search of the highly nutritious *Hippophae rhamnoides*, as woodland and lowland fruits become scarcer. The distinct lack of upland/moorland finds is suggestive that during these species fruiting season, hunter-gatherers are not present in this environment.

Ribes uva-crispa fruiting as early as mid-may would be a welcome source of nutrition before other species begin to fruit. We might expect to find an abundance of macro-fossils in the archaeological record, being of such significance as an early-fruiting food source. This fact, coupled with their distinct absence, is further suggestive that these fruits were simply not present at this time. This is further exemplified by the large number of sites containing macro-fossils of *Malus sylvestris* and *Rubus ideas*, two of the earliest fruiting lowland species.

This new and unique approach highlights a valuable technique for establishing the seasonality of a particular site. In the past dental eruption in hunted species has been used to establish the time of year a site was occupied (Rowley-Conwy, 1993 & 1995; Carter, 1997 & 1998). This could now be combined with fruit macro-fossil and fruiting season data to reinforce this approach or establish seasonality on sites where insufficient faunal remains are recovered. The technique does however experience the same limitations as faunal remain and dental eruption analysis, which is that there is no guarantee that the macro-fossils entered the archaeological record at the time of year that they were gathered, especially if the fruit are being preserved.

Chapter 7: Research Objective Five

How are the fruits, considered native to the research area processed, preserved and used in the present, in recorded history and ethnography? What evidence would we expect to find in the Mesolithic?

7.1. Introduction

In this chapter, the author first addresses the issue of the semantics of the terms in the question, notably: Native, processing and preservation. For use in this research, the meaning of these terms have been outlined and clarified. Following this, analysis and descriptions of the different techniques of preservation (section 7.2) and processing (section 7.3) has been undertaken. The discussion of these processes are to be read as a guideline on how these could have been undertaken in the past and what could be visible as result in the archaeological record and are by no means a complete list. Under every preservation and processing event, its technique, possible utensils and possible waste products are outlined and although backed up with various scholarly insights, the author reserves the freedom to infer his own assumptions onto this largely understudied subject matter. Thereafter, a complete catalogue of the modern, historical and ethnographic uses of all the species considered 'native' to the research area has been compiled (section 7.4). These three sections also seek to highlight the possible archaeological evidence that these processes and techniques could create in order to answer the sub-question: "What evidence would we expect to find in the Mesolithic?", which shall be answered in the overall discussion section of this chapter (7.5).

7.1.1 The definition of the term native and its impact on this research

Firstly, we need to examine what exactly is meant by the term ‘native’. When an author describes a species as ‘native’, one might contest that this would be decided through combining the palynological and archaeological evidence, this appears not to be the case. Pyšek *et al.* (2004: 135) and Richardson (2011) defines a ‘native species’ as having “*evolved in a given area or that arrived there by natural means (through range expansion), without intentional or accidental intervention of humans from an area where they are native*”. It seems in order to determine if a species is native, one must combine our knowledge of biomes and species specific niches, with plant history and an in-depth knowledge of regional climatic/environmental change, in order to spatially and temporally map environments that are able to host a specific species. Whether such a process has been undertaken, prior to the publication of literature describing a species as native, is impossible to infer as nothing is mentioned within said literature. The species in the next sub-chapter are those considered native to the research area, included is reference to the authors. It should be noted that many authors are reluctant to use this term when describing species and when it is used, questions should be raised as to whether the necessary research has been done to back this up or if it used in a more colloquial manner.

7.1.2. Table of fruit species considered 'native' to Northwest Europe

Fruit species considered 'native' to Northwest Europe		
Fruit Species	**Common Name**	**Reference**
Ericaceae		
Vaccinium myrtillus	Bilberry	Clapham et al. 1962, Beckett & Beckett 1979, Mears and Hillman 2007
Vaccinium vitis-idaea	Lingonberry	Clapham et al. 1962, Chiej 1984, Launert 1989, Mabey 2007:102, Mears and Hillman 2007
Vaccinium uliginosum	Alpine Bilberry or Bog Whortleberry	Clapham *et al.* 1962, Grieve 1984, Mears and Hillman 2007
Arctostaphylos uva-ursi	Bearberry	Launert 1989:128, Mears and Hillman 2007
Arctostaphylos alpine	Alpine Bearberry	Clapham et al. 1962, Huxley 1992, Mears and Hillman 2007
Empetrum nigrum	Crowberry	Clapham et al. 1962, Huxley 1992, Mabey 2007, Mears and Hillman 2007
Rosaceae		
Fragaria vesca	Wild Strawberry	Chiej 1984, Launert 1989:70, Mabey 2007:116, Wright 2010:92, Wright 2010:92
Rubus idaeus	Wild Raspberry	Chiej 1984, Bean 1989, Launtert 1989:66, Philips & Foy 1990, Mabey 2007:109-Mears and Hillman 2007, Wright 2010:87
Rubus fruticosus aggregate	Blackberry	Launert 1989:66, Mears and Hillman 2007, Wright 2010:66
Rubus caesius	Dewberry	Chittendon 1956, Clapham et al. 1962, Mears & Hillman 2007
Rubus chamaemorus	Cloudberry	Mabey 2007:114, Mears & Hillman 2007:195
Rubus saxatilis	Stone Bramble	Clapham et al. 1962
Rosa spp.	The dog roses	Launert 1989, Mears and Hillman 2007
Prunus spinosa	Blackthorn or Sloe berry	Clapham *et al.* 1962, Launert 1989, Mears and Hillman 2007
Prunus padus	Bird Cherry	Beckett & Beckett 1979, Launert 1989, Mears and Hillman 2007
Prunus avium	Wild Cherry	Clapham *et al.* 1962, Mabey 2007, Mears and Hillman 2007
Prunus cerasus	Sour Cherry	Clapham, Tootin & Warburg 1962, Regnell 2012
Prunus fruticosa	European Dwarf Cherry	Tutin *et al.* 1964
Prunus cerasifera	Cherry Plum	Hedrick 1972, Mabey 2007, Mears & Hillman 2007
Malus sylvestris	Crab apple	Clapham, *et al.* 1962, Launert 1989, Huxley 1992, Mears & Hillman 2007

Pyrus pyraster	Wild Pear	Tutin *et al.* 1964, Mears & Hillman 2007
Pyrus cordata	Plymouth Pear	Clapham *et al.* 1962, Mears & Hillman 2007
Crataegus monogyna	Hawthorn	Clapham et al. 1962, Launert 1989, Mears and Hillman 2007
Crataegus laevigata	Midland Hawthorn	Clapham *et al.* 1962, Beckett & Beckett 1979
Sorbus aucuparia	Rowan berry or Mountain Ash	Clapham *et al.* 1962, Mears & Hillman 2007
Sorbus aria	Whitebeam	Clapham *et al.* 1962, Triska 1975, Launert 1989
Sorbus devoniensis	Devon Whitebeam	Mabey 2007
Sorbus intermedia	Swedish Whitebeam	Clapham *et al.* 1962
Sorbus torminalis	Wild Service Berry or Chequer	Clapham *et al.* 1962, Beckett & Beckett 1979, Mears & Hillman 2007
<u>Adoxaceae</u>		
Viburnum opulus	Guelder Rose	Clapham *et al.* 1962, Triska 1975, Mears & Hillman 2007
Sambucus nigra	Elder	Clapham et al. 1962, Launert 1989, Mears and Hillman 2007
Sambucus ebulus	Dwarf Elderberry	Triska 1975, Chiej 1984
Sambucus racemosa var. racemosa	European Red Elder	http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?313638
<u>Grossulariacaeae</u>		
Ribes nigrum	Wild Blackcurrant	Clapham et al. 1962, Launert 1989, Mears and Hillman 2007
Ribes rubrum	Wild Redcurrant	Clapham *et al.* 1962, Chiej 1984, Launert 1989, Mears & Hillman 2007
Ribes uva-crispa	Wild Gooseberry	Clapham *et al.* 1962, Mears & Hillman 2007
Ribes alpinum	Alpine Currant	Clapham *et al.* 1962
Ribes spicatum	Nordic Currant	Clapham *et al.* 1962
<u>Elaegnaceae</u>		
Hippophae rhamnoides	Sea Buckthorn	Clapham *et al.* 1962, Launert 1989, Phillips & Foy 1990, Mears and Hillman 2007
<u>Cornaceae</u>		
Cornus sanguinea	Common Dogwood	Triska 1975, Beckett & Beckett 1979, Chiej 1984
Cornus suecica	Dwarf Cornel	Clapham *et al.* 1962, Mabey 2007

Table 7.1: Table of fruit species considered “native“ to the Mesolithic.

7.1.3. Semantics of Preservation vs processing

For the purpose of this research the terms *preservation* and *processing* are used to describe two specific and different activities although they are not mutually exclusive. The term *preservation* is used to describe the treatment of an edible foodstuff with the intention of increasing its longevity. The term *processing* is used to describe the treatment of an edible or non-edible foodstuff in order to improve its edibility or nutritional value, or to extract a specific resource.

7.2. Preservation – stores a consumable

7.2.1. Fruit leather & jellying

Technique: High-pectin fruits such as Hawthorn berries (*Crataegus monogyna*) are pulped by hand in a large vessel (and a little water added). Once pulped, the solids (such as fruit-stones) are removed. The pulp is allowed to set and dry. Drying can be assisted by the use of heat from a fire, though it is important not to cook or burn the pulp (Mears and Hillman 2007).

Possible utensils: Large vessel (leather, wood or Ertebølle style ceramic), use of fire in reducing or drying.

Possible waste products/archaeological evidence: Uncharred seeds/fruit-stones, charred seeds/fruit-stones, residue in containers.

7.2.2. Fermentation

Technique: The biological procedure of alcoholic or ethanol fermentation advances when a particular yeast species call *Saccharomyces cerevisiae* gains its energy from the transformation of different sugars into carbon dioxide and ethanol (Rasmussen, 2014).

According to Guerra-Doce (2015) there is great potential of alcoholic fermentation before the Neolithic domestication of plants and animals. An example for this is the fermented evidence on potsherds dating to ca. 7000-6600 BC from Jiahu (Henan, China) with residual traces of hawthorn fruit (*Crataegus sp.*), a yet to be identified species of wild grape and honey (Mc Govern *et al.*, 2004).

Possible utensils: Large vessel (leather, wood or Ertebølle style ceramic), fire, bone, antler or wood pulping & stirring tool.

Possible waste products/archaeological evidence: Uncharred seeds/fruit-stones, charred seeds/fruit-stones, residue in containers.

7.2.3. Pickling

Technique: Baumann (1911) writes in his chapter on the "Process of pickling" that it involves subjecting the to-be-pickled goods in a mixture of common salt, soda benzoate and pure hydrochloric acid. Thus, the need for very acidic or alkaline conditions is essential for this preserving technique. Soaking a food stuff in brine is also considered a form of pickling. Lingonberries for example, bear a high content of benzoic acid, thus a potential prime actor in this process (Hegnauer, 1966; Puupponen-Pimiä *et al*. 2004; Mears and Hillman, 2007. This technique described as ‘watering – *vattlingon*’ (discussed below) is likely a form of self-pickling.

Furthermore, what can be retrieved from the earlier mentioned ethnographic evidence from the Eskimos is that alongside coltsfoot and rhubarb leaves, Sourdock carries the most acidic properties within the Arctic and “mixed with oil or dried salmon eggs, was frequently buried for over a year, and wonderfully fresh when retrieved” (Spray, 2000: 266).

The process of pickling is also connected to alcohol production. Vinegars are perhaps the most notorious acids used in pickling but are only created through the process of fermentation.

Possible utensils: Large vessel (wood or Ertebølle style ceramic).

Possible waste products/archaeological evidence: Residue in containers, Uncharred seeds/fruit-stones.

7.2.4. Drying & smoking

Technique: During the Mesolithic period, one of the simplest methods for preservation (which will have had to have been understood relatively early on in human development) was the process of sun-drying. In fact, naturally drying fruit will dehydrate the water contents of the fruit and leave no grounds for bacterial action. Furthermore, due to the fact that it does not require heating the fruits to a very high temperature, its nutritional contents and sources of vitamin will stay intact. Thus, by simply creating a drying spot for the fruits, preferably kept away from insects, it makes an easy way to start preserving fruit for the Mesolithic household (Toğrul *et al.* 2004, Flick *et al.* 2012).

Exposing fruits to the smoke of a wood fire can preserve them by drying them out, so that bacteria cannot spread further. Two different methods of smoking can preserve food – either hot or cold smoking. The former is conducted over a short period in a kiln/smokehouse and kills the microbes but also adds alcohols and formaldehydes from the smoke for a preserving effect. The cold smoking method is usually conducted with a combination of fermenting, curing or salting to which the fruits are subjected to before the smoking commences (Flick *et al.* 2012).

Possible utensils: Drying system (either a rack or an A-frame smoker), flat stone, fire, chimney trench (for cold smoking), grindstone or pestle and mortar if using the ‘sloe-patty’ technique.

Possible waste products/archaeological evidence: Uncharred seeds/fruit stones and charred seeds/fruit-stones, post-holes from drying frame.

7.2.5. Watering – e.g. Vattlingon (see also pickling)

Technique: Simply by adding washed lingonberries (high in pectin and preservatives) into bottles of fresh water (*Vattlingon* = watered lingon), they keep at room temperature for several months at a time. Hank Shaw (Honest-food.net, 2011) confirms: "The effect is to mellow the extreme tartness and tannins in fresh cranberries, leaving them pleasantly acidic and slightly sweet". The benzoic acid in the lingonberries acts its own preservative allowing it to be stored without any other additives. This preservation is on account of the presence of benzoic acid combined with a low pH and therefore should be considered a form of natural pickling (Hegnauer, 1966; Puupponen-Pimiä *et al*. 2004; Mears and Hillman, 2007). Vattlingon is discussed later in section 7.4.1.2. of this chapter.

Possible utensils: Large vessel (leather, wood or Ertebølle style ceramic).

Possible waste products/archaeological evidence: None.

7.2.6. Cooking, Boiling or Parboiling

Technique: The front figure for this technique is doubtlessly Nicholas Appert, who in his "Art of Preserving Animal and Vegetable Substances" from 1803 used thermal sterilization of perishable goods in order to extend their longevity (Appert, 1812; Henry, 1997). Moreover, Mears and Hillman (2007) aim to dispel the widely believed myth that heating is detrimental to the vitamin content of a fruit-based food stuff. In actual fact, parboiling is quoted as being effective at preserving the vitamin content if done soon after collection. The vitamins are lost when the fruit is damaged and exposed to air. It is important to note however, Mears and Hillman's use of the term "parboiling". Excessive heat will also decrease the vitamin content.

Possible utensils: Large vessel (leather, wood or Ertebølle style ceramic), fire, stones.

Possible waste products/archaeological evidence: Uncharred seeds/fruit-stones, charred seeds/fruit-stones, cracked and charred stone.

7.2.7. Refrigeration/Freezing

Technique: This preservation tactic is achieved by storing foodstuff in a subterranean pit lined with ice or snow during the winter months. This creates a freezer space and leaves no room for microbial action to strive on the food (Henry, 1997).

Possible utensils: Pits or root cellars – may require digging implements (wood, bone or antler), ice or compact snow.

Possible waste products/archaeological evidence: Uncharred seeds/fruit-stones where refrigeration/freezing unsuccessful, water.

7.2.8. Dry Curing/Salting

Technique: This technique involves coating the food in dry edible salts such as Sodium Chloride or salts derived from sea water, in order to create a hypertonic environment that most fungi or bacteria cannot survive. This is on account of the salts dehydrating cells contacting them via osmosis and thus preventing bacterial action on the food stuff.

Possible utensils: Salt, possibly large vessel of wood or Ertebølle ceramic required to extract salt, drying rack.

Possible waste products/archaeological evidence: Post holes from drying rack, excess salt.

7.2.9. Brining

Technique: See pickling. Brining is the technique of pickling with the use of salt water (brine) where the salt content makes the water less hospitable to bacteria.

Possible utensils: Salt, water, possibly large vessel of wood or Ertebølle ceramic required to extract salt.

Possible waste products/archaeological evidence: None.

7.2.10. Sugaring

Technique: This technique is commonly used in recent history for effective preservation of fruits. The creation of jams, marmalades and preserves are all examples of the process of sugaring. Where the foodstuffs are unable to be sugared accompanying sun-drying, they can be cooked in the presence of a large concentration of sugar (Nummer, 2002). "Sugar tends to draw water from the microbes (plasmolysis). This process leaves the microbial cells dehydrated, thus killing them. In this way, the food will remain safe from microbial spoilage." (Msagati, 2012). Whilst the use of cane sugar during the Mesolithic of Northwest Europe is distinctly unlikely, storing fruit in honey is reported in literature from Ancient Greece (Wilson, 1991).

Possible utensils: Large vessel (leather, wood or Ertebølle style ceramic), honey.

Possible waste products/archaeological evidence: None.

7.2.11. Lye

Technique: The use of sodium hydroxide or potassium hydroxide on a food stuff inhibits bacterial growth by creating an environment that is too alkaline for bacteria to grow. The use of lye can be differentiated from pickling and salting on account of the action of lye on the fats present within a foodstuff. Lye causes the fats to saponify, changing the texture, appearance and flavour of the foodstuff. A modern and historic example of this process is the 'Lutefisk', now a delicacy in Norway, this was once a staple food processing technique in Scotland (Dickson & Dickson, 2000).

Whilst lye can be produced from fire ashes, research into the use of seaweed ashes in the historic period of Scotland on croft farms to create large volumes of concentrated lye has been discussed in: Preservation of seal and seabirds in 17th Century Hebrides (Scott, 1948: 125) and Preservation of dairy products (Fenton, 2007: 245).

The use of lye is likely to have been known on account of its use in dehairing hides in the production of 'buckskin' or brain tanned leather (Püntener & Moss, 2010).

Possible utensils: A cleared hearth (possibly containing charred seaweed), large vessel (leather, wood or Ertebølle style ceramic).

Possible waste products/archaeological evidence: Hearth, used lye.

7.2.12. Jugging/meat jellying & oil preservation including plant oils and seal oil/rendered fats

Technique: Jugging is typically used for the preservation meat containing foods however is combined with jellying and fat preservation under this research. The process involves cooking the foodstuffs within a casserole, with a meat stock or gravy, which will set on account of the presence of gelatine in the meat used. There are ethnographic reports of preserving plant foods in gelatine, rendered fats and even seal oil up until the mid-20th Century. Kuhnlein and Turner (1991) write that the Inupiaq Eskimo used seal oil and a seal poke (a seal skin with the holes stitched to make a sealed bag) to preserve *Rubus chamaemorus* throughout the winter.

Possible utensils: Fire, stones, large vessel (leather, wood or Ertebølle style ceramic), a 'poke'.

Possible waste products/archaeological evidence: Cracked or charred stones, residue in vessel, animal carcass, possible cracked seeds from oil extraction.

Fig. 7.1. Eskimo Seal Poke (McCutcheon, 2000) (Source: http://polarfield.com/blog/scientists-study-arctic-seal-poke-storage-system/)

Some foodstuffs can be stored effectively in oils too. The submersion in oil prevents oxidation and aerobic bacterial action.

7.3. Processing techniques for fruit – makes it consumable/more easily consumable or extracts a specific resource

7.3.1. Juicing, Pressing & Homogenising (Including Seed extraction, Pulverization, Oil extraction when seeds are 'juiced')

Technique: Fruits (and/or their seeds) are crushed in a pestle or on a grind stone, to extract juice (or oil in the case of some seeds) or create a soft semi-liquid pulp. Once the fruit is homogenised seeds can be sifted or further ground in order to be included (depending on their toxicity & palatability), following this the pulp can be further processed by cooking or drying to make fruit leathers or patties.

Possible utensils: Grind stone, pestle and mortar Large vessel (leather, wood or Ertebølle style ceramic, though ceramic likely too fragile for juicing action could be used in collection), textile or plant fibre sieve.

Possible waste products/archaeological evidence: If juicing the fruit, pulp and seeds would be waste products, if extracting oil then cracked/pressed seed remains would be present.

7.3.2. Bletting

Technique: "*The ripening of fruit, especially of fruit stored until the desired degree of decay and softness is attained*" (Glew *et al.* 2003). Fruits are allowed to decay until unpalatable compounds have broken down and the texture softened, improving the edibility and flavour of certain fruits (Hedrick, 1922).

Possible utensils: Large vessel (leather, wood or Ertebølle style ceramic).

Possible waste products/archaeological evidence: Possibility of Uncharred seeds/fruit-stones and residue.

7.3.3. Peeling & Slicing

Technique: Using a sharp tool to remove the skin of a fruit using a flint blade, bone knife or shell 'grater' (See Mears and Hillman, 2007), particularly useful as a preparation technique for a foodstuff where the skin is undesirable or inedible. Slicing a fruit exposes it to oxidation and is useful for reducing the size and increasing the surface area of a fruit that will be cooked, leached or smoked, accelerating the process.

Possible utensils/archaeological evidence: Flint blade, bone knife, shell.

Waste products: Fruit peel.

7.3.4. Leaching

Technique: This technique involves submerging a foodstuff in a porous/permeable container such as a woven bag. The foodstuff is submerged for a few hours to a few days in order to remove certain toxins that are present. Examples of this include leaching Calcium oxalate from the 'cheeky yam' in woven grass dilly bags, known from aboriginal culture, or washing high quantities of tannin from acorns (Mears & Hillman 2007).

Possible utensils: 'Dilly' bag (woven grass or plant fibre bag) or basket.

Possible waste products/archaeological evidence: Except for leached chemicals in water, none.

7.3.5. Fermentation

Technique: Fermentation is metabolic process performed by yeast, bacteria and cells (in the case of lacto-fermentation. The process converts sugar into either alcohol, acids or gases and thus can create an environment that is hostile to bacteria and fungi. Homogenised fruit or fruit juices can be made into alcohol if there is adequate sugar present by means of the natural yeast present on many fruit's skins (Battcock, 1998).

Possible utensils: Large vessel (leather, wood or Ertebølle style ceramic), stones (depending on boiling technique), wooden, antler or bone stirrer.

Possible waste products/archaeological evidence: Possibly cracked or charred stones, residue in vessel, uncharred seeds/fruit-stones, charred seeds/fruit-stones.

7.3.6. Drying/Curing

Technique: Whole, sliced or peeled fruit hung on a rack, cord drying line or A-frame smoker and dried naturally in the sun and air.

Possible utensils: Drying system (either a wooden rack, cord drying line or a wooden A-frame smoker), flat stone, fire, chimney trench (for cold smoking), grindstone or pestle and mortar if using the 'sloe-patty' technique.

Possible waste products/archaeological evidence: Possibly uncharred seeds/fruit-stones and charred seeds/fruit-stones.

7.3.7. Cooking

Technique:

- In a vessel or on skewers directly by the heat of the fire.
- By the use of stones heated in the fire and transferred into the vessel.
- Wrapped in clay or leaves and cooked in embers
- Added to other foodstuffs cooked in a pit oven

Possible utensils/archaeological evidence: Large vessel (either wood, flat stone, leather or Ertebølle style ceramic), stones (depending on boiling technique), wooden or bone stirrer, skewers (wood, bone or antler), fire tongs (a tool used to transfer hot rocks from the fire – wood, bone or antler).

Possible waste products/archaeological evidence: Uncharred seeds/fruit-stones, charred seeds/fruit-stones, fruit peel, pit/hole, poorly fired clay or carbonised leaves.

7.4. Plant, fruit and lore descriptions, ethnographic and modern historical uses:[4]

7.4.1 The heather family *Ericaceae*

7.4.1.1. Bilberry (Blaeberry) *Vaccinium myrtillus*

The Bilberry as it is commonly known, can be found in woodland, moorland and heathland across Northwest Europe (Clapham *et al.* 1962, Beckett & Beckett 1979). The deciduous shrub, that commonly grows 20-50cm in size (Mabey, 1989), can tolerate very acidic soils and can grow up to 1250m altitude (Clapham *et al.* 1962, Beckett & Beckett 1979). They can currently be found across the UK and Ireland from Southeast England to the North of Scotland, throughout the Baltic countries (Mears and Hillman, 2007) across central Europe and into Macedonia (Stefkov *et al*. 2014).

Fig. 7.4.1 Bilberry (Blaeberry) *Vaccinium myrtillus*

The fruit are true berries that grow to roughly 10mm in diameter (Launert 1989:130, Huxley 1992) from July to September (Mabey, 1989) and are extremely high in vitamins and antioxidants (Mears and Hillman 2007). The berries can be consumed cooked or raw (Facciola 1990). They are sweet in taste and very palatable (Hedrick, 1972; Simmons, 1972; Triska, 1975; Chiej, 1984; Launert, 1989; Mabey, 1989) and their small seeds make them ideal for making preserves (Grieve 1971). However, unlike its close relative *Vaccinium vitis-idaea, V. myrtillus* lacks the Benzoic and oxalic acid that, whilst making the berries less consumable in large quantities, allows them to keep for much longer (Mears and Hillman, 2007). *V.myrtillus* will begin to ferment and become vinegary if left for any length of time (ibid). Despite this, the berries if dried will keep and can be consumed like raisins (Loewenfeld & Back, 1980).

It is also useful to note that whilst Wright (2010:125) states it a plus that like the blueberry, the bilberry lacks hard pips. However, the lack of hard pips has an impact on where we would expect evidence for the consumption of bilberries archaeologically. If the berries and seeds are consumed whole, they would likely only be recovered in coprolite, in the stomachs of mummified human remains or waste dumps where spoilt fruits might be discarded. This is useful to note for all species with soft, edible pips.

[4] All images relating to the food descriptions have been retrieved from *www.pfaf.org* on the 17th of April, 2016 and although each species image is not directly refered to in the text, every joinging image to a chapter should be regarded as such.

7.4.1.2. Cowberry (Lingonberry) *Vaccinium vitis-idaea*

The evergreen shrub of the lingonberry can be found across Eurasia from as far north as northern Scandinavia and Iceland, and like Bilberries, as far south as Macedonia; from Iceland in the west to Japan in the East (Clapham *et al*. 1962, Chiej 1984). V. vitis-idaea tolerates very acidic soils such as podsol and peat at pH 3-3.5 and is often found growing in areas considered marginal today: Grassy mountainsides, pine and spruce woodlands, moorlands and bogs (Launert, 1989; Mabey, 1989). It can often be found growing amidst its close relative the bilberry (Mears and Hillman 2007) growing to roughly 40 cm high and 1 metre across (Mabey, 1989).

Fig. 7.4.2 Cowberry (Lingonberry) *Vaccinium vitis-idaea*

The lingonberry, a "true berry" roughly 6mm across (Huxley, 1992), can be consumed cooked or raw (Yanovsky, 1936) and are pleasantly palatable (Chiej, 1984) – notably more so after the first frosts (Johnson 1862). The berry grows to approximately 9mm diameter (Launert, 1989) and will sometime yield two crops per year (Holtom & Hylton, 1979). In many cases have been gathered in greater quantities than any other fruit. Added in its raw, dried or cooked form to other foods/meals, used to make fruit leathers or jams (Mears and Hillman 2007). The fruit can be harvested from August through until sometimes as late as March (ibid) making them a great source of winter vitamins.

With high levels of benzoic acid present in the berries (Hegnauer, 1966), they will keep fresh stored in water for over a year (Puupponen-Pimiä *et al*. 2004; Mears and Hillman, 2007). It is suggested that this natural preservative effect may be used to keep more perishable foods fresher for longer (Mears and Hillman, 2007).

The benzoic and oxalic acid (Mears and Hillman 2007) as well as the chemical arbutin (Launert 1989) present in the berries is a mild toxin and so cannot be consumed in their raw form in large quantities. However, arbutin is the active compound in both Lingonberries and Cranberries that is effective at treating urinary tract infections (Ulltveit, 1998). The juice from the berries can also be used to make a purple dye (Coffey, 1993).

7.4.1.3. Alpine bilberry (Bog Whortleberry) *Vaccinium uliginosum*

Fig. 7.4.2.1 Alpine bilberry (Bog Whortleberry) *Vaccinium uliginosum*

The alpine bilberry is a deciduous shrub growing to around 80 cm tall, on bogs and moorlands across the northern hemisphere including Northern Europe, Asia and America (Clapham *et al.* 1962, Grieve, 1984). The alpine bilberry is very similar to *V. myrtillus* in its appearance and properties. A 6mm diameter berry, dark blue in colour (Huxley, 1992). The fruit can be eaten raw, cooked (Chittendon, 1956; Triska, 1975; Moerman, 1998) or dried like raisins (Elias & Dykeman 2009). It is sweet, juicy and is a fairly good source of vitamin C (Bean, 1981; Moerman, 1998). The plant itself is an acid soil loving, deciduous shrub that can grow to around 40cm high (Launert, 1989). As its name suggests, it grows readily in wet conditions and in the United Kingdom is found in Scotland and Cumbria (Clapham *et al* 1962; Grieve, 1984; Mears and Hillman 2007).

Mears and Hillman (2007) suggest the berries be consumed shortly after harvesting as they do not keep very well. However, they also state that the Alaskan Native American community (the Dena'ina) use a large amount of these berries stored in oil or lard and kept cool. Bean (1981) suggests that these fruits should not be eaten in large quantities as they can cause headaches; Frohne and Pfänder (1984) suggest this is due to the presence of a fungal infection in some of the berries.

7.4.1.4. Common Bearberry *Arctostaphylos uva-ursi* & Alpine Bearberry *Arctostaphylos alpine*

These two species share a similar name, a closeness in family and a resemblance in fruit but are two quite different plants.

Similar to many of the other *Ericaceae*, the evergreen bearberry grows only to about 10cm tall but forms a shrubby carpet layer up to a meter across (Launert, 1989; Mears and Hillman 2007). Whilst the fruit, a drupe, are considered edible either cooked or raw (Simmons, 1972; Chiej, 1984; Moerman, 1998; Elias & Dykeman, 2009) it is extensively reported as being insipid and dry in its raw state (Turner, 1979; Grieve; 1984; Launert, 1989; Facciola, 1990; Mears and Hillman 2007), improving and sweetening when cooked (Craighead *et al*. 1991). The 6-8.5mm drupes (Launert 1989; Huxley 1992) can also be dried (Moerman, 1998) or added to other foods to increase their carbohydrate content (Turner, 1979) however its high tannin content makes them dangerous to consume in large quantities (Karalliedde, 2012).

Fig. 7.4.3 + Fig. 7.4.4 Common Bearberry *Arctostaphylos uva-ursi* & Alpine Bearberry *Arctostaphylos alpine*

The deciduous alpine bearberry is a shrub about 10cm by 10cm with fruit approximately 8mm across (Huxley, 1992). Their habitat overlaps with the lingonberry in mountainous moorland with low pH soils (Clapham *et al*. 1962) and is often mistaken *V.vitis-idaea* as they have a very similar appearance (Mears and Hillman 2007). Like the bearberry, the fruit of the alpine bearberry is edible cooked (Chittendon, 1956; Tanaka, 1976; Elias & Dykeman, 2009) and raw, though is also considered insipid and bitter (Turner, 1979, Moerman 1998) and the taste improves with cooking (Moerman, 1998). However, the fruits are much juicier than the bearberry (Turner, 1979; Moerman, 1998). However, Moerman (1998) suggests that the yields from harvesting the alpine bearberry are low which may reduce their significance as a resource.

7.4.1.5. Crowberry *Empetrum nigrum*

Fig. 7.4.5 Crowberry *Empetrum nigrum*

The evergreen Crowberry typically grows to 30cm x 50cm, with fruit up to 8mm (Huxley 1992, Mabey 2007) and is found growing on mountain moorlands and on some blanket bog (Clapham *et al*. 1962) with a strong north and north-western distribution in northwest Europe (Mears and Hillman 2007). The fruit is edible cooked or raw but has a slight acidity/insipidity (Turner and Szczawinski 1979; Mears & Hillman, 2007) and a watery taste (Facciola, 1990). Bean (1989) considers them undesirable but Schofield (2003) says the flavour improves significantly after frost. Mabey (2007) makes reference to them being difficult to collect in any number, like the alpine bearberry, perhaps making them less significant as a resource.

Despite these negative reviews of the fruit Mears and Hillman (2007) state that the berries are used extensively in North America and Scandinavia. They also suggest the berries keep without preparation in a cool, dark place.

The fact that, like some of the other *Ericaceae,* the fruit remain on the plant from midsummer, throughout the winter, into early spring (Schofield, 2003; Mears & Hillman, 2007), makes them a useful source of nutrition during a time of possible scarcity. Despite this, Facciola (1990) uses an ethnographic example of the Inuit freezing or drying the berries to allow for winter availability. This suggests that security of the food resource is more important than having it fresh from the plant. Naturally, the longer a fruit stays on the plant, the higher risk of losing yield to other fruit consumers.

7.4.2 The rose family *Rosaceae*

7.4.2.1. Wild strawberry *Fragaria vesca*

"Doubtless God could have made a better berry, but doubtless God never did" – Dr William Butler, quoted in *The Compleat Angler* (Walton, 1653).

Fig. 7.4.6 Wild strawberry *Fragaria vesca*

Fragaria vesca is Latin for little fragrant one and it is this fragrance or taste that Dr Butler was likely referring to when he praised *F.vesca* so heavily. The fruit is a small drooping red berry (Mabey, 2007), approximately 1cm in diameter (Wright, 2010), with protruding seeds that is the first fruit of the year to ripen in early June and lasting in some years into October (Mears and Hillman, 2007; Mabey, 2007; Wright, 2010). They are heavily praised as being very delicious cooked or raw (Facciola, 1990; Mabey, 2007; Wright, 2010). Mabey (2007:116) notes they are best consumed straight away from specimens growing on limestone. He continues to praise the aromatic berry saying: "what it lacks in size it more than makes up for in flavour". It is worth noting at this point that flavour is perhaps an easily overlooked yet important factor in the Mesolithic diet – it is often noted at the lengths to which some hunter-gatherers such as the Hadza in Tanzania will go to collect honey (Marlowe *et al*. 2014). However, honey is considered the most energy dense of naturally occurring foodstuffs (ibid) and so in this case flavour and calorific value or nutritional value are likely not mutually exclusive.

F. vesca is described as a 'genuine native', perennial plant, that grows up to 30cm tall (Launert 1989:70; Wright, 2010:92) in dry, grassy habitats and heaths, woodland clearings, scrub and on calcareous soils (Chiej, 1984; Launert, 1989; Mabey, 2007; Wright, 2010). They are widespread across the United Kingdom except for in the far north of Scotland (Mabey, 2007; Wright, 2010).

The raspberry group:

7.4.2.2. Wild Raspberry *Rubus idaeus*

The biennial wild raspberry is found growing throughout the U.K. and across Europe into temperate Asia but not as prevalent as the bramble (Launert, 1989; Mabey, 2007; Mears and Hillman, 2007; Wright, 2010). The fruit is easily spotted on the plants distinctive, long woody canes, 1.5 to 2 metres long (ibid). The plant thrives in rocky woodlands, woodland edges, heaths (Chiej, 1984; Launert, 1989; Bean, 1989; Philips & Foy, 1990; Mabey, 2007; Mears and Hillman, 2007; Wright, 2010) and Wright (2010:87) describes them as "a native of the British Isles".

Fig. 7.4.7 Wild Raspberry *Rubus idaeus*

The compound fruit is one of the first to ripen (Mabey, 2007), sometimes as early as late June until September (Launert, 1989; Mabey, 2007; Wright, 2010). The fruit, a red to yellow, pubescent, compound fruit formed by multiple single-seeded 'drupelets', is highly praised by many sources stating they are delicious, rich and substantial (ibid). However, it is also noted that the fruit are less abundant than others such as the blackberry (*Rubus fruticosus aggr.)* (Mears and Hillman, 2007). They are also notably harder to gather as, if they are under ripe they will not easily come away from the plant, once ripe they are so soft they will fall from the plant with the lightest touch (Wright, 2010).

Despite their difficulty in collection, the berries are a significant resource. Not only are they high in sugars and vitamins including vitamin C (Launert, 1989), they also contain lambertianin D and tetrameric ellagitannin (Tanaka *et al*. 1993; Puupponen-Pimiä *et al*. 2004), essential nutrients that are not, for example, found in the Nordic diet in any common food except wild raspberries, making them the most significant source (Häkkinen, 2000; Puupponen-Pimiä *et al*. 2004).

The fruit can be consumed cooked or raw (Usher, 1974; Chiej, 1984; Hedrick, 1972; Facciola, 1990; Mabey, 2007; Wright, 2010) although Wright (2010) notes that they do not keep well and should be used as soon as possible. Mears and Hillman (2007) proclaim it is doubtless that Mesolithic hunter-gatherers across Europe feasted on the berries. This is backed up by the use of Native American ethnography, where feasting and preserving the berries for winter appears standard practice for many of the communities that lived throughout North America. The Woods Cree dried the berries with fish or fish oil; the Okanagan-Colville and Micmac crushed them to make juice; Fisherman-Lake Slave “boiled them and placed them in birch-bark baskets in the sun to dry, then stored the dried loaves in a cache, to be broken into pieces and boiled before being eaten” (Kuhnlein and Turner, 1991; Mears and Hillman, 2007). Zutter & Monckton (1996) assessed the diet of the Huron Native Americans, despite maize cultivation being their principle staple, raspberries and other soft fruits fulfilled almost 25% of their annual calorific intake as well as being a good source of vitamins, minerals and antioxidants (Mears and Hillman, 2007).

Mears and Hillman (2007) continue, the climate may have been too damp to create loaves but may have been used to make fruit leathers. A process that involves pureeing the fruit and removing the seeds. The removal and potential discarding of seeds that takes place when juicing, making fruit leather and other similar activities, is an important depositional process to consider for large, uncharred seed ‘hoards’. The harder pips of raspberry when compared with the *Ericaceous* fruits, are more persistent in archaeological record, commonly found throughout the Mesolithic but not usually connected with human consumption (Mears and Hillman, 2007). It could be suggested that hoards may be just natural build-up of unconsumed rotten fruit around the plant. However, medieval cesspits and some earlier faecal deposits show raspberry seeds to be a common constituent in the diet (Mears and Hillman, 2007).

7.4.2.3. Blackberry (Bramble) *Rubus fruticosus aggregate* (inc *Rubus ulmifolius*)

The *Handbook of the Rubi of Great Britain* by Watson states the blackberry aggregate is made up of over 286 slightly differing micro species (Mears and Hillman, 2007:192), with some reporting over 400 (Mabey, 2007). Regardless, the blackberry is known, harvested and loved by many modern foragers and Mears & Hillman (2007) state that they are the most prevalent of foraged foods found in the archaeological record of the U.K. with a similar distribution across sites as the wild raspberry (However, there is no citation given for this data). Mears & Hillman (2007) continue, stating the earliest absolute evidence for the consumption of

Fig. 7.4.8 Blackberry (Bramble) *Rubus fruticosus aggregate*

blackberries are the seeds that were found in the stomach of a body found in the Essex Clay dating to the Neolithic. It appears very likely that if an agrarian is consuming them, earlier hunter-gatherers would also indulge in the fruits.

It seems commonly regarded that the Blackberry is the most dependable and bountiful quarry of the fruits (Launert, 1989; Mabey, 2007; Wright, 2010; Mears and Hillman, 2007). Wright (2010) writes that it is not unusual for one person to collect over 65kg in a season – August till October. The straggly and sprawling, thorn ridden, deciduous shrub is like natures barbed wire (Launert, 1989; Mabey, 2007; Wright, 2010), growing across 3m+ and over a metre high (Wright, 2010). The shrub is quite impenetrable despite the relative abundance and ease of harvest of the berry compared to other species. The plant is very adaptable and can be found in woodland, meadows, hedgerows and heaths (Clapham *et al*. 1962, Launert, 1989; Phillips & Foy, 1990; Mabey, 2007; Wright, 2010), on all soil types except in fenlands and other very wet conditions (Wright 2010).

The fleshy fruit, commonly found across Northern Europe, is made up of several single-seeded, red at first then turning black (Launert, 1989; Wright, 2010). The fruit are edible both raw and cooked (Loewenfeld and Back, 1980; Chiej, 1984; Launert, 1989; Facciola, 1990; Mabey, 2007; Wright, 2010; Mears & Hillman, 2007). It is widely noted that the berries on each specimen come in 3 types: First is those at the tip of the shoots that are the first to ripen, these are the juiciest, sweetest and best tasting, best eaten straight from the plant. Second is the ones around the tips, not as juicy nor as sweet but still useful in making preserves or with other foodstuffs. Finally is the smaller berry found further back inside the bush, these are bitter and hard, ripening much later in October. These are used with other foodstuffs (Launert, 1989; Mabey, 2007; Wright, 2010; Mears & Hillman, 2007).

Mears and Hillman (2007) remark that typical preservation methods for fruits leave blackberries tasting fowl and insipid. Wright (2010) that the mould species on the berries are fast acting and once picked, the berries will not keep for more than a day. However, the significance of this resource is not to be underestimated. High in fibre (in some cases more than wholemeal bread gram for gram), vitamin C and sugars (Launert, 1989), the berry is a great fruit fresh but can also be preserved using more unusual methods. The berries make a great wine, especially with the quantities that they can be harvested (Wright 2010:66), it may be that the natural fungi aforementioned encourage the fermentation. Mabey (2007) suggests making a 'junket' from the juice of the ripest of blackberries. The juice is left to stand for a few hours to a day in a warm place. The soft jelly that is formed is sweet and delicious, and quite unlike fruit leather in its appearance. A dull purple-blue dye can be extracted from the berry (Grae, 1982).

These modern descriptions of the blackberry suggest that their importance as a Mesolithic foodstuff is likely significantly high. However, due to the difficulties in their storage, it appears likely a seasonal feast rather than a preserved staple unless fermented.

Not pertaining to the fruit themselves: The branches have been used historically as a strong weaving material however they must first be de-thorned.

7.4.2.4. Dewberry *Rubus caesius*

The dewberry is often mistaken for the blackberry and without knowledge of the few differentiating features, it is easy to see why. The berry looks like a blackberry that has not developed properly (Wright, 2010) with fewer drupelets, irregularly sized, often larger in size and have an unusual wax/dust-like blue-grey covering on them (Hedrick, 1972; Mears & Hillman, 2007; Wright, 2010). It is can be consumed cooked or raw, however the berries burst easily when they are ripe which makes them quite difficult to pick intact (Mears & Hillman, 2007; Mabey, 2007; Wright, 2010) and in turn will make storage whole difficult. Wright (2010) says they are very tasty and Hedrick (1972) agrees saying they are superior in taste to blackberries despite being on the whole, smaller. The berries should be treated like blackberries if they require storage. The dye that is made from the dewberry is also the same colour as its better known relative (Grae, 1982).

Fig. 7.4.9 Dewberry *Rubus caesius*

The plant itself is similar again to blackberry but a smaller, the spines softer and less vicious (Wright, 2010; Mears & Hillman, 2007). It grows to around 40cm high and sprawls across damp woodland, scrubland, dry meadows and other grassy spots, typically on basic soil across Europe and Asia to Scandinavia in the north and Spain in the south (Chittendon, 1956; Clapham *et al*. 1962).

7.4.2.5. Cloudberry *Rubus chamaemorus*

Fig. 7.4.10 Cloudberry *Rubus chamaemorus*

As a fellow member of the *Rubus* family, the Cloudberry shares in the visual similarities in shape as the Blackberry – an aggregate fruit (Mabey, 2007). However, unlike the Blackberry the Cloudberry is red when unripe turning a bright yellow/orange when ripe (ibid). The plant itself also differs from its relatives by growing on wet peat soils and typically grows to only around 15cm high (Mabey 2007). Nowadays this plant grows most commonly in Scandinavia and in subalpine and arctic regions, however it can still be found in the United Kingdom in the bogs of Wales, Northern England but principally Scotland (Mabey, 2007; Mears & Hillman, 2007).

The fruit can be consumed raw or stewed (Facciola, 1990; Moerman, 1998) and represents a significant part of the diet for rural Scandinavians throughout history due to its high levels of Vitamin C, growing in areas that typically lack food high in said vitamin (Moerman, 1998; Mears & Hillman, 2007). It is sour in taste but is noted as being quite delicious similar to cooked apples (Coffey, 1993).

It is known for producing large yields though this has been very rare in the UK during recorded history. Most likely due to the reduction in their habitat due to the draining of native wetlands and bogs to make way for agriculture and overgrazing in those biomes that remain (Mears & Hillman, 2007). Despite this, Mears & Hillman (2007) suggest that in the wooded Mesolithic of the UK that this was an abundant and successful fruiting species. They continue stating that ethnographic literature points to these berries being something of a staple in northern region due to their abundance, being first to ripen and so high in vitamin C.

In 1862 Pierpoint Johnson observed the Laplanders burying their cloudberry harvest in the snow to preserve them throughout the long arctic winter, allowing them to access the fruits in times of vitamin scarcity (Mears & Hillman, 2007). Kuhnlein & Turner (1991) also observe the Haida and the Tsimshian storing hard, unripened Cloudberries in water and grease in cedar boxes – some were scalded beforehand (Mears & Hillman, 2007).

Kuhnlein and Turner (1991) also states the berries are greatly prized among the Inupiaq Eskimo and neighbouring indigenous peoples in Alaska (mentioned previously in section 7.2.12. of this chapter). They are some of the first berries to ripen and people travel in the summer to the open tundra in order to harvest them. They note that in the past families have gathered over 110 litres of the fruits. These were consumed raw with the addition of seal oil or covered in the seal oil and preserved in a seal poke (a seal skin with the holes stitched to make a sealed bag). On some occasions the berries were held temporarily to be mixed with crowberries (*Empetrum nigrum*) which ripen later and then are stored together for winter. On occasion the fruits have been pickled in sourdock (*Rumex arcticus*) mixture (ibid.). The Canadian Inuit also preserve cloudberries in seal oil (Porsild, 1954; Kuhnlein and Turner, 1991).

7.4.2.6. Stone Bramble *Rubus saxatilis*

Stone bramble is a deciduous shrub that grow on basic rocky ground, preferably in wooded shady location across Britain and Europe. It typically grows to around 30cm tall and is not sprawling like *Rubus ideaus* or *fruticosus* (Clapham *et al*. 1962).

Fig. 7.4.11 Stone Bramble *Rubus saxatilis*

Similar to the other members of this family, the stone bramble can be eaten cooked or raw (Brouk, 1975; Tanaka, 1976). It is noted that the flavour is particularly acidic (Facciola, 1990) although not unpleasant (Hedrick, 1972). Stone bramble is much less common than *Rubus ideaus* or *fruticosus* and whilst this may have changed since the Mesolithic, it is likely not a staple resource.

The dog roses: There are 14 native varieties that are all very similar with similar properties, including: 7.4.2.6.1 Dog rose (Rosehips) Rosa canina, 7.4.2.6.2 Field Rose Rosa arvensis, 7.4.2.6.3 Burnet Rose Rosa pimpinellifolia & others. Combined under a single group for the purposes of this research.

The dog roses are found across Eurasia, from Britain and Norway in the Northwest, Northern Africa in the south and SW Asia to the East. They are commonly found on waste and scrubland, hedgerows and on bank sides (Launert, 1989; Mears and Hillman, 2007). The roughly 30mm fruit can be consumed cooked (as a tea or stewed mush) or raw, however the seeds bear very fine hairs that are an irritant for the mouth and digestive system, the seeds or hairs must be removed before consumption (Kavasch, 2005; Mears & Hillman, 2007). The flavour improves in sweetens following a frost (or bletting) (Loewenfeld & Back, 1980).

The fruit have been used historical for making syrups for a vitamin supplement (namely vitamin C) for use over winter when vitamins are more scarce (Bown, 1995; Mears & Hillman, 2007). Mears and Hillman (2007) impress upon the importance of this fruit as a nutrient resource. The berries themselves contain 2000mg per 100g of flesh (max) and thus has the greatest concentration of vitamin C of any fruit throughout Great Britain.

Fig. 7.4.12 Dog rose (Rosehips) *Rosa canina*

Fig. 7.4.13 Field Rose *Rosa arvensis saxatilis chamaemorus*

Fig. 7.4.14 Burnet Rose *Rosa pimpinellifolia*

They continue to illustrate this point by citing the Ministry of Health's mass harvesting of the fruit via volunteers during World War 2 when imported fruits were limited. The fruit also contains vitamin P, K, E, B group and pro-vitamin A and provide up to 12% sugar per volume of fresh. Despite the irritant hairs, the seeds themselves are a useful vitamin E source. The hairs must be removed and the seeds ground to meal which can then be added to foods as a supplement (Kavasch, 2005).

Not pertaining to the fruit: The leaves can be dried and used for an infusion that is a substitute for tea or coffee (Uphof, 1968; Usher, 1974; Chiej, 1984; Facciola, 1990). The petals can also be used raw or cooked (Kunkel, 1984) and in China are considered a vegetable (Freethy, 1985). The de-thorned stems are effective as hand drills for starting fire and can also be woven.

The stone-fruits:

7.4.2.7. Blackthorn (Sloe) *Prunus spinosa*

Blackthorn is found throughout Eurasia from Britain, Scandinavia and Siberia to Iran and across the Mediterranean. The deciduous shrub grows up to 3 metres tall and is commonly found in hedgerows and woodlands in well-lit places on most soils (Clapham *et al.* 1962; Launert, 1989). The roughly 1.5cm diameter fruit with a single large seed (Huxley 1992) can be consumed both cooked and raw (Hedrick, 1972; Harrison *et al.* 1975; Triska, 1975; Loewenfeld & Back, 1980; Chiej, 1984; Bean, 1989; Mabey, 2007). Most modern pickers of this fruit find it far too astringent to consume fresh from the plant and usually requires a frost to make the berries palatable (Facciola, 1990). The modern application for these fruits is primarily in the production of preserves or the flavouring of spirits and are pickled in France. The seeds of blackthorn may also be consumed cooked or raw however they are known to contain hydrogen cyanide and so notably bitter seeds should be rejected (Facciola, 1990; Mears & Hillman, 2007). The fruits can also be dried and steeped to make a fruit tea (ibid).

Fig. 7.4.15 Blackthorn (Sloe) *Prunus spinosa*

Mears & Hillman (2007) note that harvesting by picking is somewhat dangerous as the thorns are sharp and often go septic. It is their suggestion to beat the bushes to harvest. Mears & Hillman

(2007) also suggest making a mash from the berries after a frost to make them optimally consumable and storable. Due to the abundance of the fruit, ease of processing and storage, they refer to this as a “seasonal staple”.

Not pertaining to the fruit: Edible flowers that can be added to salads (Facciola, 1990; Mears & Hillman, 2007) and leaves can be stewed for a tea. The wood is a dense hardwood that burns well and slowly and can be used in hardwood carving projects including bows.

7.4.2.8. Bird cherry *Prunus padus*

Bird cherry is a deciduous tree that grows near water and on moist ground in open woodland (Launert, 1989). Growing to around 15 metres tall on both low lying alkaline and upland acidic areas (Beckett & Beckett 1979), across Europe from Scandinavia and Britain to the Mediterranean and east to Central Asia. The edibility of the roughly 5mm diameter fruit (Huxley, 1992) is somewhat contentious. Langs (1987) states they are foul tasting and poisonous however Uphof (1959), Hedrick (1972), Triska (1975) Mabey (2007) and Mears and Hillman (2007) say they are edible, both raw and cooked.

Fig. 7.4.16 Bird cherry *Prunus padus*

The fruits, although astringent, are pleasant when ripe. The bitter taste means in recent history the berries have been processed for preserves or jams (Bean, 1989; Facciola, 1990). Despite the presence of Hydrogen Cyanide, the kernel is considered edible a good source of protein, oils and starch (Facciola, 1990; Mears & Hillman, 2007). If consumed raw the notably bitter or almond flavoured kernels should be rejected. Anderson (2002) found the tribes-people of the Amur valley in Russia (Ulchi, Nanai, Udegai and Orok) using this berry very much as a staple. The berry and kernel are ground until homogenous and then rolled flat into patties. These patties are cured and then roasted until the smell of HCN (almond aroma) is not present (Mears & Hillman, 2007).

Not pertaining to fruit: The flowers (like many in the rosaceae family) are sweet and can be chewed for a pleasant flavour (Kunkel, 1984; Facciola, 1990). The young leaves can be eaten when cooked or boiled as a vegetable (Kunkel, 1984), this is notably popular in Korea (Facciola, 1990). Facciola (1990) also states the bark can be used for an infusion. The wood of Bird Cherry is desired by woodworkers and cabinet makers for its hardness, colour, durability and ease of work (Johnson, 1862; Uphof, 1959; Bean 1989).

7.4.2.9. Wild Cherry *Prunus avium*

Wild Cherry is a deciduous tree found in woodlands and hedgerows across Europe from Britain and Scandinavia to Northern Africa and East to Western Asia, growing to around 18 metres tall on good soils (Clapham *et al.* 1962; Mabey, 2007). The 2cm fruit contains a single seed and both seed and fruit can be used in the same way as *Prunus padus* (above) (Hedrick, 1972; Triska, 1975; Loewenfeld & Back, 1980). The fruit is relatively sweet (Bean, 1989) and in recent history has been used in pastries and preserves. Like *P. padus* the seeds contain HCN and when consumed fresh notably bitter ones should be rejected.

Fig. 7.4.17 Wild Cherry *Prunus avium*

Not pertaining to fruit: A gum can be harvested from wounds in the bark which can be used as an adhesive or chewed and eaten (Johnson, 1862; Facciola, 1990). The wood is like that of *P. padus* and is desirable for woodworking (Johnson, 1862; Uphof, 1959; Polunin, 1969).

7.4.2.10. Sour Cherry *Prunus Cerasus*

Fig. 7.4.18 Sour Cherry *Prunus Cerasus*

Dwarf Cherry is a deciduous tree only growing to around 6 metres. This tree was going to be omitted on account of Clapham and Tutin (1962) stating that they are native to South Eastern Europe and Western Asia and only naturalised in Northern Europe and Britain. However, Regnell (2012) refers to the finds from Tågerup as *Prunus avium/cerasus* and thus was included.

The 1.8cm diameter fruit has a single seed (Huxley, 1992) and both fruit and seed can be used the same as *P. padus* and *P. avium* (Chittendon, 1956; Hedrick, 1972; Loewenfeld & Back, 1980; Bean 1989; Facciola, 1990; Mabey, 2007). Like both *P. padus* and *P. avium*, it also contains HCN and therefore notably bitter seeds should be avoided. Sour Cherry seeds can be used to produce an edible oil (Uphof, 1959; Usher, 1971) that can be used for preserving/drying, for lighting, osmetics and added to foods like salads (Facciola, 1990).

Not pertaining to fruit: Like *P. avium* a gum can be harvested for an adhesive or a gum for chewing (Usher, 1971). It is also noted the leaves can be made into an infusion as a substitute for tea (Uphof, 1959; Usher, 1971; Facciola, 1990).

7.4.2.11. European Dwarf Cherry *Prunus fruticosa*

Fig. 7.4.19 European Dwarf Cherry *Prunus fruticosa*

The European dwarf cherry is a deciduous shrub growing to around 1 metre tall. It is most commonly found on grassland and steppe environments but also on forest steppe and on forest margins across Europe to central Asia (Tutin *et al.* 1964).

The fruit 1.5cm fruit and single seed can be treated in the same way as *P. padus*, *P. avium* and *P. cerasus* (Facciola, 1990; Huxley, 1992). It has a similar flavour to the aforementioned though notably tart (Tanaka, 1976; Bean, 1989).

7.4.2.12. Cherry Plum *Prunus cerasifera*

The cherry plum is a deciduous tree growing to around 9 metres, preferring a woodland edge environment. It has spine tipped branches from which the fruits hand on single stalks approximately 1.5cm long. The 2-3cm berries are edible raw or cooked in preserves or pastries (Hedrick, 1972; Harrison *et al.* 1975; Loewenfeld & Back, 1980; Facciola, 1990; Mabey, 2007) and are sweet, pleasant and juicy with a slight acidity (Facciola, 1990; Mears & Hillman, 2007). They look like a small plum with a thinner skin (Facciola, 1990).

Fig. 7.4.20 Cherry Plum *Prunus cerasifera*

Each fruit contains a seed that can also be consumed cooked and raw (Huxley, 1992). The fruit can be processed effectively for storage and mass consumption in the same way as the other *Prunus* varieties.

The apple's (pomes fruit):

7.4.2.13. Crab Apple *Malus sylvestris*

The Crab Apple tree is a widespread, well known deciduous tree that grows up to 10 metres usually in semi-shade and woodland edge environments on calcareous and neutral soils (Clapham, *et al.* 1962; Launert, 1989; Huxley, 1992; Mears & Hillman, 2007). It is found all across Europe from the U.K. and Scandanavia in the north, to the Mediterranean in the south and western Asia in the East.

Fig. 7.4.21 Crab Apple *Malus sylvestris*

The 2-4 cm fruit can be consumed cooked or raw however some trees fruits sweeten and some do not so it pays to have good knowledge of your local environs (Loewenfeld & Back, 1980; Launert, 1989; Huxley, 1992; Mears & Hillman, 2007). The flavour also improves following the first frosts (Loewenfeld & Back, 1980; Mears & Hillman, 2007). The fruit can be cooked/baked alone or in pastries and other foodstuffs, juice can be squeezed or stewed to create preserves (Facciola, 1990; Mears & Hillman, 2007). They can keep through winter however extra care must be taken to ensure the fruit do not bruise during collection or storage (Mears & Hillman, 2007). Mears and Hillman (2007) note that although the fruit are low in most vitamins, they have a good content of other useful nutrients, namely potassium, Iron, phosphorus, magnesium, manganese, calcium, sulphur, pectin and malic and citric acids. The pectin content makes the fruit useful in helping other fruit preserves to set (Usher, 1974; Brouk, 1975).

Not pertaining to the fruit: Chiej (1984) notes that the leaves can be used to make a pleasant tea. The wood is fantastic for burning being dense, fine grained and the smoke smelling very pleasant. It can also be good for carving/turning.

7.4.2.14. Wild Pear *Pyrus pyraster*

The Wild Pear is a spiny shrub that grows to around 15 metres and is common in open woodland and woodland edge throughout Europe (Tutin *et al.* 1964; Mears & Hillman, 2007). The 3 to 4 cm diameter fruit (notably smaller than its domestic relatives) is edible cooked or raw and quite abundant on the tree (Kunkel, 1984; Mears & Hillman, 2007). Mears & Hillman (2007) note the fruit are hard and have little taste and state they do not know how to make them palatable. They also state once they have fallen from the tree they blett and the flavour improves and the fruit softens.

Fig. 7.4.22 Wild Pear *Pyrus pyraster*

7.4.2.14. Plymouth Pear *Pyrus cordata*

The Plymouth Pear is a thorny deciduous shrub growing to around 4 metres. It is only found in western France and around Plymouth in Devon (Clapham *et al.* 1962; Mears & Hillman, 2007). The fruits are notably small, around 10 – 18mm (Huxley, 1992; Mears & Hillman, 2007), and are edible both cooked and raw (Tanaka, 1976; Mears & Hillman, 2007).

Fig. 7.4.23 Plymouth Pear *Pyrus cordata*

7.4.2.15. Hawthorn *Crataegus monogyna*

The Hawthorn is a deciduous shrub found across Europe, the Mediterranean and east to Afghanistan. It grows to around 6 metres tall in woods and hedgerows on many soil types except acidic sand (Clapham *et al.* 1962; Launert, 1989). The roughly 10 mm diameter fruits can be consumed cooked and raw (Hedrick, 1972; Loewenfeld & Back, 1980; Huxley, 1992) however when fresh it is notably bland and grainy (Launert, 1989). It has been used in recent history to make jam and preserve (Launert, 1989; Facciola, 1990). The fruit can be pulped with a little water to create a thick fruit paste, this is then sieved to remove the seeds and other particulates. This sets naturally due to their high pectin content and can be dried to create a chewy "fruit leather" that can be kept for almost a year (Mears & Hillman, 2007). The fruit is well noted for its beneficial effects on the cardiovascular as it contains proanthocyanidins (Lewis, 2003).

Fig. 7.4.24 Hawthorn *Crataegus monogyna*

Not pertaining to the fruit: Kunkel (1984), Facciola (1990) and Mabey (2007) note the young shoots can be consumed raw in salads. Uphof (1959), Lust (1983), Kunkel (1984) and Facciola (1990) state the leaves can be used to make a pleasant infusion like tea and the seeds can be roasted for a coffee substitute (Uphof, 1959; Kunkel, 1984; Loewenfeld & Back, 1980). Facciola (1990) states the flowers are good in syrups and other sweets however picking the inflorescence will likely effect the berry yield. The wood is very dense and hard, difficult to carve but turns well and used in making tool handles (Uphof, 1959; Usher, 1971; Chiej, 1984). Being hard and dense it makes a valuable fuel wood (Grieve, 1984).

7.4.2.16. Midland Hawthorn *Crataegus laevigata*

The Midland Hawthorn is a deciduous shrub that can grow to around 6 metres tall in woodland and hedgerows on clay loams across Europe from Scandinavia to the Mediterranean and east to Poland but most notably the British Midlands (Clapham *et al.* 1962; Beckett & Beckett, 1979). Beckett & Beckett (1979) states they are an indicator of ancient woodland and when found in hedges they are typically remnants from a previously present forest.

Fig. 7.4.25 Midland Hawthorn *Crataegus laevigata*

The approximately 10mm diameter fruit, inflorescence, seeds, shoot and leaves can be used in very much the same way as *C. monogyna* (Uphof, 1959; Hedrick, 1972; Loewenfeld & Back, 1980; Kunkel, 1984; Launert, 1989; Facciola, 1990; Huxley, 1992; Mabey, 2007).

The wood works like *C. monogyna* and can be used for the same applications (Uphof, 1959; Usher, 1971; Chiej, 1984; Grieve, 1984). Grieve (1984) states it is highly prized as fuel because it burns hotter than oak and charcoal from the Midland Hawthorn is said to be able to melt pig iron without a blast furnace.

7.4.2.18. Rowan (mountain ash) *Sorbus aucuparia*

The Rowan is a deciduous tree that can grow to around 15-20 metres tall though most are smaller (Mears & Hillman, 2007). It is found in woodland, scrubland and mountainous terrain across Europe from Iceland in the northwest, the Mediterranean in the south and western Asia. It's preference for altitude has earned it the common name "mountain ash" (Clapham *et al.* 1962; Mears & Hillman, 2007).

Fig. 7.4.26 Rowan (mountain ash) *Sorbus aucuparia*

The 7.5mm fruit's (Huxley, 1992) edibility is contentious, Triska (1975) states in quantity these fruit are an emetic and purgative. Mears & Hillman (2007) are also dismissive of the fruit stating that they had attempted over 16 different processing techniques (combinations of freezing, drying, steaming, roasting, stewing, pickling) and none had made them palatable without the addition of sugar. They concluded that despite being pomes they would not have made a frequently used or substantial part of the Mesolithic diet.

It is considered edible, both raw and cooked by (Hedrick, 1972, Chiej, 1984; Launert, 1989; Mabey, 2007) however Chiej (1984) notes that they make nice, tart jams and Nyman (1868) and Høeg (1974) recalling their use to make cider or dried for jam suggests the authors may be referring to the fruits flavour after processing with sugar. It may also be noting direct edibility over palatability. Hedrick (1972) suggest grinding the fruit into a meal and using the powder as a flour-like supplement however Mears & Hillman's (2007) recent, aforementioned experiments suggest this would be more of a famine food. To further add to this contention Oberdorfer (1990) & Kallman (1993) state they are a valuable vitamin C source used historically for treating scurvy (and kidney stones). It should be remembered however that the fruits are available throughout autumn when time harvesting may be better spent gathering other species.

Not pertaining to the fruit: The wood is a fine-grained hardwood that is useful as a tool wood. Similar to, though not as good as ash. It has been used in furniture and barrel making (Usher, 1971; Triska, 1975; Chiej, 1984).

7.4.2.19. Whitebeam *Sorbus aria*

Fig. 7.4.26.1 Whitebeam *Sorbus aria*

Whitebeam is a deciduous tree that grows 20-25 metres tall (Launert, 1989; Fitter & More, 2012) on limestone or chalk rich soils in woodland and scrubland. It's found as far north as Britain, south to Spain and east to Greece and Eastern Europe (Clapham *et al.* 1962; Triska, 1975; Launert, 1989).

The roughly 10mm fruit (Huxley, 1992) can be eaten cooked or raw but is typically bletted before being consumed raw (Johnson, 1862; Hedrick, 1972; Tanaka, 1976; Facciola, 1990; Mabey, 2007). It can be stewed for use in preserves, jams and as a compote. It can also be ground once dried and added as a supplement to other foods (Uphof, 1959; Hedrick, 1972).

Not pertaining to the fruit: The wood is a dense hardwood and fine grained. This makes it a decent burning wood, nice for carving and has historically been used for used for making beams (Johnson, 1862; Bean, 1989).

7.4.2.20. Devon Whitebeam *Sorbus devoniensis*

It is not certain whether or not Devon Whitebeam is a hybrid species with *S. torminalis* (Bean, 1989) and so might not have been present during the Mesolithic. It is typically found in ancient woodland in Southwestern United Kingdom, namely Devon, growing to around the same height as *S. aria* (Mabey, 2007). The 15mm fruit (Huxley, 1992) and wood are treated in the same way as its close relative *S. aria* (Bean, 1989; Mabey, 2007).

Fig. 7.4.27 Devon Whitebeam *Sorbus devoniensis*

7.4.2.21. Swedish Whitebeam *Sorbus intermedia*

Swedish Whitebeam may also be of possible hybrid origin and so one must question its potential availability in the Mesolithic. It can be found across Europe though is only naturalised in the British Isles (Clapham *et al.* 1962). It is very similar in size and appearance to *S. aria* and the wood and fruit can be treated in the same way (Hedrick, 1972; Huxley, 1992).

Fig. 7.4.28 Swedish Whitebeam *Sorbus intermedia*

7.4.2.22. Wild Service Tree (Chequers) *Sorbus torminalis*

The Wild Service Tree is a slim deciduous tree growing to around 11 metres tall (Launert, 1989) preferring limestone and clays across Europe from Denmark and the U.K. to North Africa and west to western Asia (Clapham *et al.* 1962; Beckett & Beckett, 1979; Mears & Hillman, 2007). The 1.5 cm fruit is edible cooked or raw, though young fruits are particularly astringent (Johnson, 1862; Hedrick, 1972; Bean, 1989; Facciola, 1990; Huxley, 1992;

Fig. 7.4.29 Wild Service Tree (Chequers) *Sorbus torminalis*

Mabey, 2007; Mears & Hillman, 2007). The fruit is rich in vitamin C and is best picked after the first frosts or once bletted as they become softer and sweater (Facciola, 1990; Mears & Hillman, 2007).

Mears and Hillman (2007) state the seeds are very soft and care must be taken due to their cyanogenic glycoside content. They suggest to consume the fruit in any quantity they must be pounded to a pulp and treated like the *Prunus* patties (cured and cooked).

Not pertaining to the fruit: The wood of the Wild Service Tree is a great carving and turning wood due to its dense nature and fine grain (Johnson, 1862).

7.4.3. Adoxaceae family (formerly the larger *Caprifoliaceae* family)

7.4.3.1 Guelder Rose *Viburnum opulus*

The Guelder Rose is another fruit of contention. Whilst it is not toxic, if consumed in a large number or when unripe, can be emetic and purgative (Cooper & Johnson, 1984; Frohne & Pfänder, 1984; Mears & Hillman 2007). It is also described by Mabey (2007) as a "cloying fruit" and Grieve (1984) notes its unpleasant smell.

Fig. 7.4.29.1 Guelder Rose *Viburnum opulus*

The deciduous shrub grows to around 2-4 metres tall (Launert, 1989) in hedgerows, scrubland, woodland in damp conditions from Britain and Scandinavia, south to Spain and East to Western Asia (Clapham *et al.* 1962; Triska, 1975). The 6-8.5mm drupe with a single seed (Launert, 1989; Huxley, 1992) is considered edible either raw, or cooked (Uphof, 1959; Hedrick, 1972; Mabey, 2007). Facciola (1990) suggests best used as a cranberry substitute when making preserves. It is likely that their intense sour and bitter flavour is what causes their purgative effect which may be improved with processing.

Not pertaining to the fruit: Mears & Hillman (2007) note *Viburnum opulus*' value as wood for arrow shafts. They are particularly effective at this role due to their straightness, hardness and particularly their stiffness, resisting the arched paradox (ibid). Grieve (1984) also comments on their use for making good skewers because of the woods aforementioned features. Mertens (2000) mentions that Viburnum had also been associated with Mesolithic finds of fish traps and leister spears.

7.4.3.2. Elder *Sambucus nigra*

Fig. 7.4.30 Elder *Sambucus nigra*

Elder is a 2-10-metre-tall deciduous shrub that grows in hedgerows, woodland, scrubland and wasteland across Europe from Britain and Scandinavia in the northwest to northern Africa and Western Asia in the south and east (Clapham *et al.* 1962; Launert, 1989).

The 6-8mm fleshy drupe (Launert, 1989) grows in clusters/trusses that Huxley (1992) and Mears & Hillman (2007) commend for their ease of harvest. Picking at the base of a cluster allows the harvester to collect many with a single pick without risk of berries rolling away. Any foliage including stems from *S. nigra* should not be ingested as they can have an emetic effect (Launert, 1989; Mears & Hillman, 2007). The fruit are considered edible cooked or raw by Uphof (1959), Usher (1971), Hedrick (1972) and Mabey (2007), but (Cooper & Johnson, 1984; Frohne & Pfänder, 1984; Mears & Hillman, 2007) state, similar to the trees foliage, the present emetic effect can sometimes occur in the raw berries, depending on the sensitivity of the consumer.

The fruits have been used in a number of foodstuffs including drinks (alcoholic and soft), fruit puddings, preserves, sauces, chutneys and stewed in pastries. Drying the fruit reduces their bitterness and emetic effect if consumed raw (Loewenfeld & Back, 1980; Facciola, 1990), a technique used by the Roma to create what they refer to as “hedge currants” (Mears & Hillman, 2007).

The fruit are a good source of anthocyanins, vitamin A, fibre, iron (13 percent of the guideline daily amount), potassium, betacarotene, vitamin B6, and 87 percent of the guideline daily amount of vitamin C (Kaack & Austed, 1998).

Not pertaining to fruit: The flowers of the shrub have also been used extensively raw and cooked in a number of preparations (Hedrick, 1972; Loewenfeld & Back, 1980; Mabey, 2007). Namely steeped to make a tea (Facciola, 1990), in flavouring stewed fruits and preserves and making sparkling wine (Facciola, 1990). Like the berries they can also be dried for later use particularly if making infusions. Using the flowers in the spring will reduce the trees fruit yield in the autumn.

The leaves have been used historically to repel insects, crushed and hung around doors or in barns with cattle (Holtom & Hylton, 1979; Mabey, 1979; Grieve, 1984). The core of the branches contains a spongy white pith that is easily removed making them very useful for making blow pipes, instruments and smoking pipes (Grieve 1984). The wood is fine grained and good valued for carving, particularly for skewers or for things that require a hollowed centre (Polunin, 1969; Triska, 1975; Grieve, 1984; Phillips & Foy, 1990).

7.4.3.3. Dwarf Elderberry *Sambucus ebulus*

Dwarf Elderberry is a perennial shrub that grows to around 1-metre-tall, found in woodland, scrubland, hedgerows and wasteland in Europe from Britain and Holland to the Mediterranean and central Asia (Triska, 1975; Chiej, 1984). As the name suggests it is the dwarf variety of *S. nigra* and is similar in use and properties. The foliage and greenery excluding the fruit and flowers are known to be a purgative and cause gastric upset (Cooper & Johnson, 1984; Launert, 1989) and raw fruits may cause a similar reaction in sensitive persons and so cooking is recommended (Cooper & Johnson, 1984; Frohne & Pfänder, 1984).

Fig. 7.4.31 Dwarf Elderberry *Sambucus ebulus*

The 6mm fruit is easily harvested as it grows in clusters on the tree (Huxley, 1992) and can be used cooked added as a flavouring for broths or soups (Kunkel, 1984). Kunkel (1984) also states the leaves may be used in an infusion though due to the plants reputation for gastric upset, likely better avoided.

7.4.3.4. European Red Elder Sambucus racemosa var. racemosa

European Red Elder is a deciduous shrub that grows to around 4 metres tall and is native to both North America and Europe. It is found across mainland Europe from Belgium, the Netherlands and Germany in the North, Italy and Spain in the south and Romania in the east; preferring moist or wet soil conditions near rivers in both wooded and open areas (GRIN Global Database, 2011).

Fig. 7.4.32 European Red Elder Sambucus racemosa var. racemosa

Like the other *Sambucus* family members the foliage and greenery excluding the fruit and flowers are known to be a purgative and cause gastric upset (Cooper & Johnson, 1984; Launert, 1989) and raw fruits may cause a similar reaction in sensitive persons and so cooking is recommended (Cooper & Johnson, 1984; Frohne & Pfänder, 1984). The 5mm fruit, growing in clusters (Huxley 1992), are said to be edible cooked or raw (Yanovsky, 1936; Tanaka, 1976; Moerman, 1998), Facciola (1990) states they are unpalatable unless dried. Despite their bitterness (Facciola, 1990) they have a high carbohydrate, fat and protein content as well as a fine vitamin C content (Launert, 1989). Similar to the flowers can also be used cooked or raw. Yanovsky (1936) Tanaka (1976), Facciola (1990) also note the root can be used to make an infusion.

7.4.4. Blackcurrant family *Grossulariaceae*

7.4.4.1. Wild/European Blackcurrant *Ribes nigrum*

Wild Blackcurrant is a deciduous shrub that grows to around 2.2 metres tall (Launert, 1989). Found in woodland and hedgerows, particularly near rivers across Europe from Scandinavia and the United Kingdom, to southern France and east to Central Asia (Clapham *et al.* 1962; Launert, 1989). The 1 – 1.2cm black fruit (Huxley, 1992; Mears & Hillman, 2007) are edible cooked and raw though in recent history is more notably used in cooking foodstuffs such as preserves, pastries and cordials (Chittendon, 1956; Hedrick, 1972; Harrison *et al.* 1975; Launert, 1989; Mabey, 2007). The fruit are very nutritious and high in antioxidants with around 4% Vitamin C content (nearly 10 times more than a lemon) (Phillips & Foy, 1990; Mears & Hillman, 2007). They also contain B group vitamins, vitamin P, potassium, iron, calcium, magnesium and a larger amount of pro-vitamin A than both oranges and lemons. This nutritional content plus the present organic acids and saccharides means they have been widely exploited for use in herbal medicine (Mears & Hillman, 2007).

Fig. 7.4.33 Wild/European Blackcurrant *Ribes nigrum*

Not pertaining to the fruit: The leaves can be made into a soup or dried for use in infusions (Kunkel, 1984; Facciola, 1990). Komarov (1968) states the leaves can be used to preserve vegetables.

7.4.4.2. Wild Redcurrant *Ribes rubrum*

Fig. 7.4.34 Wild Redcurrant *Ribes rubrum*

The Wild Redcurrant is a deciduous shrub that grows to around 1-1.2m tall, in woodland and hedgerows particularly near water or where damp, across Western Europe except Ireland (Clapham *et al.* 1962; Chiej, 1984; Launert, 1989; Mears & Hillman, 2007). The 6-10mm pleasantly acidic red berries are edible cooked or raw though more commonly cooked in recent history in much the same way as *R. nigrum* (Chittendon, 1956; Hedrick, 1972; Bean, 1989; Mabey, 2007; Mears & Hillman, 2007). The fruit have also been used in cosmetics (Chiej, 1984).

7.4.4.3. European Gooseberry *Ribes uva-crispa*

Fig. 7.4.35 European Gooseberry *Ribes uva-crispa*

The wild European Gooseberry is a deciduous shrub that grows to around 1-1.2m high, commonly found in woodland and in hedgerows, particularly near streams, across Europe from Britain (Excluding Ireland) and Scandinavia to the Mediterranean and far western Asia (Clapham *et al.* 1962; Mears & Hillman, 2007). The roughly 100x10mm fruit is notably smaller and harder than cultivars, with stiffer spines/hairs on the rind (Mears & Hillman, 2007). Whilst edible cooked or raw (Chittendon, 1956; Usher, 1971; Hedrick, 1972; Chiej, 1984; Mabey, 2007; Mears & Hillman, 2007), Mears & Hillman (2007) suggest that they are best cooked/stewed or made into preserve (ibid). As with other *Ribes* species the fruits have been used in cosmetics, particularly for degreasing (Chiej, 1984).

Not pertaining to the fruit: Grieve (1984) states the young leaves can be used as a salad green however they contain hydrogen cyanide so best used in moderation.

7.4.4.4. Alpine Currant *Ribes alpinum*

The Alpine Currant is a deciduous shrub that grows to around 1-1.2m tall, across Europe from Britain and Scandinavia to North Africa and Eastern Europe, in mountainous, rocky environs, notably on limestone (Clapham *et al.* 1962). The roughly 5mm fruit can be consumed cooked or raw though it has somewhat mixed reviews; Polunin (1969) describes the fruit as insipid, Chittendon (1956) & Bean (1989) state they are unpalatable, however (Hedrick, 1972) states that whilst not as palatable as *R. rubrum,* they are sweet and not excessively acidic.

Fig. 7.4.36 Alpine Currant *Ribes alpinum*

7.4.4.5. Nordic Currant *Ribes spicatum*

The Nordic Currant is a deciduous shrub growing to around 1.5-2m tall, typically found in woodland on limestone across Northern Europe including the British Isles and northern Asia (Clapham *et al.* 1962). The fruit can be consumed cooked or raw in much the same way as *R. rubrum* (Clapham *et al.* 1962; Tanaka, 1976; Bean, 1989).

Fig. 7.4.37 Nordic Currant *Ribes spicatum*

7.4.5. Elaeagnus family *Elaegnaceae*

7.4.5.1. Sea Buckthorn *Hippophae rhamnoides*

Fig. 7.4.38 Sea Buckthorn *Hippophae rhamnoides*

Sea Buckthorn is a sprawling deciduous shrub that grows to around 1-3 m tall, though occasionally as a tree will grow to 10m (Launert, 1989). It has a coastal distribution particularly on dunes and sea cliffs across Europe and Asia from Scandinavia and Britain to Spain and as Far East as Japan (Clapham *et al.* 1962; Launert, 1989; Phillips & Foy, 1990). Polunin (1969) and Triska (1975) are alone in suggesting the fruits are poisonous, the fruit have been much researched for their health benefits and though acidic (Bean, 1989), are certainly edible and somewhat beneficial (Frohne & Pfänder, 1984; Mears & Hillman, 2007).

The 6-8mm berries (Huxley, 1992) cover the plant, around 100 every 10cm and stay on the plant from late summer until early spring, making them a 'winter-long' quarry (Mears & Hillman, 2007). Whilst their abundance and persistence makes these fruit a significant resource, their nutrient content is undeniably one of the best of any northern European fruits. 100g of the mashed fruits harvested in autumn contains more vitamin C (120mg) and E than the guideline daily amount (GDA) and beta carotene equivalent to 200 times the GDA of vitamin A (Facciola, 1990; Mears & Hillman, 2007). It also has a high mineral content, notably iron, potassium, manganese and boron, and is high in omega 3 and other unsaturated fatty acids.

Despite being oily, very sour and with a bitter after taste, they are used to make juices, fruit leather, can be pulped and made into patties for cooking (like sloes – see *P. spinosa*) or mixed with other fruit to improve their nutritional content and the seeds can be roasted and ground or pressed to make a slow drying oil (Mears & Hillman, 2007; Launert, 1989). They are also used in cosmetics because of their high vitamin content (Launert, 1989).

Whilst medicinal aspects of the fruit covered have for the most part been omitted, the health benefits of sea buckthorn cannot be understated. Eidelnant (2003) states “it is difficult to name a sphere of medicine in which sea buckthorn products are useless” as the use of sea buckthorn syrup has been found to normalise the metabolism and immune system, treat malignant tumours, counter liver damage, counter degenerative memory diseases, effectively treat skin ailments, gastro-intestinal problems, stabilise blood-sugar levels and is an effective anti-oxidant, antiviral and antibacterial (Mears & Hillman, 2007).

Not pertaining to the fruit: The wood is very hard, durable, tough and close-grained making it exceptional for carpentry and turning as well as for fuel and charcoal production (Uphof, 1959; Usher, 1971; Mears & Hillman, 2007).

7.4.6. *Cornaceae* family

7.4.6.1. Common Dogwood *Cornus sanguinea*

Fig. 7.4.39 Common Dogwood *Cornus sanguinea*

Common Dogwood is a deciduous shrub growing to around 2.5-3m, in woodland, scrubland and hedgerows, particularly on calcareous soil, across Europe from Scandinavia and Britain to the Mediterranean and Greece (Triska, 1975; Beckett & Beckett, 1979; Chiej, 1984). Whilst some report that the fruit is poisonous, this is not the case (Frohne & Pfänder, 1984). The roughly 8mm fruit (Huxley 1992) can be consumed cooked or raw (Tanaka, 1976; Frohne & Pfänder, 1984). However, the leaves can be an irritant (Frohne & Pfänder, 1984) and the bitter taste of the fruits can have an emetic and purgative effect on sensitive individuals (Chittendon, 1956; Chiej, 1984; Bean, 1989). Interestingly, Johnson (1862) did not consider the fruit a worthwhile foodstuff.

Perhaps of greater value is the seeds. Though also present in the fruit, the seeds contain nearly 50% oil that can be extracted and processed to make it edible/usable in cooking and preservation

(Hedrick, 1972). The oil is of particular value in lighting as lamp fuel (Johnson, 1862; Polunin, 1969; Triska, 1975; Chiej, 1984; Kunkel, 1984).

Not pertaining to the fruit: The straight stems of the young plant are of value in basketry and arrow making (though arrow wood must be seasoned and basket rods must be soaked) (Polunin, 1969; Triska, 1975; Chiej, 1984). The mature wood is strong and hard, and can be used for spindles and tool handles (Johnson, 1862; Usher, 1971; Bean, 1989). It is also a good fuel wood both seasoned and as charcoal (Johnson, 1862).

7.4.6. 2. Dwarf Cornel *Cornus suecica*

Fig. 7.4.40 Dwarf Cornel *Cornus suecica*

The Dwarf Cornel is a perennial plant that grows to around 20cm, on moorland, heathland and in proximity to *Ericaceae*, in across northern/arctic Europe, Asia and America though can be found as far south as Britain and Germany (Clapham *et al.* 1962; Mabey, 2007). The fruit can be consumed cooked or raw (Uphof, 1959; Usher, 1971; Turner, 1979; Elias & Dykeman, 2009) but is typically combined with other fruits as alone it is somewhat unpalatable (Hedrick, 1972). The fruits rich pectin content (Schofield, 2003) may make the fruit useful in jellying and preserving other fruits.

7.4.7. A note on the ethnographic evidence and its significance

Overall, the ethnographic study highlights a vast array of uses for the fruits as well as highlighting those with significant vitamin and mineral contents. When we compare the top species by number of find-sites with the evidence from ethnography, we can begin to understand why these species might have been the most significant to the Mesolithic hunter-gatherer communities of Northwest Europe.

Many of the species present have multiple uses, however it is unlikely that a resourceful hunter-gatherer group would harvest resources from a fruiting crop without exploiting the fruit crop too, unless the situation did not permit for this (high pressure/emergency situation). Fruit woods such as *Crataegus spp., Prunus spp.* and *Malus sylvestris* provide excellent wood for carving and excel as fuel wood, slow-burning, with good heat and with a pleasant smoke. The burning of fuel wood with associated fruit could account for some of the charred fruit stones entering the record, however it seems more likely that fruit would be removed first before burning. Furthermore, woods would likely require seasoning first before they could be burnt effectively. This would provide more than adequate time for any attached fruits to fall from the plant and decompose along with all the plants foliage.

The ethnographic research into *Rubus ideaus* and the other species in the highlights its value as a resource and provides affirmation of its place as the most utilised species by number of sites. *Rubus ideaus* fruits are not only high in sugars and therefore of important calorific value, but also have a significant nutritional value with a high vitamin C content (Launert, 1989), as well as lambertianin D and tetrameric ellagitannin (Tanaka *et al*. 1993; Puupponen-Pimiä *et al*. 2004). The research has highlighted that these essential nutrients are not found in the Nordic diet in any common food other than wild raspberries and thus are a really vital resource (Häkkinen, 2000; Puupponen-Pimiä *et al*. 2004) significant in maintaining human health.

Similarly, the nutrient content of *Malus sylvestris* is of profound value. Whilst lacking in vitamins, *M. sylvestris* has a significant content of potassium, Iron, phosphorus, magnesium, manganese, calcium, sulphur, pectin and malic and citric acids. The pectin content makes the fruit useful in helping other fruit preserves to set (Usher, 1971; Brouk, 1975; Mears & Hillman, 2007). Their potential to be stored throughout the winter further adds to their value as a source of these nutrients during a time of scarcity (Mears & Hillman, 2007). Interestingly however, fruits with inedible (fowl tasting, unchewable or poisonous) seeds, like those of the pome fruits (inc. *Malus sylvestris*) that contain cyanide and are not useful as food (in an unpalatable core), are more likely to be discarded and therefore, survive in the archaeological record.

Cornus sanguinea is perhaps one of the most interesting species that ranks highly in the species by number of find sites. It is found on ten sites across six countries with the majority of finds in Denmark (40%) and 20% in Sweden. The finds date from the Early Mesolithic until the Ertøbolle and Mesolithic to Neolithic transition. This continuity of finds throughout the period, particularly the cracked seed finds impresses upon the potential importance of the seed oil as a resource. Johnson (1862) suggested that the fruit was not a worthwhile foodstuff. However, the seeds contain nearly 50% oil that can be extracted and processed to make it edible (Hedrick, 1972). The oil's value for lamp fuel (Johnson, 1862; Polunin, 1969; Triska, 1975; Chiej, 1984; Kunkel, 1984) cannot be overstated and the practical value of oil as a preservative and a sealant for foodstuffs, leather products and wood is also significant. To envisage Mesolithic hunter-gatherers utilising oil from cracked seeds paints a vividly different picture of the period and brings into question a whole aspect of the 'Stone Age' economy that has previously been overlooked.

Crataegus monogyna found on eight sites across four countries was noted in chapter five for the notable trend towards finds on sites dating to the later Mesolithic and Danish Ertebølle periods. It is noteworthy that the seeds can be homogenised and used within a food stuff. When homogenised, the seeds are ground down and incorporated in 'patties' that can be cooked, thus no seeds would be found. The seeds are typically removed if processing 'fruit leather', which is a preservable food stuff with a long longevity (up to a year) and has a sweet pleasant texture (Mears & Hillman, 2007). This prevalence of seed finds, dating to the later Mesolithic, could indicate an increase in the importance of having preserveable fruit and nutrient sources towards the end of the Mesolithic period, perhaps as a result of loss of gathering grounds and food security due to the Neolithic advance. It could also represent a shift toward food decadence, where taste and texture is more important than calorific value during a period of stability and abundance. Furthermore, it could be representative of the development of a preserved foodstuff based economy as is suggested of the Ertebølle period already (Rowley-Conwy, 1999). Something that was observed among sedentary hunter-gatherers in California during the 19th and 20th Century, who harvested and preserved acorns that in turn impacted their inter-tribal rank and worth (Anthropology Museum Sacramento, 2007). Having a mobile preserved nutrient source, one also containing sugars, proanthocyanidins and other antioxidants (Lewis, 2003), would undoubtedly be of value and may have become an essential to the communities of the Later Mesolithic.

Sambucus nigra represents another possible preservable fruit 'currency'. The fresh fruits can produce an emetic effect so should be dried or cooked (Loewenfeld & Back, 1980; Facciola, 1990), Drying the fruits to create "hedge currants" was a strategy employed by the Roma (Mears & Hillman, 2007) and represents a valuable staple. Not least on account of their ease of harvest. The whole cluster can be gathered by detaching the stem above it. This allows many to be collected with a single pick. These dried 'hedge currants' are a very similar resource to the fruit leather created from *Crataegus monogyna*. They are high in anthocyanins and are a good source of fibre, vitamin A (providing 17% of the Guideline Daily Amount per 100g), iron (13% of GDA), potassium, vitamin B6m betacarotene and 87% of the GDA for Vitamin C which is a significant proportion especially if it can be easily preserved. Unlike *C. monogyna*, *S. nigra* seeds are found throughout the period including the Early Mesolithic.

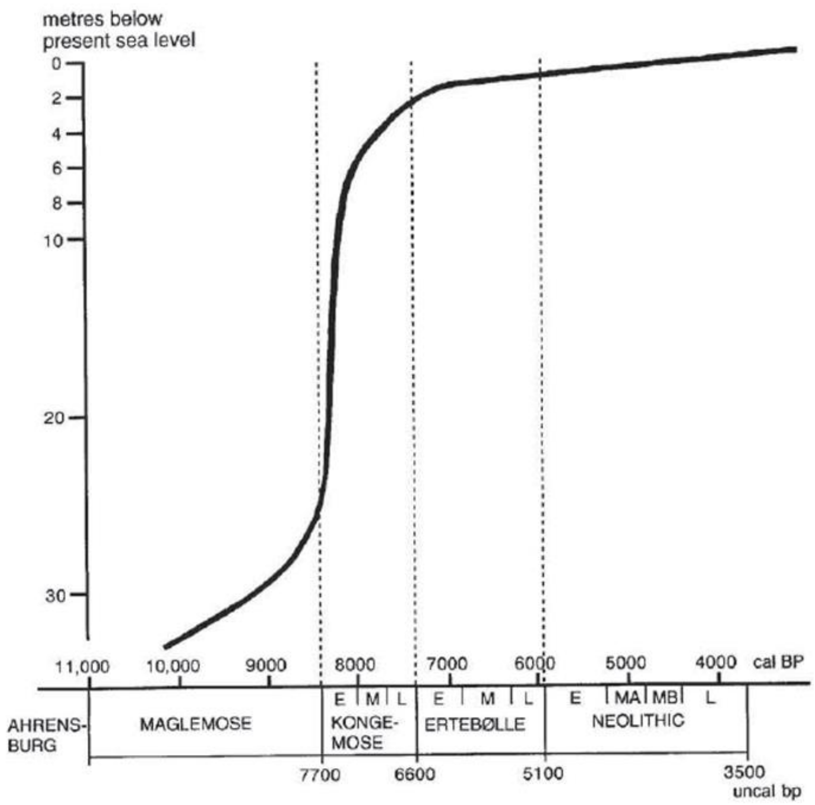
Prunus spinosa 'patties' are referred to by Mears and Hillman (2007) as a 'seasonal staple' on account of the fruits abundance, ease of preservation, processing and storage. This coupled with their presence across five sites in four countries would suggest it is a relatively important food species. As the fruits are most palatable after the first frosts this may represent one of the last harvests of the fruit gathering season, with the exception of fruits that can remain throughout the winter such as *Hippophae rhamnoides*. The finds are dated from the Early to the late Mesolithic suggesting a continuity of use throughout the period.

Both *Viburnum opulus* and *Sorbus aucuparia* despite being considered edible both cooked and raw, are noted for their unpalatability and emetic or purgative properties. Mears and Hillman (2007) experimented with over 16 techniques to make the fruits of *Sorbus aucuparia* palatable but simply were unable without the addition of sugar. This produces something of a dilemma as they are found in the archaeological record and are also a valuable nutrient source, particularly vitamin C. This may represent a case where nutrition was more important than taste, perhaps most significant during periods of famine. In the case of *Vibrunum opulus,* a case can be made for seed finds representing discard from the production of arrows. The fruit are edible cooked or raw, but have the same unpleasant purgative and emetic properties as well as a bitter insipid taste. The shoots however produce superior arrow shafts that resist the arched paradox, and are found on several archaeological sites throughout European prehistory (Mears & Hillman 2007). The wood has also been identified as having been used for fish traps and leister spears during the Mesolithic (Mertens, 2000).

Empetrum nigrum has a slight insipidity (Turner and Szczawinski 1979; Mears & Hillman, 2007), watery taste (Facciola, 1990) and are considered undesirable by some (Bean, 1989). They are also difficult to harvest in any number similar to the alpine bearberry (Mabey, 2007) and found growing on upland moorlands and blanket bogs (Clapham *et al*. 1962). This reaffirms the hypothesis made in chapter 6 discussion that *Empetrum nigrum*, fellow fruiting *Ericaceae* family members, and *Cornus suecica* that are clearly present in the palynological study yet almost absent in macro-fossil finds, are not likely to be gathered on account of their peripheral and somewhat inaccessible biome. Furthermore, their fruiting season overlaps with species with far greater nutritional significance that are present in a completely distinct and separate biome.

However, the ethnographic study suggests these berries have been extensively used throughout North America and Scandinavia, and that they preserve exceedingly well without preparation (Mears and Hillman, 2007). It is also notable that the *Ericaceae* fruits and *Cornus suecica* exist in areas with a peri-arctic orientation where their exploitation would be important if groups were inhabiting or passing through them. The very small single seeds of these species may account for their distinct lack of macro-fossil evidence in the archaeological study and therefore, there still remains some contention about this fruit and its family's role in the diet of Mesolithic hunter-gatherer's.

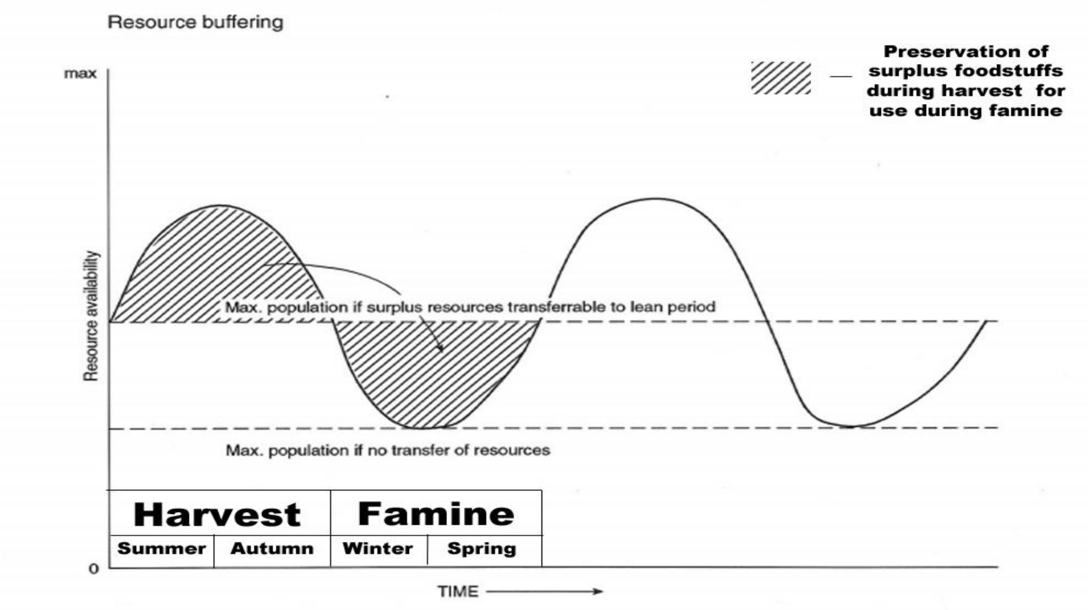
Hippophae rhamnoides would be undoubtedly important to the communities of the Mesolithic. They are extremely high in essential vitamins and minerals, they are highly effectively medicinally, they are available for harvesting throughout the winter during an otherwise famine period, and they are coastally orientated, a biome that we know to have played a crucial role in the lives of Mesolithic communities (Andersen, 1995; Fischer, 1995; Nordqvist, 2000; Erlandson, 2001). However, it is this coastal orientation that may be the reason why so few macro-fossil remains from this species have been recovered, it stands to reason if they were exploited by the coast, that the potential finds are now inundated (cf. Graph 7.4.1) and thus much less likely to be recovered.



Graph 7.4.1 Graph depicting Sea level curve and chronology of the Danish Mesolithic and Neolithic (From Rowley-Conwy, P. 1999: Christensen, 1995; Fischer 1997)

Another reason for the lack of macro-fossils may be as a result of the techniques employed to extract the fruit. Mears and Hillman (2007) suggest that grasping the small branches and pulling with the direction of thorns in an action much akin to milking a cow, removes the otherwise difficult to extract fruit pulp. Gathering the fruit individually would likely be a difficult and hazardous operation on account of the numerous sharp thorns and very soft fruits. This technique creates a fruit pulp from which the seeds are separated and discarded. Therefore, this unique harvesting technique may account for the lack of macro-fossil evidence for *Hippophae rhamnoides* during this period.

The importance of a having preservable vitamin sources cannot be overstated. Layton's (2005) graph has been adapted and shows clearly the impact of seasonal differentiation in resource availability between periods of abundance and scarcity. What the graph suggests is that the carrying capacity can be increased where foodstuffs from the peek availability periods can be preserved and exploited during periods of scarcity. This is particularly relevant in areas such as Northwest Europe that have very distinct growing season (spring-summer), harvest season (summer-autumn) and famine season (winter-spring).



Graph 7.4.2 Graph depicting resource buffering strategy during the Mesolithic (Layton, 2005).

The graph (Graph. 7.4.2) illustrates the importance of preserved food and nutrient sources such as fruit on maintaining a constant carrying capacity throughout the famine period. It is notable however that when compared with the calendar of availability in chapter six, the fruits that are available during the famine period, *Arctostaphylos uva-ursi*, *Empetrum nigrum* and *Hippophae rhamnoides*, present scarce macro-fossil evidence in the archaeological record. Whilst reasons for this possible scarcity have be discussed above, it is important to highlight that although they may be available during the famine period, they are perhaps less portable than the other more easily harvested fruit products available earlier in the year, such as *Crataegus monogyna* fruit leather.

The results of this research are suggestive that the preference is for the use of fruits that are available during the harvest period in large quantity, which are also readily preserved, as opposed to the gathering of fresh fruits that are more difficult to harvest, during the famine period. This may also be on account of hunter-gatherer seasonal movement patterns taking communities away from the uplands (Rowley-Conwy, 1998; Rowley-Conwy, 1999) and coast (Rowley-Conwy, 2015) during the winter/famine period (Zvelebil *et al*. 1998). One could also infer the presence of a hibernation-like behaviour among hunter-gatherer communities in Northwest Europe, where expending more energy in the harvest to gather more preservable fruits is more efficient than searching for fresh fruits during a period where exposure to colder temperatures and harsh weather conditions can increase the metabolic rate over 7% and thus calorie expenditure will be greater (Passmore & Durnin, 1955).

It should be remembered however that the seeds of the *Ericaceae* species and *Hippophae rhamnoides* are much smaller than those of *Crataegus monogyna* or *Malus sylvestris* and less numerous than those of *Rubus ideaus*, and therefore likely to be less visible in the archaeological record. Furthermore, *C. monogyna* and *M*. *sylvestris* are fruits that benefit from heat processing (with fire) and thus may be more likely to survive better on account of increased chance of carbonisation.

7.5. Discussion: What evidence would we expect to find in the Mesolithic?

Overall, to link this whole section back to the actual significance of fruit use and evidence for fruit during the Mesolithic of Northwest Europe, there are broad number of techniques that can be employed for either processing or preserving fruit in the Mesolithic. Preservation techniques include: fruit leather & jellying, fermentation, pickling (including brining and vattlingon), drying & smoking, cooking (including boiling and parboiling), refrigeration & freezing, dry-curing & salting, sugaring, lye, jugging & meat jellying.

It seems likely that the principal preservation techniques that could have been used would be fruit leather, drying (& dry curing) & smoking, cooking and possibly refrigeration, jugging/meat jellying and freezing (during winter). As seen by the preservation and processing techniques in use throughout ethnographic accounts, a similar set of tactics in use is regarded as highly likely during the Mesolithic. In the following paragraphs, this likelihood is being assessed.

Fermentation could be possible but requires quite specific conditions in order to produce a palatable, consumable product. These include: ample sugar in the mash (fruit pulp), a heat treated mash to sterilise undesirable bacteria, fruit peel added to the mash following sterilisation to promote natural yeast growth, and storage in a cool dry place for an ample period of time. On account of the time requirements of such a process and the refined processing required, it seems less likely that anyone other than more sedentary hunter-gatherers would undertake this process.

The process of pickling, more specifically vinegar pickling is tied to the process of fermentation as it is required in order to produce the key ingredient. It is therefore even less likely that this preservation technique was commonplace, however the use of brine (sea water), or the use of plant acids (vattlingon or sourdock) may have occurred.

Without a readily available source of sugar, besides honey, it is unlikely that the processing of sugaring was used. The case study of the Hadza suggests that when found, honey is shared amongst the community and consumed raw shortly after its retrieval. Lye preservation is a possibility, the simple use of caustic fire ashes may have been known to the hunter-gatherers of the Mesolithic of Northwest Europe, on account of the use of lye for dehairing pelts for leather processing. Whilst pelts can be dehaired by dry-scraping, the use of lye is easier and less time (Groenman-van Waateringe *et al*. 1999; Püntener & Moss, 2010).

After examination of possible preservation and processing techniques, it is clear that there are number of finds we might expect pertaining to these activities or waste products of these activities. If this evidence is persistent enough to be identifiable, it could be attributed to activities such as these. These forms of evidence have been divided into two categories comparing their relative persistence in the archaeological record (based on whether they are organic materials, inorganic or carbonised) in order to highlight what evidence we are more and less likely to find:

Inorganic or Carbonised evidence– more likely to persist: Large vessels (Ertebølle style ceramic, broken/used vessels with residue), post holes, flat stones, chimney trenches, grindstones or pestle and mortars, pits or root cellars, charred seeds/fruit-stones, hearths, cleared hearths (possibly containing charred seaweed), lye accumulations, scorched chimney trench for cold smokers, cracked and charred stones.

Organic evidence – less likely to persist: Large vessel leather or wood, drying system (either a wooden rack or a wooden A-frame smoker), (bone, antler or wood) pulping & stirring tool, digging implements (wood, bone or antler), animal carcass, a ‘poke’, ice or compact snow, salt, water, sea water, honey, uncharred seeds/fruit-stones.

Unfortunately, it is very difficult to reverse engineer conclusions based on the evidence we find because even if a technique produces only inorganic evidence that persists and is found (such as drying and smoking), the finds and features could be attributed to a number of other activities including activities not pertaining to processing and preservation of fruits. It is also notable that several of the processing and preservation techniques had no possible waste products or archaeological evidence. Thus it will be very difficult for archaeology as a discipline to establish if these techniques were ever used. In order to firmly answer the questions of which techniques were used to process and preserve fruits, exceptional preservation conditions with very particular find orientations would be required. For example: a hearth and wooden a-frame drying rack with sliced fruits hung from it would be very likely indicative of drying and smoking.

Chapter 8 - Conclusions

8.1: Concluding the research objectives

This thesis has at its heart five research objectives relating to the importance, abundance and use of different fruit species during the Mesolithic of Northwest Europe. It is the first study to have create a comprehensive (yet not exhaustive) compendium of fruit species and their abundances during that time period and links these availabilities to their possible preservation and processing techniques and point out their possible terms of use.

A research paper with a focus on fruit in the Mesolithic period had never previously been done. Prior research looking into plant-foods and plant macrofossils on Mesolithic sites and within countries in Europe, and the palynology of sites with pollen pertaining to the Mesolithic, have been undertaken. However, the previous research’s approach of including all plant remains from a few sites makes it difficult to compare the data and discuss the trend relating specific species across a larger habitat area. Here, all research questions are being revisited once again and the main findings are being concluded.

1. Why is fruit significant in understanding the lives of the hunter-gatherers in the Mesolithic of Northwest Europe and in understanding the people of the Mesolithic in their wider context?

Fruit are not the most significant foodstuffs or even the most significant plant foods in terms of calories, fats or as a percentage of the overall diet of modern hunter-gatherer communities. It is also difficult to ascertain if the dietary make-up of Mesolithic hunter-gatherers is comparable to modern hunter-gatherers. Although fruit are high in sugars, more significant are a number of antioxidants, vitamins, minerals, phenols, sterols and other nutrients that are not easily substituted through other dietary foodstuffs (Grieve, 1971; Darwin, 1996). Not only must its culinary value have been of significance, its further usages need to be mentioned. Their usage in medicine, as baits for trapping, in making paints and dyes, in creating soaps or fish poisons through saponins chemicals and in providing oils from fruit seeds (*Cornus sanguinea*) need not be underestimated (Sale, 1981; Francis *et al*. 2002).

2. Which edible species of fruit were available throughout the Mesolithic of Northwest Europe and what does palynology suggest about their relative abundance?

Percentage Ubiquity

Family/Genus/Species	Total times presence detected	% ubiquity
Empetrum nigrum	2021	39.81
Rosaceae Undifferentiated	1559	30.71
Sorbus aucuparia	264	5.20
Hippophae rhamnoides	258	5.08
Viburnum undifferentiated	166	3.27
Sorbus undifferentiated	155	3.05
Ericaceae Undifferentiated	154	3.03
Viburnum opulus	128	2.52
Vaccinium undifferentiated	85	1.67
Sambucus undifferentiated	66	1.30
Crataegus undifferentiated	63	1.24
Prunus undifferentiated	61	1.20
Rubus undifferentiated	17	0.33
Cornus undifferentiated	13	0.26
Arctostaphylos undifferentiated	13	0.26
Rosa undifferentiated	12	0.24
Rubus chamaemorus	11	0.22
Prunus padus	10	0.20
Sambucus nigra	8	0.16
Arctostaphylos uva-ursi	6	0.12
Ribes undifferentiated	3	0.06
Arctostaphylos alpinus	2	0.04
Sambucus racemosa	1	0.02
Total	5076	

Table 8.1: Percentage Ubiquity of all samples in the research area (15,000 – 5,700 cal BP).

Percentage Total

Family/Genus/Species	Total pollen samples detected	% total
Empetrum nigrum	12178876	23.23
Rosaceae Undifferentiated	9637758	18.38
Viburnum opulus	6784610	12.94
Sorbus aucuparia	6627517	12.64
Sorbus undifferentiated	6052449	11.54
Viburnum undifferentiated	2551716	4.87
Vaccinium undifferentiated	2130397	4.06
Sambucus undifferentiated	1495230	2.85
Crataegus undifferentiated	1378498	2.63
Prunus undifferentiated	1138314	2.17
Hippophae rhamnoides	882457	1.68
Rosa undifferentiated	863841	1.65
Ericaceae Undifferentiated	323341	0.62
Arctostaphylos undifferentiated	263891	0.50
Cornus undifferentiated	41592	0.08
Rubus undifferentiated	28298	0.05
Rubus chamaemorus	20012	0.04
Prunus padus	15499	0.03
Sambucus nigra	9516	0.02
Arctostaphylos uva-ursi	7380	0.01
Arctostaphylos alpinus	4686	0.01
Ribes undifferentiated	2274	0.004
Sambucus racemosa	240	0.0005
Total	52438393	

Table 8.2: Percentage Total of all samples in the research area (15,000 – 5,700 cal BP).

In this study percentage ubiquity relates to the number of times or years that a species' pollen is identified (Table 8.1). Where this figure is high, a species is available more frequently throughout the study period. Similarly, where the number is low the species is less commonly available. Therefore, the top five most frequently available species groupings would be: *Empetrum nigrum, Rosaceae Undifferentiated, Sorbus aucuparia, Hippophae rhamnoides* and *Viburnum undifferentiated*. The most consistently available species groupings are *Empetrum nigrum* and *Rosaceae Undifferentiated* by a significant margin: 39.81% and 30.71%, with *Sorbus aucuparia* the next nearest at 5.2%.

Percentage total (Table 8.2) is calculated from the number of pollen samples or pollen grains detected within a given date range. This number is a guideline of the quantity of pollen being released by a given species group. Whilst it may be that different species release variable volumes of pollen compared to one and other, and also depending on environmental factors, as well as there being many factors impacting pollen accumulation in a pollen reservoir (discussed in chapter 4), the results aims to provide a gauge for species relative abundance. When referenced alongside the ubiquity results, an understanding of how much pollen is being released and how often, can be ascertained.

The top five results for pollen percentage total are very similar to ubiquity: *Empetrum nigrum, Rosaceae Undifferentiated, Viburnum opulus, Sorbus aucuparia* and *Sorbus undifferentiated.* It is apparent that although *Hippophae rhamnoides* is relatively consistently available during the period, it's absence from the top five pollen total (actual position: 11th place with 1.68%) is suggestive that is not particularly abundant. The difference in percentage total between the top five is far less severe that in percentage ubiquity: *Empetrum nigrum* 23.23%, *Rosaceae Undifferentiated* 18.38%, *Viburnum opulus* 12.94%, *Sorbus aucuparia* 12.64%, *Sorbus undifferentiated* 11.54%.

What is particularly noteworthy, is that the fruit species in the top five species by number of sites where macro-fossils have been recovered during excavation, are all low in their percentage total categories: *Sambucus undifferentiated* 2.85%/*Sambucus nigra* 0.02%, *Crataegus undifferentiated* 2.63%, *Cornus undifferentiated* 0.08% and *Rubus undifferentiated* 0.05%. *Malus sylvestris* is only identifiable at family level in the palynology (*Rosaceae Undifferentiated)*, and it may be that *Rosaceae Undifferentiated* represents pollen from *Crataegus*, and *Rubus* too, that could not be identified to genus level. *Viburnum opulus, Empetrum nigrum* and *Sorbus aucuparia* coming 7th, 8th and 9th respectively in the number of sites where macro-fossils have been recovered. The evidence does seem to impress upon the importance of the species within top five species by number of sites where macro-fossils have been recovered during excavation, as although seemingly far less abundant than other species in the palynology, they are most commonly found on sites in Northwest Europe.

In order to compensate for the difficulties in comparing undifferentiated genus and family groups with species groups, two tables with the data combined into family groups only were created. These were then adjusted on account of the different number of fruiting species per family to create an average percentage per species member. The process eliminated the visible bias towards the significance of undifferentiated categories such as *Rosaceae Undifferentiated* and better answer this research question.

Family/Genus/Species	Total times presence detected/number of members	% ubiquity per member	Total pollen samples detected/number of members	% total per member
Adoxaceae *4 members*	92.25	1.82	2710327.75	5.17
Cornaceae *2 members*	6.5	0.13	20796	0.04
Elaegnaceae *1 member*	258	5.08	882457	1.68
Ericaceae *5 members*	456.2	8.99	2981714.2	5.69
Grossulariacaeae *5 members*	0.6	0.01	454.8	0.00 (0.000867)
Rosaceae *23+ members*	93.57	1.84	1120095.09	2.14
Total times detected	5076		52438393	

Table 8.3: Research data divided by the total number of fruiting species in each family area (15,000 – 5,700 cal BP).

The produced tables (compiled into a single table in this chapter – cf. Table 8.3) illustrate quite a different picture than the % ubiquity and % total per number of family members (including Family Undifferentiated undifferentiated, and Family Genus undifferentiated groups). A greater dominance of *adoxaceae* when relatively compared by number of species is perceivable. Comparatively perceivable is the lower dominance of the *Rosaceae* family by number of family members, a group that otherwise would appear very significant in the initial tables. The tables do highlight both the dominance and prevalence of the *Ericaceae* family as well as the distinct insignificance of the *Grossulariacaeae* family by comparison.

The palynological study also highlighted a number of interesting changes occurring throughout the broader period:

- During the Late Mesolithic the previous status quo of pollen levels changes quite substantially whilst *Empetrum nigrum* and *Rosaceae Undifferentiated* remained the most ubiquitous, their total pollen decreases so much so that *Sorbus undifferentiated*, *Viburnum opulus* and *Sorbus aucuparia* becomes most dominant. *Sorbus undifferentiated* also increases markedly on the previous period. It could be the result of climatic or environmental changes, it might also be indicative of propagation of the more populace species. Habitat destruction is another possibility.

- The diversity of species increase from the Late Upper Palaeolithic until the Late Mesolithic, after which it decreases.
- There is a single explosion event of *Rosa undifferentiated* that occurs in the Middle Mesolithic, making it the highest total pollen per presence detected, of any species.
- The number of annual occurrences and total amount of pollen increases by period until its zenith in the Middle Mesolithic.

Period group	Total times presence detected	% of total	Total pollen samples detected	% total
Late Upper Palaeolithic	574	11.31	1739640	3.32
Early Mesolithic	1182	23.29	7650602	14.59
Middle Mesolithic	1386	27.30	19135897	36.49
Late Mesolithic	924	18.20	14360969	27.39
Mesolithic to Neolithic transition	1022	20.13	9667189	18.43
Total	5076		52438393	

Table 8.4: Comparison of total number of times all species are present and the total pollen samples across 15,000 – 5,700 cal BP.

3. Which edible fruit species do we have archaeological evidence for from the Mesolithic period?

This question can be answered simply and effectively by table 8.5:[5]

Species Considered Native	**Evidence for gathering (macro-fossil on archaeological site)**	**Available (Identified in Pollen Cores)**
Rosa spp.	Y	Y
Prunus padus	Y	Y
Sorbus aucuparia	Y	Y
Viburnum opulus	Y	Y
Sambucus nigra	Y	Y
Hippophae rhamnoides	Y	Y
Rubus idaeus	Y	Genus level
Rubus fruticosus aggregate	Y	Genus level
Rubus caesius	Y	Genus level
Rubus saxatilis	Y	Genus level
Prunus spinosa	Y	Genus level
Prunus avium	Y	Genus level
Prunus cerasus	Y	Genus level
Cornus sanguinea	Y	Genus level
Crataegus monogyna	Y	Genus level
Fragaria vesca	Y	Family level
Malus sylvestris	Y	Family level
Pyrus pyraster	Y	Family level
Empetrum nigrum	Y - dubious	Y
Vaccinium vitis-idaea	Y - dubious	Genus level
Rubus chamaemorus	Genus level	Y
Prunus fruticosa	Genus level	Genus level
Prunus cerasifera	Genus level	Genus level
Crataegus laevigata	Genus level	Genus level
Sorbus aria	Genus level	Genus level
Sorbus devoniensis	Genus level	Genus level
Sorbus intermedia	Genus level	Genus level
Sorbus torminalis	Genus level	Genus level
Pyrus cordata	Genus level	Family level

[5] For visual representation and stimuli of each species, refer back to Chapter 7.

Arctostaphylos uva-ursi	N	Y
Arctostaphylos alpine	N	Y
Sambucus racemosa	N	Y - dubious
Vaccinium myrtillus	N	Genus level
Vaccinium uliginosum	N	Genus level
Sambucus ebulus	N	Genus level
Ribes nigrum	N	Genus level
Ribes rubrum	N	Genus level
Ribes uva-crispa	N	Genus level
Ribes alpinum	N	Genus level
Ribes spicatum	N	Genus level
Cornus suecica	N	Genus level
	Present/identified	
	Present/identified - single or dubious occurrence	
	Identified at a genus level	
	Not present/identified	

Table 8.5: Comparison of species considered native, present in the archaeology and present in palynology. Firstly weighed by archaeological presence and then by palynological presence. WIth adjustments for dubious data entries.

4. Is there any discrepancy between the fruits that were available and the fruits for which there is archaeological evidence for?

The short answer to research question four is clearly yes, however the results highlight a number of interesting points with a broad impact:

- Where a species has been identified as present/ identified in the pollen cores, it has also been identified in the archaeology. Suggesting that where fruits are definitely present in the environment, they are also handled on sites and thus deposited in the archaeological record.
- Species that are found in the archaeological record have must been present in the environment however some 12 are only identifiable genus or family level. *Malus sylvestris* is only identifiable to family level in the palynological study, but is in the top five species of macro-fossils by number of sites. This comparison highlights this

limitation of palynological study. Less like is the suggestion that this evidence of long distance trading.

- The *Ericaceae* species present in the pollen study appear to be absent from the archaeological study besides a few pieces of questionable evidence for *Vaccinium vitis-idaea* and *Empetrum nigrum.*
- Despite *Cornaceae* being relatively insignificant in % total and % ubiquity pollen per family member. The number of finds from *Cornus sanguinea* and find sites suggest this is a prized species nonetheless.

5. How are the fruits, considered native to the research area used, processed and preserved in the present, in recorded history and ethnography? What evidence would we expect to find in the Mesolithic?

Firstly, chapter 7 that discusses how fruits are used, processed and preserved in the present, recorded history and ethnography, is of value in providing confirmation and clarity for a number of conclusions from previous research questions. In the interests of providing a complete and comprehensive synopsis of fruit use, these points will be listed first, despite constituting the second half of the chapter. Following this a table of preservation and processing techniques and the possible evidence we might expect to find in the Mesolithic has been compiled.

- The species *Empetrum nigrum*, *Artostaphylos uva-ursi*, *Arctostaphylos alpine* and *Rubus chamaemorus* are the only species that are fully present in the palynology but not present from archaeological excavations. The ethnographic study confirms that these species are all upland or moorland species with a boreal/sub-arctic biome preference. Similarly, *Cornus suecica*, *Ribes alpinum*, *Sambucus ebulus*, *Vaccinium vitis-ideae*, *Vaccinium myrtillus*, *Vaccinium uliginosum* and *Empetrum nigrum* have either an upland/moorland orientation, a boreal/sub-arctic biome, or both. Furthermore, there are no macro-fossils from fruit species with either regional preference found in the archaeology at all. The only exception to this being *Sorbus aucuparia* although this species can also be found in woodland or coastal biomes. There are a number of possibilities as to why this is: Communities are not present in these biomes during fruiting, the species are not present in Northwest Europe or present but not producing fruit, the fruit seeds are small and the fruits not heat treated thus less likely to be found during excavation, the wetter conditions of the moorlands and uplands wash the macro-fossil evidence from sites, the fruit are not easily harvested in large volumes and therefore more readily available fruits are sought.

- The ethnographic suggest the *Ribes* genus is native to the research area. However, the very brief presence of *Ribes undifferentiated* and the distinct absence of *Ribes* fruit macro-fossils suggests that the genus was only pioneering during the research period and not established. It's consideration as a native species must therefore be rejected. Conversely, the ethnographic study suggests *Sambucus racemosa* is native to Central Europe and not Northwest Europe. Although it does appear very briefly in the pollen study, its consideration as a native species should be similarly rejected.
- *Sorbus aucuparia* and *Viburnum opulus* are both within the top 10 for percentage ubiquity, percentage total and species by number of sites macro-fossils are present; however, both are notably insipid, bitter and have emetic properties. Despite a 14 different experimental attempts to make *Sorbus aucuparia* palatable, Mears and Hillman (2007) did not succeed. *Sorbus aucuparia* does have a significant vitamin C source if one can get over the foul taste. It may be that tastes have changed distinctly since the Mesolithic period, however, it is unlikely that the fruits emetic properties have. The wood of *Viburnum opulus* excels at a number of different tasks including for use in fish traps and as arrows, and therefore find may represent stripped and deposited foliage as opposed to consumption debris.
- The top five species by number of find sites: *Rubus ideaus, Malus sylvestris, Cornus sanguinea, Crataegus monogyna*; all appear to be valuable significant in their high concentrations of specific vitamins, minerals and hard to source nutrients, with the exception of *Cornus sanguinea*. They are also fruits that can be effectively preserved in order to provide access to these nutrients during times of scarcity. In the case of *Cornus sanguinea* however, an oil can be extracted that is of value for lighting, cooking and sealing organic materials (wood & leather).

Preservation technique	**Possible utensils**	**Possible waste products/archaeological evidence**
Fruit leather & jellying	Large vessel (leather, wood or Ertebølle style ceramic), use of fire in reducing or drying.	Uncharred seeds/fruit-stones, charred seeds/fruit-stones, residue in containers.
Fermentation	Large vessel (leather, wood or Ertebølle style ceramic), fire, bone, antler or wood pulping & stirring tool.	Uncharred seeds/fruit-stones, charred seeds/fruit-stones, residue in containers.
Pickling	Large vessel (wood or Ertebølle style ceramic)	Residue in containers, Uncharred seeds/fruit-stones

Drying & smoking	Drying system (either a rack or an A-frame smoker), flat stone, fire, chimney trench (for cold smoking), grindstone or pestle and mortar if using the 'sloe-patty' technique.	Uncharred seeds/fruit stones and charred seeds/fruit-stones, post-holes from drying frame.
Watering	Large vessel (wood or Ertebølle style ceramic)	None
Cooking, Boiling or Parboiling	Large vessel (leather, wood or Ertebølle style ceramic), fire, stones	Uncharred seeds/fruit-stones, charred seeds/fruit-stones, cracked and charred stones
Refrigeration/Freezing	Pits or root cellars – may require digging implements (wood, bone or antler), ice or compact snow	Uncharred seeds/fruit-stones where refrigeration/freezing unsuccessful, water
Dry Curing/Salting	Salt, possibly large vessel of wood or Ertebølle ceramic required to extract salt, drying rack	Post holes from drying rack, excess salt
Brining	Salt, water, possibly large vessel of wood or Ertebølle ceramic required to extract salt.	None
Sugaring	Large vessel (leather, wood or Ertebølle style ceramic), honey	None
Lye	A cleared hearth (possibly containing charred seaweed), large vessel (leather, wood or Ertebølle style ceramic)	Waste products/archaeological evidence: Hearth, used lye.
Jugging/meat jellying, oil preservation & Seal oil/rendered fats	Fire, stones, large vessel (leather, wood or Ertebølle style ceramic), a 'poke'.	Cracked or charred stones, residue in vessel, animal carcass

Processing technique	**Possible utensils**	**Possible waste products/archaeological evidence**
Juicing, pressing & Homogenising	Grind stone, pestle and mortar Large vessel (leather, wood or Ertebølle style ceramic, though ceramic likely too fragile for juicing action could be used in collection), textile or plant fibre sieve	If juicing the fruit, pulp and seeds would be waste products, if extracting oil then cracked/pressed seed remains would be present
Bletting	Large vessel (leather, wood or Ertebølle style ceramic)	Possibility of Uncharred seeds/fruit-stones and residue
Peeling & Slicing	Flint blade, bone knife, shell	Fruit peel
Leaching	'Dilly' bag (woven grass or plant fibre bag) or basket	(leached chemicals in water) none

Fermentation	Large vessel (leather, wood or Ertebølle style ceramic), stones (depending on boiling technique), wooden, antler or bone stirrer	Possibly cracked or charred stones, residue in vessel, uncharred seeds/fruit-stones, charred seeds/fruit-stones
Drying/Curing	Drying system (either a wooden rack, cord drying line or a wooden A-frame smoker), flat stone, fire, chimney trench (for cold smoking), grindstone or pestle and mortar if using the 'sloe-patty' technique.	Possibly uncharred seeds/fruit-stones and charred seeds/fruit-stones
Cooking	Large vessel (either wood, flat stone, leather or Ertebølle style ceramic), stones (depending on boiling technique), wooden or bone stirrer, skewers (wood, bone or antler), fire tongs (a tool used to transfer hot rocks from the fire – wood, bone or antler)	Uncharred seeds/fruit-stones, charred seeds/fruit-stones, fruit peel, pit/hole, poorly fired clay or carbonised leaves

Table 8.6: Summary of research objective five.

It was the aim of this research question to highlight the tools that would be required and potential archaeological evidence that would be produced by the possible techniques of fruit processing and preservation. It seems however that exceptional preservation conditions would need to be combined with quite specific artefact orientations in order to identify any of the processing and preservation techniques mentioned. Based on the table above, the more persistent utensils and archaeological evidence could easily be interpreted as debris from a number of these activities, and at the same time, none of them. It seems that with current archaeological techniques and in lieu of evidence available in such exceptional preservation conditions, it seems it is still too soon to clearly ascertain these activities from archaeological evidence.

8.2 Evaluation and future research

This research clearly outlines a ground breaking field in Mesolithic archaeology, the study of fruit. Where this has previously been an aspect of plant remains studies, this research highlights the necessity for researching fruit as an independent topic. As the first of its kind, the work highlights a number of significant aspects of the discipline and seeks to effectively create a foundation of research that can be built upon, whilst also highlighting the possible pitfalls and erroneous findings that one might produce in the study of this data. The value of this research as a platform from which other studies may expand, is evident from the accessory data produced in appendices 2 and 7 (where fruit pollen throughout the period is further broken down into individual country) and included in the tabulated datasets throughout this research including the table of Archaeological finds in Tables 5.1. and 5.2. Furthermore, the compiled and tabularised datasets combing archaeological evidence for fruit species from the Mesolithic, as well as those comparing this evidence with the palynological presence/absence and seasonal availability, are the first of their kind. They provide the basis from which future research into this field can expand.

The research effectively draws on palynology to first understand what species are available throughout the period and compare their relative abundance. This approach was not without its limitations:

- The accuracy and quality of the study is tied to the accuracy and breadth of the Fossil Pollen Database.
- It is difficult to make assumptions of the number of species based on quantities of pollen found. Different species may produce different volumes of pollen based on a number of factors and does not imply fruiting success. Furthermore, differential distances of species from pollen reservoirs or biomes with more pollen reservoirs, will likely have an impact on their visibility and significance in the pollen record.
- There are a number of taphonomic factors including changes in fluvial conditions which can impact the volumes of pollen accumulation.

Despite these limitations the palynological study uses a number of approaches to try and make effective comparisons between species and family groups possible, whilst also stressing the importance that the data should be seen as a guide of the species present rather than a steadfast representation of the number of fruits available.

Future research into the palynology of fruit species in the Mesolithic could include:

- A more detailed comparison between the palynology data for each country, with the fruit macro-fossil finds in that countries archaeology. This might hint at possible anomalies that could infer things like long distance trade and the transportation of seeds as well as inconsistencies with the palynology.
- Maps could be used to compare palynological finds over time across the research area and broadly map the areas where individual species may be available. The data needed to produce these is available within this appendices 2 and 7. These maps could also be compared with similar ones based on the archaeological finds of fruit macro-fossils, this data is also available. This would help create a strong visible and clearly comparable data set to examine what fruits are available where and thus further highlight inconsistencies.

The archaeological study could also be improved by expanding the database to include grey literature and unpublished material, as well as completing a more comprehensive search of data from literature published in other languages. Furthermore, the creation of a more accurate and more comprehensive calendar of availability would be beneficial to the study, although in order to ensure accuracy seasonality data over hundreds of years would need to be examined. The calendar would also benefit from a more specific biome category. The calendar in this research only facilitates comparisons between coastal, upland & moorland and woodland & lowland biomes. If these categories were further refined, clearer and more accurate assumptions about hunter-gatherer movement patterns could be made.

The experiment in appendix 3 in combination with the archaeological study of plant macro-fossil remains, highlights a large gap in our knowledge in the average number of seeds present in specific fruits. This is particularly significant as our lack of understanding makes it difficult to compare the number of fruit being harvested and their volumes. For example, a single *Prunus avium* seed would represent a much larger volume of fruit (and thus sugars and nutrients) than a seed of *Rubus ideaus.* Further research could be undertaken in the form of a comprehensive series of experiments, such as the raspberry experiment in appendix 1, in order to ascertain an average range for the number of seeds present in each species.

This data could then be combined with more detailed research into the specific quantities of macrofossils that have been found, presumably via examining the collections or through personal communications with the authors of papers where quantifiable values have not been given. This would allow us to understand how many whole fruit are represented by the seeds finds. This data can then be cross-compared with the fruits nutritional values and the energy or time required in harvesting them, against the number of finds. Therefore, aiming to establish more accurately what fruits are being gathered, in what quantity and whether there is a correlation between which fruits are being gathered in the largest volumes and their calorific or nutritional value.

The importance of the species *Cornus sanguinea* for the production of oil, as a possible high value resource, has been identified throughout this research. Regnell (2011) suggests the large number of cracked seeds found during excavation of Tågerup relate to oil production. The seeds are noted for their approximately 50% oil content and should hunter-gatherers be producing oil from pressing dogwood seeds for use in lighting, cooking and sealing/preserving organic materials, the implications are massive. This ramification of this industry would require a paradigm shift in our interpretations of people at this time and their economy. In order to test this an experimental archaeology project should be undertaken in order to see how oil extraction from the *Cornus sanguinea* seeds, affects them, and whether they resemble the cracked seeds found at Tågerup.

Appendices

Appendix 1 - List of the sites, countries and sources references compiled in the palynological study.

Appendix 2 - Palynology study pollen tables and graphs.

Appendix 3 - Raspberry seed experiment.

Appendix 4 - Calendar of seasonal availability including biome categories and presence in archaeological record.

Appendix 5 - Compendium of pollen evidence from the FPD for the Mesolithic of Northwest Europe.

For appendices, please see CD-ROM attached to this thesis in plastic sleeve at the back cover.

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