

1 Exploring the composition of lithic assemblages in Mesolithic
2 south-eastern Norway

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5 **Abstract**

6 This paper leverages multivariate statistics to explore the composition of 54 Mesolithic assemblages
7 located in south-eastern Norway. To provide analytical control pertaining to factors such as variable
8 excavation practices, systems for artefact categorisation and raw-material availability, the sites chosen
9 for analysis have all been excavated relatively recently and have a constrained geographical distribution.
10 The assemblages were explored following two strains of analysis. The first of these entailed the use of
11 artefact categories that are established within Norwegian Mesolithic archaeology, while the other involved
12 drawing on measures that have been linked directly to land-use and mobility patterns associated with
13 lithic assemblages more widely. The findings pertaining to the established artefact categories largely
14 reflect the temporal development previously reported in Norwegian Mesolithic research—research that
15 has been based on more subjectively driven methods. Furthermore, the chronological trends associated
16 with variables taken from the so-called whole assemblage behavioural index, originally developed for
17 characterising Paleolithic assemblages in terms of associated mobility patterns, also align with the
18 development previously proposed in the literature. This provides an initial indication that these measures
19 are applicable in a Norwegian Mesolithic setting as well, setting the stage for a more targeted and rigorous
20 model evaluation outside this exploratory setting. This might ultimately yield a powerful comparative
21 tool for more extensive analyses of Mesolithic assemblages.

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25 **1 Introduction**

26 This study employs multivariate exploratory statistics to analyse lithic assemblages associated with a larger
27 number of Mesolithic sites located in south-eastern Norway. This is done to identify latent patterns and
28 structure in the relationship between the assemblages, with the ultimate aim of identifying behaviourally
29 induced variation in their composition across time. However, the composition of the assemblages can be
30 expected to be determined by a multitude of factors (e.g. Dibble et al., 2017; Rezek et al., 2020), ranging from
31 the impact of natural formation processes, to various and intermixed behavioural aspects such as purpose,
32 duration, frequency and group sizes at visits to the sites. The assemblages are also likely to be impacted
33 by variation in lithic technology, artefact function, use-life and discard patterns, as well as procurement
34 strategies and access to raw materials. Finally, analytic and methodological dimensions relating to survey,
35 excavation and classification practices are also fundamental to how the assemblages are defined. Consequently,
36 the analysis conducted here is done from an exploratory perspective, where all of these factors should be seen
37 as potential contributors to any observed pattern. In an attempt to limit the influence of some potentially
38 confounding effects, the material chosen for analysis has a constrained geographical distribution, and stems
39 from recent investigations that have employed comparable methods for excavation and classification within
40 larger unified projects.

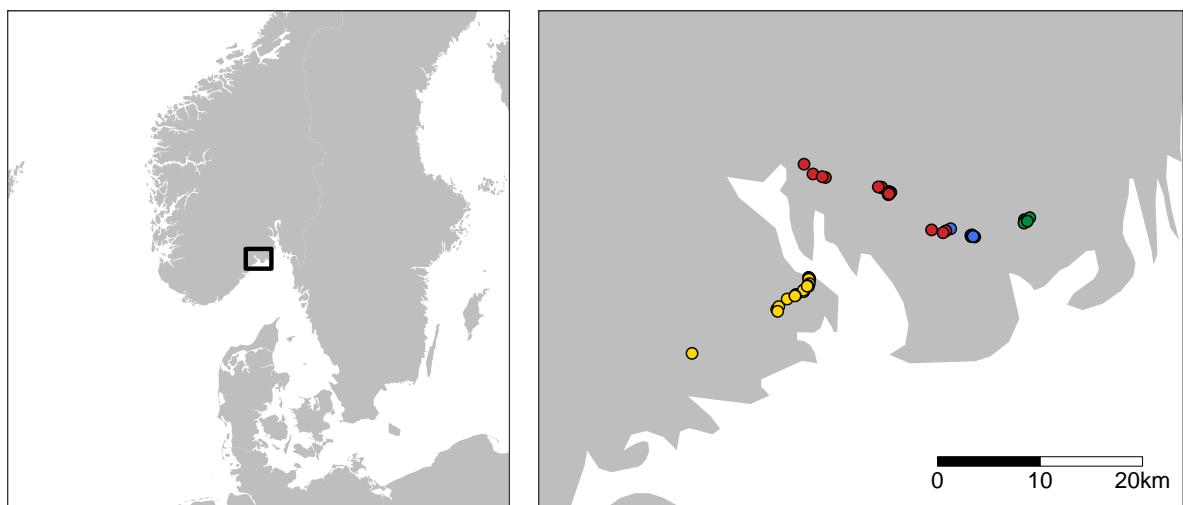
Even though each individual assemblage can have been impacted by an virtual infinitude of effects that might skew an archaeological interpretation, this does not preclude the applicability of inductive analyses aimed at revealing overarching structure in the data without imposing overly complex analytical frameworks that attempt to account for these particularities (Bevan, 2015). Structure that can be revealed from considering all of the assemblages in aggregate can constitute a step in an iterative analytical chain that ultimately aims to tease apart the multitude of factors that have shaped the composition of the assemblages, and should be of value to subsequent in-depth studies of any individual site. The most immediate danger of the approach outlined here is rather to be overly naive in the causal significance and cultural importance that is ascribed to any identified pattern. As such, the main aim of this analysis is to compare the results with findings reported in previous literature concerned with the Mesolithic in southern Norway and have the generation of new hypotheses as a possible outcome. To this end, the analysis follows two analytical avenues. The first involves an analysis of the assemblages using the classification of the artefacts done for the original excavation reports. The second involves an analysis of the assemblages in light of the so-called whole assemblage behavioural index (e.g. Clark and Barton, 2017), which has been employed in other contexts to align properties of lithic assemblages with land-use and mobility patterns.

2 Archaeological context and material

The 54 coastal sites chosen for analysis here have a relatively limited geographical distribution in south-eastern Norway (Figure 1A). The sites were excavated as part of four larger excavation projects that all took place within the last 15 years (Jaksland and Persson, 2014; Melvold and Persson, 2014; Reitan and Persson, 2014; Solheim, 2017a; Solheim and Damlien, 2013). The sites included in the analysis consist of all Mesolithic sites excavated in conjunction with the projects that have assemblages holding more than 100 artefacts. The institution responsible for these excavations was the Museum of Cultural History in Oslo. This has led to a considerable overlap in the archaeological personnel involved, and comparable excavation practices across the excavations. Furthermore, with these projects, major efforts were made to standardise how lithic artefacts were to be classified at the museum (Koxvold and Fossum, 2017; Melvold et al., 2014). As a result, this should reduce the amount of artificial patterning in the data incurred by discrepancies in the employed systems for categorisation (e.g. Clark and Riel-Salvatore, 2006; Dibble et al., 2017). In this setting, for example, bias could potentially follow from the fact that two of the projects have sites with relatively contemporaneous dates (Jaksland, 2014; Solheim and Damlien, 2013, see also Figure 1B). Any project-dependent classification practice could as a consequence lead to an exaggeration of chronological differences between the assemblages. While this is difficult to fully account for, I do believe that the relative contemporaneity of the excavation projects, as well as the overlap in excavation and classification practices should minimise the above-mentioned effects.

A defining characteristic of the Norwegian Mesolithic is that a clear majority of the known sites are located in coastal areas (e.g. Bjerck, 2008). Furthermore, these coastal sites appear to predominantly have been located on or close to the contemporary shoreline when they were in use (e.g. Åstveit, 2018; Breivik et al., 2018; Møller, 1987; Solheim et al., 2020). In south-eastern Norway, this pattern is combined with a continuous regression of the shoreline, following from isostatic rebound (e.g. Romundset et al., 2018; Sørensen, 1979). The fairly rapid shoreline displacement means that the sites tend not to have retained their strategic or ecologically beneficial shore-bound location for long periods of time (cf. Perreault, 2019, p. 47). Consequently, the shore-bound settlement, combined with the rapid shoreline displacement has resulted in a relatively high degree of spatial separation of cumulative palimpsests, to follow the terminology of Bailey (2007), while the reconstruction of the trajectory of relative sea-level change allows for a relatively good control of when these accumulation events occurred. In other parts of the world, a higher degree of spatial distribution means that while the physical separation of material can help delineate discrete events, this typically comes at the cost of losing temporal resolution as any stratigraphic relationship between the events is lost (Bailey, 2007). However, as the rate of isostatic rebound has varied throughout the Mesolithic in the region, and local topography and bathymetry will have impacted how rapidly a site lost its shore-bound location, this effect is not evenly distributed in time and space. In the earliest part of the Mesolithic, the displacement rate within the study area would have been around as much as 8.8 cm/year, falling to around 0.5 cm/year towards the end of the

A



B

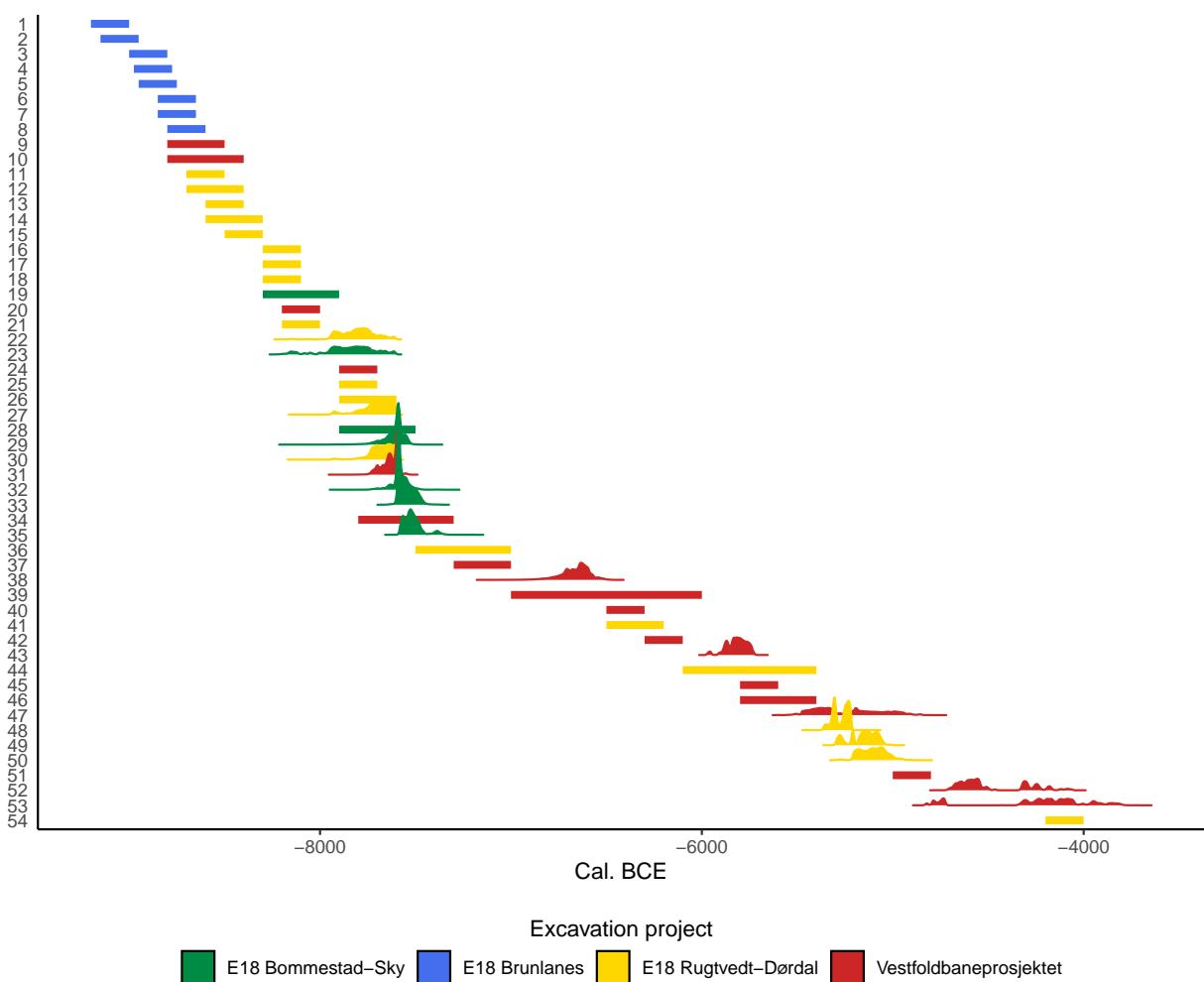


Figure 1: A) Spatial and B) temporal distribution of the sites chosen for analysis. Radiocarbon age determinations are given as the sum of the posterior density estimates. Solid lines indicate that the site has been dated with reference to relative sea-level change and typological indicators. These follow the original reports.

91 Mesolithic (Sørensen et al., 2014). Thus, while relative sea-level change appears to have reduced the degree of
92 mixing that has occurred in the assemblages, it is worth bearing in mind that this could vary depending on
93 when and where they were in use, potentially reducing the degree to which their composition can be directly
94 compared.

95 The 54 sites analysed here have been dated by reference to relative sea-level change, typology and/or
96 radiocarbon dates (Table 1). Date ranges for sites based on shoreline displacement and typology are taken
97 from the original reports and follow the evaluation done by the original excavators. Where radiocarbon age
98 determinations believed to be associated with the lithic material are available, these have been calibrated
99 using the IntCal20 calibration curve (Reimer et al., 2020) and subjected to Bayesian modelling using OxCal
100 v4.4.4 (Bronk Ramsey, 2009) through the oxcAAR package (Hinz et al., 2021) for R (R Core Team, 2020).
101 The only constraint imposed for the modelling of the dates was that the dates from each site are assumed to
102 represent a related group of events through the application of the Boundary function (Bronk Ramsey, 2021).
103 The resulting posterior density estimates were then summed for each site. Radiocarbon data is provided in
104 the supplementary data, and has also been collated and reported by Solheim (2020).

105 The lithic data analysed here is based on the classification of the site assemblages done for the original
106 excavation reports, and consists of 48 variables representing differentdebitage and tool types. While the
107 classification practices for the excavation projects were standardised to an extent, there are some instances
108 where time was allocated to identify additional artefact sub-categories aimed at answering specific research
109 questions. Some categories in the original reports have therefore been combined in the dataset. This for
110 example pertains to the category narrow-blades (width > 8mm and < 12mm), which was only separated from
111 (macro-)blades (width \geq 12 mm) and micro-blades (width \leq 8 mm) for some of the sites. Narrow-blades were
112 combined with the blade category here. Furthermore, the artefact data have here been divided into flint and
113 non-flint materials. Flint does not occur indigenously in Norway, and is only available locally as nodules that
114 have been transported and deposited by retreating and drifting ice (e.g. Berg-Hansen, 1999). This means
115 that the distribution and quality of flint has been impacted by a diverse set of factors relating to climatic and
116 geographical factors such as, but not limited to, topographic variability, shoreline morphology and ocean
117 currents (Eigeland, 2015, p. 46). Thus, while flint is treated as a unified category here, the variability in
118 quality could have been substantial (Eigeland, 2015, pp. 45–53). Furthermore, the various non-flint raw
119 materials that have been lumped together have quite disparate properties, where fine-grained cryptocrystalline
120 materials are often used as a substitute or supplement to flint, while other, coarser materials are usually
121 associated with the production of axes and other macro tools. Given this differentiated use, these raw-material
122 properties are expected to be reflected in the retaineddebitage and tool categories. An important benefit of
123 combining all of the non-flint materials is that this reduces the dependency on whether or not these have been
124 correctly and consistently categorised for the reports (cf. Frivoll, 2017). While certainly a topic deserving
125 of more attention, the general sentiment in the literature is that there would have been stable access to
126 locally available non-flint raw-materials of good quality in south-eastern Norway (e.g. Eigeland, 2015, p.
127 370; Glørstad, 2011). Finally, while factors such as landscape changes through shoreline displacement can
128 have led to variable raw-material availability at the analysed sites, their relatively constrained geographical
129 distribution hopefully counteracts some non-behavioural sources of variation.

130 Studies concerned with chronological changes in the composition of lithic assemblages in southern Norway
131 have typically had a focus on morphological variation among artefacts (e.g. Ballin, 1999; Bjerck, 1986;
132 Reitan, 2016) or been concerned with technological processes associated with certain sub-categories of the site
133 inventories, such as the production of blades or axes (e.g. Berg-Hansen, 2017; Damlien, 2016; Eymundsson et
134 al., 2018; Solheim et al., 2020). Studies that have involved entire assemblages have either been concerned with
135 general compositional traits such as relative frequency of various tool types and raw-materials (Breivik, 2020;
136 Breivik and Callanan, 2016; Reitan, 2016; Viken, 2018), or involved extremely in-depth studies of technological
137 organisation associated with a handful of assemblages (Eigeland, 2015; Fuglestvedt, 2007; Mansrud and
138 Eymundsson, 2016). These studies are, however, based on narratively driven methods, leaving the weighting
139 of the different variables for the final interpretations unclear. To my knowledge, only a single study dealing
140 with the composition of Mesolithic assemblages in southern Norway has involved the use of a multivariate
141 quantitative framework, which was employed to structure the analysis of eight Middle Mesolithic assemblages
142 (Solheim, 2013; see Glørstad, 2010, pp. 145–146 for a spatial application). In sum then, previous studies

¹⁴³ have typically either been limited to a small number of sites, to a subset of the inventories, to morphological
¹⁴⁴ characteristics, or to subjectively and narratively driven methods that are difficult to scale and consistently
¹⁴⁵ balance in the comparison of a larger number of artefact categories and assemblages.

Table 1. Analysed sites.

no	Site name	Dating method	Reported start (BCE)	Reported end (BCE)
1	Pauler 1	Shoreline/typology	9200	9000
2	Pauler 2	Shoreline/typology	9150	8950
3	Pauler 3	Shoreline/typology	9000	8800
4	Pauler 5	Shoreline/typology	8975	8775
5	Pauler 4	Shoreline/typology	8950	8750
6	Pauler 6	Shoreline/typology	8850	8650
7	Bakke	Shoreline/typology	8850	8650
8	Pauler 7	Shoreline/typology	8800	8600
9	Nedre Hobekk 2	Shoreline/typology	8800	8500
10	Solum 1	Shoreline/typology	8800	8400
11	Tinderholt 3	Shoreline/typology	8700	8500
12	Tinderholt 2	Shoreline/typology	8700	8400
13	Dør dal	Shoreline/typology	8600	8400
14	Tinderholt 1	Shoreline/typology	8600	8300
15	Skeid	Shoreline/typology	8500	8300
16	Hydal 3	Shoreline/typology	8300	8100
17	Hydal 4	Shoreline/typology	8300	8100
18	Hydal 7	Shoreline/typology	8300	8100
19	Hovland 2	Shoreline/typology	8300	7900
20	Nedre Hobekk 3	Shoreline/typology	8200	8000
21	Hydal 8	Shoreline/typology	8200	8000
22	Hegna vest 1	Radiocarbon	8000	7800
23	Hovland 5	Radiocarbon	8000	7700
24	Sundsaasen 1	Shoreline/typology	7900	7700
25	Hegna øst 6	Shoreline/typology	7900	7700
26	Hegna vest 4	Shoreline/typology	7900	7600
27	Hegna vest 2	Radiocarbon	7900	7550
28	Nordby 2	Shoreline/typology	7900	7500
29	Hovland 4	Radiocarbon	7900	7500
30	Hegna vest 3	Radiocarbon	7800	7600
31	Prestemoen 1	Radiocarbon	7700	7600
32	Hovland 1	Radiocarbon	7700	7400
33	Hovland 3	Radiocarbon	7650	7450
34	Gunnarsrød 7	Shoreline/typology	7800	7300
35	Torstvet	Radiocarbon	7500	7100
36	Hegna øst 5	Shoreline/typology	7500	7000
37	Gunnarsrød 8	Shoreline/typology	7300	7000
38	Langangen Vestgård 1	Radiocarbon	6800	6600
39	Gunnarsrød 2	Shoreline/typology	7000	6000
40	Gunnarsrød 6b	Shoreline/typology	6500	6300
41	Hegna øst 7	Shoreline/typology	6500	6200
42	Gunnarsrød 6a	Shoreline/typology	6300	6100
43	Gunnarsrød 4	Radiocarbon	6000	5800
44	Stokke/Polland 3	Shoreline/typology	6100	5400
45	Gunnarsrød 10	Shoreline/typology	5800	5600
46	Langangen Vestgård 2	Shoreline/typology	5800	5400
47	Vallermyrene 4	Radiocarbon	5500	5200
48	Hegna øst 2	Radiocarbon	5350	5200

49	Stokke/Polland 8	Radiocarbon	5300	5200
50	Stokke/Polland 5	Radiocarbon	5300	5000
51	Prestemoen 2	Shoreline/typology	5000	4800
52	Vallermyrene 1	Radiocarbon	4700	4100
53	Langangen Vestgård 3	Radiocarbon	4350	4000
54	Stokke/Polland 9	Shoreline/typology	4200	4000

146 3 Methodology

147 The relatively constrained geographical distribution of the analysed sites, the limited temporal range over
 148 which they were investigated, as well as the methodological equivalency across excavation projects hopefully
 149 leads to an exclusion of some biases that might otherwise skew an exploratory analysis, rendering it more
 150 likely that behaviourally meaningful patterns are identified. However, the exploratory perspective means
 151 that a wide range of combinations and transformations of variables has been explored to identify patterning
 152 in the data. While only parts of this process can sensibly be reported here, the data and employed R
 153 programming script is freely available as a research compendium, following Marwick et al. (2018), allowing
 154 readers to explore and scrutinise the data and the final analytical choices made (Marwick, 2017). However,
 155 this inductive data-dredging or pattern-searching approach does constitute a limited inferential framework
 156 (Clark, 2009), as it involves a *post hoc* accommodation of explanations to meet the observed data — data
 157 that is both selectively and subjectively reported upon. The process can still provide the identification of
 158 empirical patterns with respects to the employed units of analysis, which in turn can form the basis for social
 159 and behavioural hypotheses. This can lay the foundation for a deductive research agenda with targeted model
 160 evaluation for which clear test implications can be derived (Clark, 2009, p. 29).

161 The first part of the analysis involves employing the method of correspondence analysis (CA), using the
 162 lithic count data as classified for the original excavation reports. The purpose of this exercise is to evaluate
 163 the degree to which the composition of the assemblages align with patterns that have been suggested by
 164 earlier studies — studies that have employed more informally driven methods. This consequently assumes
 165 that the artefact categories employed in Norwegian Stone Age archaeology are, at least to a certain extent,
 166 behaviourally meaningful. However, the approach taken is also partially informed by the so-called Frison
 167 effect (Jelinek, 1976), which pertains to the fact that lithics studied by archaeologists can have had long
 168 and complex use-lives in which they took on a multitude of different shapes before they were ultimately
 169 discarded. Several scholars have built on this to argue that morphological variation in retouched lithics from
 170 the Paleolithic cannot be assumed to predominantly be the result of the intention of the original knapper to
 171 reach some desired end-product, but rather that what is commonly categorised as discrete types of artefacts
 172 by archaeologists can instead in large part be related to variable degrees of modification through use and
 173 rejuvenation (e.g. Barton, 1991; Barton and Clark, 2021; Dibble, 1995). Consequently, several artefact
 174 categories have here been collapsed for the CA. This for example pertains to tool types such as scrapers,
 175 burins, drills, knives and otherwise indeterminate artefacts with retouch. That these categories are internally
 176 consistent and categorically exclusive in terms of fulfilled purpose is at best a dubious proposition, in turn
 177 potentially rendering their contribution as discrete analytic units misleading. These have all been combined
 178 into the single category “small flint tools.” (A full overview of the aggregated variables and their constituent
 179 parts is provided in the supplementary material). While aggregating artefact categories in this manner could
 180 potentially subsume important variation, it does also reduce the possibility that any conclusions are not
 181 simply the result of employing erroneous units of analysis. An underlying assumption is therefore effectively
 182 that the retained categories represent artefact categories that have fulfilled different purposes or are related
 183 to different technological processes. While largely intuitive in nature, it does seem reasonable to assume that
 184 for example large non-flint stone tools such as axes, adzes, chisels, clubs and hatches, here categorised as
 185 non-flint macro tools, have fulfilled different purposes than the previously mentioned small flint tools.

186 However, for the most part we lack even a most basic understanding of what any individual lithic object
 187 in an assemblage has been used for (Dibble et al., 2017). For example, a vast amount of artefacts defined
 188 as debitage are likely to have fulfilled the function of tools, and both debitage and formal tool types could

189 have had various different purposes and had a multitude of shapes throughout their use-life. While use-wear
190 analysis could potentially offer a way to identify what artefacts were used for towards the end of their use-life,
191 these kinds of analyses are extremely time-consuming and are therefore typically only conducted on a smaller
192 number of artefacts that have already been selected for analysis based on their shape (e.g. Solheim et al.,
193 2018). Thus, while these analyses can potentially get at in-group variation pertaining to the end-state of a
194 group of artefacts, they do not tell us whether or not their classification as a unified group is meaningful
195 in the first place (Dibble et al., 2017). This has major implications that the above-outlined analysis does
196 not take properly into account, rendering it difficult to align any identified pattern with specific behavioural
197 dimensions. As a consequence, the second part of the analysis employs a suite of measures developed for
198 the classification of lithic assemblages with these inferential limitations in mind (see Barton et al., 2011;
199 Clark and Barton, 2017, and below). The logic behind these measures are founded on an understanding of
200 technology as being organised along a continuum ranging between curated and expedient (Binford, 1979,
201 1973; Binford, 1977). An expedient technological organisation pertains to the situational production of tools
202 to meet immediate needs, with little investment of time and resources in modification and rejuvenation,
203 resulting in high rates of tool replacement. Curated technological organisation, on the other hand, has been
204 defined as related to manufacture and maintenance of tools in anticipation of future use, the transport of
205 these artefacts between places of use, and the modification and rejuvenation of artefacts for different and
206 changing situations.

207 However, following not least from the ambiguous definition first put forward by Binford (1973), the theoretical
208 definition of curation, its archaeological correlates, and behavioural implications have been widely discussed
209 and disputed, and no single definition has ever been reached (e.g. Bamforth, 1986; Nash, 1996; Shott, 1996;
210 Surovell, 2009, pp. 9–13). The continuum between curated and expedient technology has for example been
211 related to dimensions such as land-use and mobility strategies and raw-material quality and availability (e.g.
212 Andrefsky, 1994; Clark and Barton, 2017; Kuhn, 1992; Parry and Kelly, 1987; Smith, 2015). Still, that the
213 distinction can offer a useful analytical point of departure if clearly and explicitly operationalised seems more
214 or less agreed upon, and some dimensions of the concept are generally accepted. For example, although
215 precisely how it is measured may vary, the empirical correspondent to a curated technological organisation is
216 typically defined by high degrees of retouch, as this is commonly seen as a means of realising the potential
217 utility of a tool — or extending its use-life — by the repeated rejuvenation and modification of edges (e.g.
218 Bamforth, 1986; Dibble, 1995; Shott and Sillitoe, 2005).

219 Furthermore, one concrete operationalisation of the terms have been forwarded by Barton (1998) and colleagues
220 (e.g. Barton et al., 2013, 2011, 1999; Barton and Riel-Salvatore, 2014; Clark and Barton, 2017; Riel-Salvatore
221 and Barton, 2007; Riel-Salvatore and Barton, 2004; Villaverde et al., 1998), who through a series of studies
222 have shown that the relationship between volumetric density of lithics and relative frequency of retouched
223 artefacts in lithic assemblages have a consistent negative relationship across a wide range of chronological
224 and cultural context, ranging from Pleistocene and Holocene assemblages in Europe and Asia, to assemblages
225 associated with both Neanderthals and modern humans (Barton et al., 2011; Riel-Salvatore et al., 2008).
226 This relationship is taken to reflect degree of curation, and is in turn mainly to follow from the accumulated
227 nature of land-use and mobility patterns associated with the assemblages (Barton and Riel-Salvatore, 2014).
228 In this model, higher degree of mobility would mean a higher dependency on the artefacts and the material
229 people could bring with them, and dimensions such as weight, reliability, repairability, and the degree to
230 which artefacts could be manipulated to fulfil a wide range of tasks are therefore assumed to have been factors
231 of concern. From this it follows that the empirical expectation for short-term camps is a curated technological
232 organisation with higher relative frequency of retouched artefacts, and a lower overall density of lithics (Clark
233 and Barton, 2017). More time spent in a single location, on the other hand, is assumed to lead to better
234 control of raw-material availability and to allow for its accumulation. This should in turn lead to a more
235 expedient technological organisation with reduced necessity for the conservation of lithics and extensive use of
236 retouch. The empirical expectation for lower degree of mobility is therefore relatively high density of lithics,
237 a low relative frequency of retouched artefacts, as well as a higher number of cores and unretouched flakes
238 and blades. These variables and underlying logic constitute what has been termed the whole assemblage
239 behavioural index (WABI, Clark and Barton, 2017), and is the main framework adopted here.

240 However, as these measures are argued to predominantly be determined by land-use and mobility patterns,

relative frequency of chips and relative frequency of non-flint material are also included in the analysis as these measures have also been linked to mobility patterns and is of central importance in Norwegian Stone Age archaeology (e.g. Bicho and Cascalheira, 2020; Breivik et al., 2016; Kitchel et al., 2021; Reitan, 2016) — the use of local non-flint material has been taken to indicate reduced mobility and increased familiarity with local surroundings (Glørstad, 2010, p. 181; Jakslund, 2001, p. 112). In sum, the variables employed in the analysis are relative frequency of secondarily worked lithics (RFSL), defined as the number of retouched or ground lithics divided by the assemblage total; volumetric density of lithics (VDL), defined as number of artefacts per excavated m³; relative frequency of chips, defined as the proportion of artefacts with size < 0.1 cm; relative frequency of cores, simply the proportion of all artefacts classified as cores in the original reports; relative frequency blanks, here defined as the proportion of all artefacts classified as flakes, blades, micro-blades or fragments; and finally relative frequency of non-flint material. Following Bicho and Cascalheira (2020), the analysis is done using principal components analysis (PCA), leading to a shift in focus from the relative composition emphasised by the CA, to having more weight placed on patterning in the most abundant occurrences (Baxter, 1994, pp. 71–77, 103).

A note should also be made on the fact that a few variables that are sometimes invoked for the classification of sites in terms of associated mobility patterns are omitted here (e.g. Bicho and Cascalheira, 2020; Breivik et al., 2016). For the assemblage data itself this especially pertains to diversity in tool-types (see also Canessa, 2021), which has been omitted in light of the previously mentioned Frison effect. Some site specific aspects such as number of features has also been disregarded as taphonomic loss is likely to have led to a chronological bias in their preservation. Similarly, the number of activity areas, effectively number of artefact clusters, however defined, has also been disregarded. This follows most notably from the fact that the impact of post-depositional processes at Stone Age sites in Norway is arguably understudied (Jørgensen, 2017). This pertains for example to the impact of bio-turbation in the form of three-throws, which can have a detrimental effect on the original distribution of artefacts, and which can be expected to have been relatively frequent on several of the sites treated here (Darmark, 2018; Jørgensen, 2017).

4 Results

Figure 2 displays the CA using the lithic count data. The general impression from the plots is that a chronological dimension is associated with the patterning in the data. This is indicated by the general transition across the colour scale in the row plot (Figure 2A), combined with the fact that the two first dimensions of the CA accounts for as much as 80.53 % of the inertia or variance in the data, as well as the horseshoe curve or Guttman effect evident in the column plot (see Baxter, 1994, pp. 119–120). The earliest sites tend to be located in the upper left corner of plot A, with increasingly younger sites towards the bottom along the second dimension. Although fewer in number, the sites from the later parts of the Mesolithic are drawn out along the first dimension of the plot, and are not as impacted by the second dimension as the more numerous older sites.

The column plot (Figure 2B) reveals that the earliest sites are characterised by the flint artefact categories microburins, projectiles, as well as flint macro tools and associated debitage. It is also interesting that these sites to a larger extent are characterised by core fragments, both in flint and non-flint materials, rather than the cores themselves. The non-flint material on the earliest, or among the earliest sites, appears to be centred around the production of projectiles, as both the projectiles themselves and non-flint blades are important constituents of the assemblages at these sites. Site number 9, Nedre Hobekk 2, located in the upper right quadrant of the row plot represents a somewhat curious case in that its assemblage is dominated by axe production in metarhyolite (Eigeland, 2014). However, as the site had been quite heavily impacted by modern disturbances, this led Eigeland (2014, p. 124) to suggest that the material might have been compromised. This could explain its position as an outlier in the plot. The use of metarhyolite for the production of axes is present at other contemporary sites as well, but is evidently not as prominent a part of these assemblages (Jakslund and Fossum, 2014). In sum, the findings for the earliest sites are in large part in line with previous research (e.g Bjerck, 2017; Breivik et al., 2018; Damlien and Solheim, 2018; Fuglestvedt, 2007; Jakslund and Fossum, 2014).

290 The first dimension, which is pulling some of the later sites towards the right of the plot, is mainly defined
291 by macro tools and associateddebitage in non-flint materials that are negatively correlated with more flint
292 dominated assemblages. Sites with high values on the first dimensions are later Mesolithic sites associated
293 with axe production in non-flint materials, but the later sites occur along the entire dimension, indicating
294 that while these axe production sites are a feature of the later Mesolithic, there is marked variation among
295 the sites. Although the sample size is quite strained and the discussion of finer chronological points might
296 not be warranted, the first dimension does appear to be of less importance for the absolute latest sites,
297 as indicated by their location to the left of the plot. This could indicate that specialised axe production
298 sites disappear towards the end of the Mesolithic, a notion that would be in line with previous research (e.g.
299 Eigeland, 2015, p. 370; Glørstad, 2011; Reitan, 2016).

300 As most of the variation in the data is accounted for by the dominating non-flint material in later assemblages,
301 this suppresses and makes it difficult to discern patterns in the flint data. A second CA was therefore run
302 excluding the non-flint material (Figure 3). While not as substantial, there is clear temporal patterning in
303 the flint data as well. This is most marked for the very earliest sites which are pulled away from the main
304 cluster, as projectiles, microburins, macro tools, debitage from their production, and flakes characterises these
305 sites. Slightly younger sites appear more impacted by core fragments and blades. The temporal transition
306 in the main cluster is not as marked, but clearly present, and is driven by a larger proportion of blades,
307 flakes and small tools in the earliest assemblages of the cluster, which is opposed to chips, fragments and
308 partly micro-blades. Apart from the impact of core fragments, which is not always highlighted, this must be
309 considered very much in agreement with previous research (e.g. Solheim, 2017b, with references). A marked
310 presence of core fragments has, however, previously been noted as one of several similarities between Early
311 Mesolithic Norwegian sites and Late Palaeolithic sites from continental Europe (Fuglestvedt, 2007; see also
312 Bjerck, 2017). Overall, the comparatively limited impact of the flint material can possibly be the result of the
313 aggregation of categories that leads to an suppression of otherwise temporally distinct patterns, and there
314 are certainly technological nuances in the flint material that is temporally contingent but not recorded during
315 a regular classification of the material (e.g. Damlien, 2016; Eigeland, 2015; Fuglestvedt, 2007; Solheim et
316 al., 2020). However, while the former pertains to the analytical trade-off between robustness and sensitivity,
317 the latter is likely to be true for the non-flint material as well (Eigeland, 2007). The overall pattern does
318 speak to the impact the properties of the raw-material has for the general composition of the assemblages (cf.
319 Manninen and Knutsson, 2014).

320 Moving on to the PCA of measures that have been linked to mobility, some of the variables with severely
321 skewed distributions were initially transformed. These are displayed in the correlation matrix in Figure 4.
322 Figure 5 displays the resulting PCA. There is a general temporal transition from older to younger sites from
323 the upper left to the bottom right of the plot. The second dimension is mainly defined by a negative correlation
324 between the VDL and RFSL (Figure 6). Almost orthogonal to this is the strong negative correlation between
325 relative frequency of chips and blanks. While there is a slight tendency for blanks to be more associated with
326 younger sites, frequency of chips appears to be largely independent of time. However, the almost suspiciously
327 strong negative correlation between chips and blanks can perhaps have a practical explanation. Seeing as
328 the frequency of non-flint material is positively correlated with blanks and negatively correlated with chips
329 (Figure 4), one explanation to this pattern could be that smaller non-flint pieces are simply more difficult
330 to identify and separate from naturally fragmented stone during excavation and classification. This could
331 conceivably have led to an over-representation of blanks as compared to chips in assemblages with a high
332 proportion of non-flint material. While this is not necessarily the entire explanation behind the relationship,
333 this does make it difficult to place much analytical weight on this pattern. Relative frequency of cores is not
334 especially impactful in the PCA, and appears to be independent the temporal dimension as well. That is not
335 to say that cores may not be indicative or related to mobility patterns, but to get at this may require further
336 analysis beyond their simple classification as cores (Kitchel et al., 2021).

337 Thus, while some secondary expectations of the WABI does not seem to apply to the present material, it is
338 difficult to say to what degree this is caused by idiosyncrasies in the Norwegian system for classification of
339 lithics and properties of the lithic material itself. The relationship between VDL and RFSL does correspond
340 to the model and follows a clear temporal trend that is also correlated with the increased use of local raw
341 material. Thus, if the relationship between VDL and RFSL is accepted as a proxy for curation, and is related

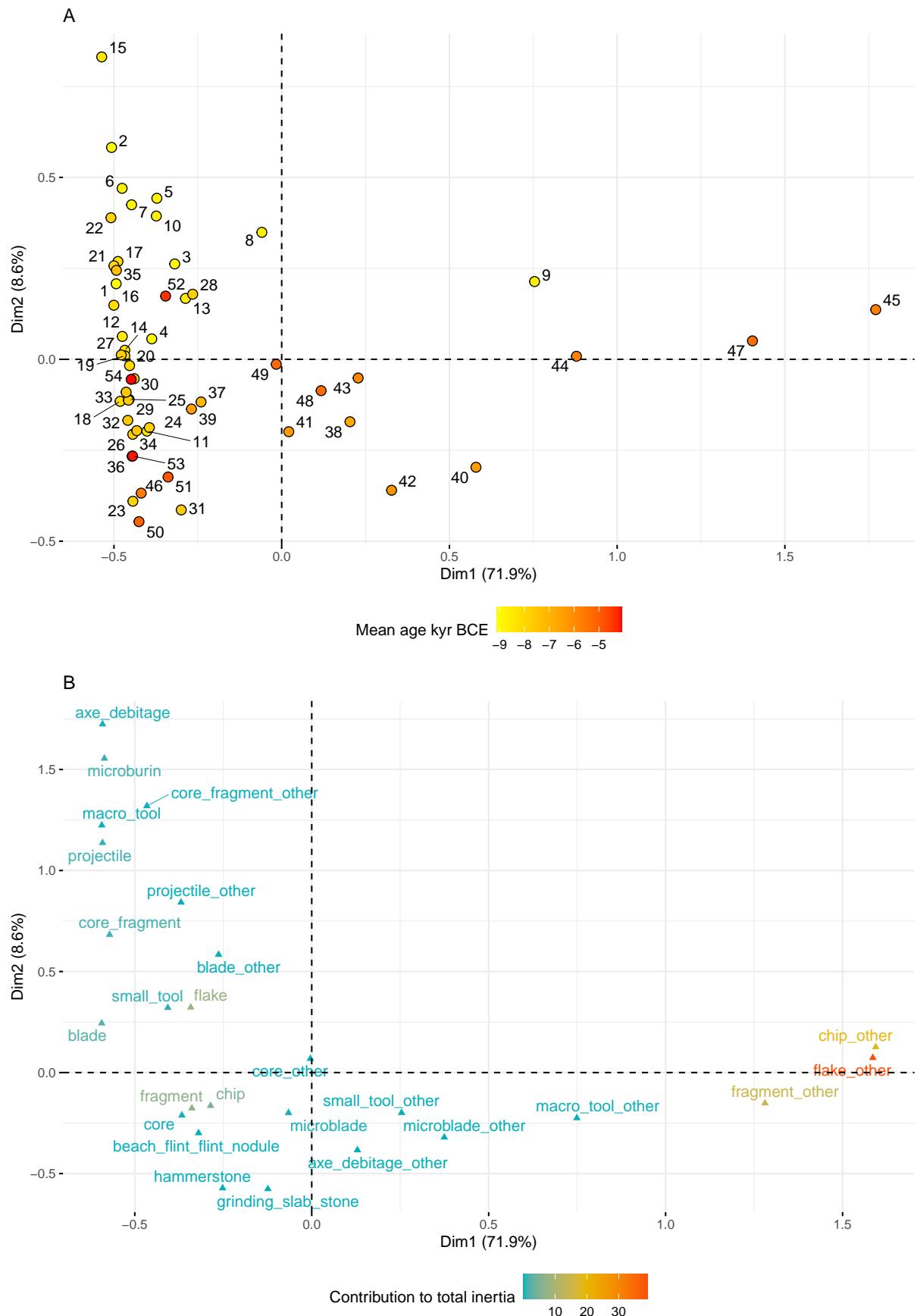


Figure 2: Correspondence analysis using the artefact count data. A) Row plot, B) Column plot.

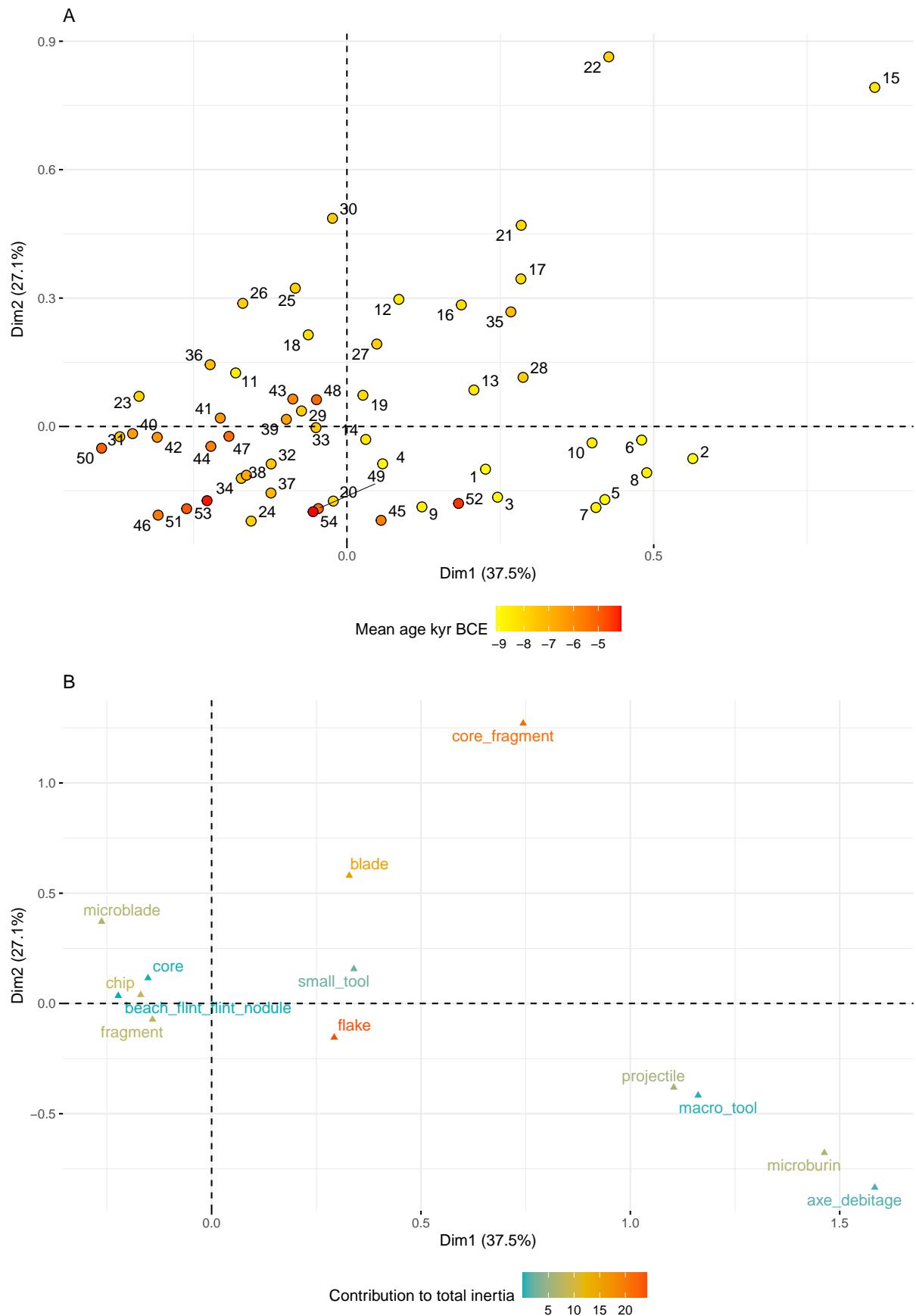


Figure 3: Correspondence analysis using the flint data. A) Row plot, B) Column plot.

342 to land-use and mobility patterns, these findings would be in line with previous research into the Mesolithic of
 343 Norway, indicating that earlier sites are associated with higher degree of mobility than sites from later phases
 344 (e.g. Bergsvik, 2001; Bjerck, 2008; Glørstad, 2010; Jakslund, 2001). To explore this proposition further, these
 345 two variables are subjected to more detailed scrutiny below.

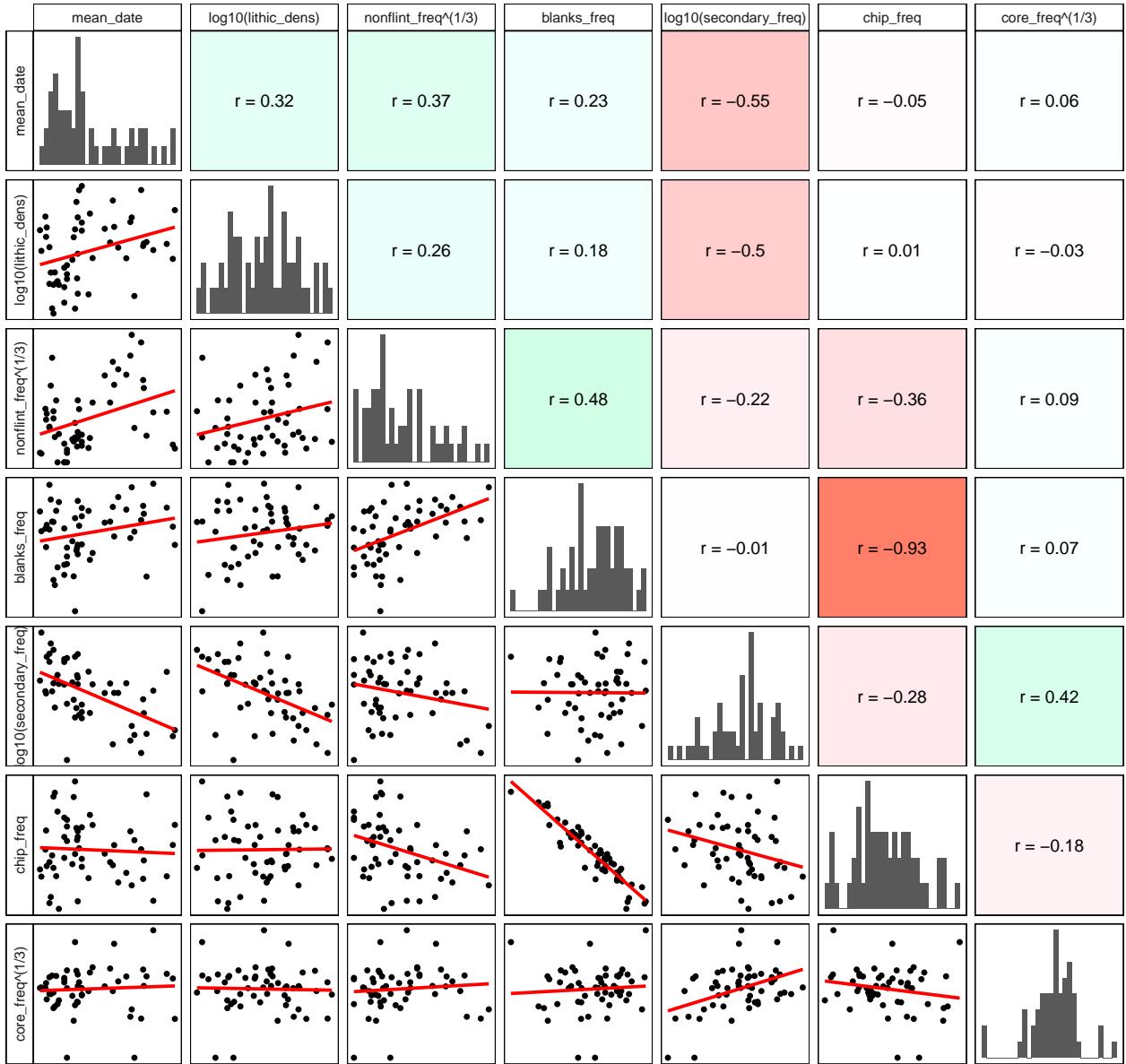


Figure 4: Correlation matrix showing transformation of skewed variables for the PCA. The mean age of the sites has also been included to visualise overall temporal trends. Cells below the diagonal display the bivariate distributions with a fitted OLS-regression. The cells above the diagonal display and are coloured by the corresponding Pearson's correlation coefficient.

346 Figure 7A illustrates the negative correlation between the two variables ($r = -0.5$) while also displaying a
 347 general tendency for younger sites to be associated with a higher volumetric density of lithics and a lower
 348 relative frequency of secondarily worked lithics than older sites. The linear correlation is stronger between the
 349 mean site age and RFSL ($r = -0.51$), than between mean site age and VDL ($r = 0.22$). As variable non-flint
 350 availability and workability has also been suggested to potentially impact these dimensions (Manninen and
 351 Knutsson, 2014), Figure 7B displays the same relationship, but exclusively for the flint data. While the

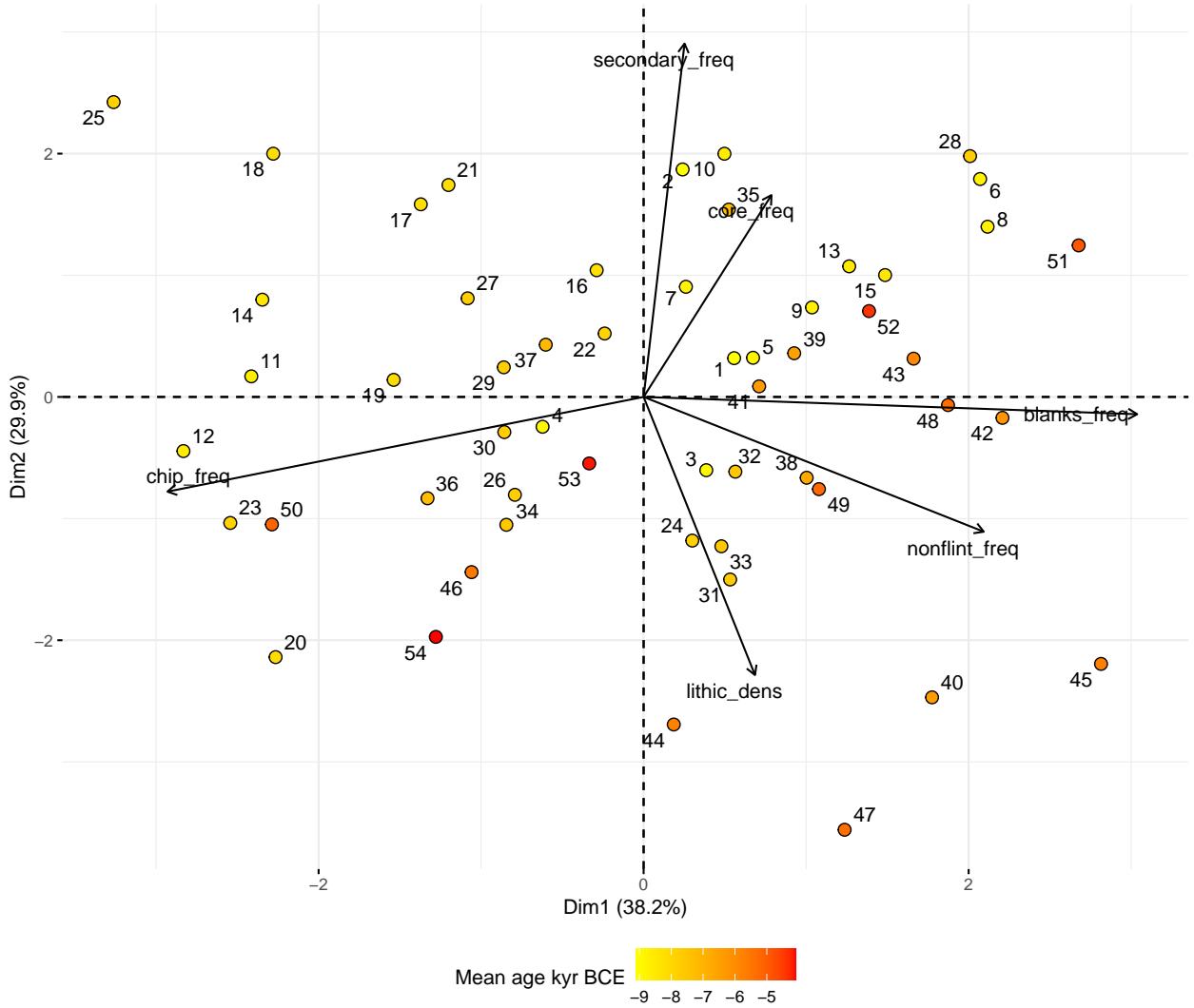


Figure 5: PCA using variables that have been related to mobility patterns. Note that details on the transformation of the variables has been left out of the plot for clarity, but follow those given in Figure 4.

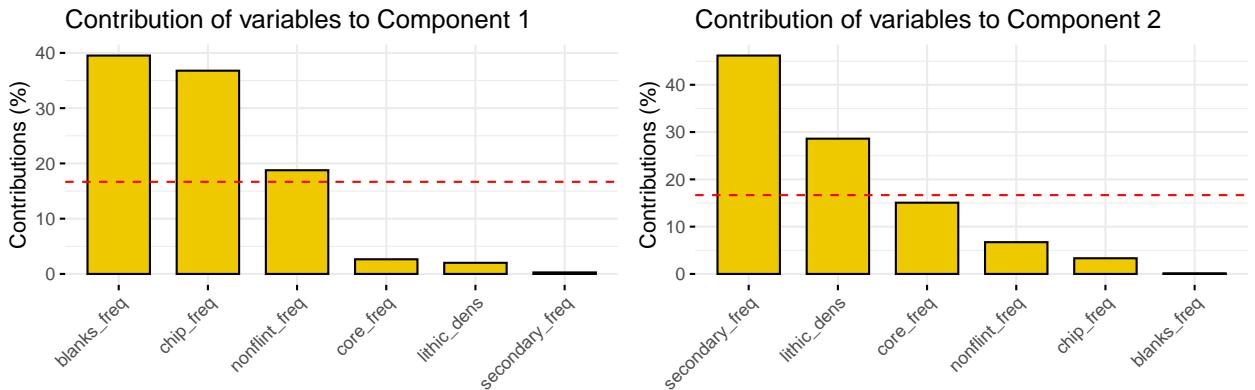


Figure 6: Contribution of variables to the components of the PCA. The dotted red line indicates the expected contribution from each variable given a uniform distribution of impact.

negative correlation is slightly less marked when only the flint data is considered ($r = -0.4$), the general pattern is the same. The relationship between mean site age and relative frequency of secondarily worked flint is even stronger ($r = -0.57$), but as indicated by the more spread out distribution along the x-axis, the volumetric density of flint is not temporally contingent ($r = 0.1$). As was also indicated by the CA, this follows from the fact that non-flint materials make up a higher share of the assemblages for some of the later Mesolithic sites, and is a point returned to below where the temporal dimension of the relationship between VDL and RFSL is explored further.

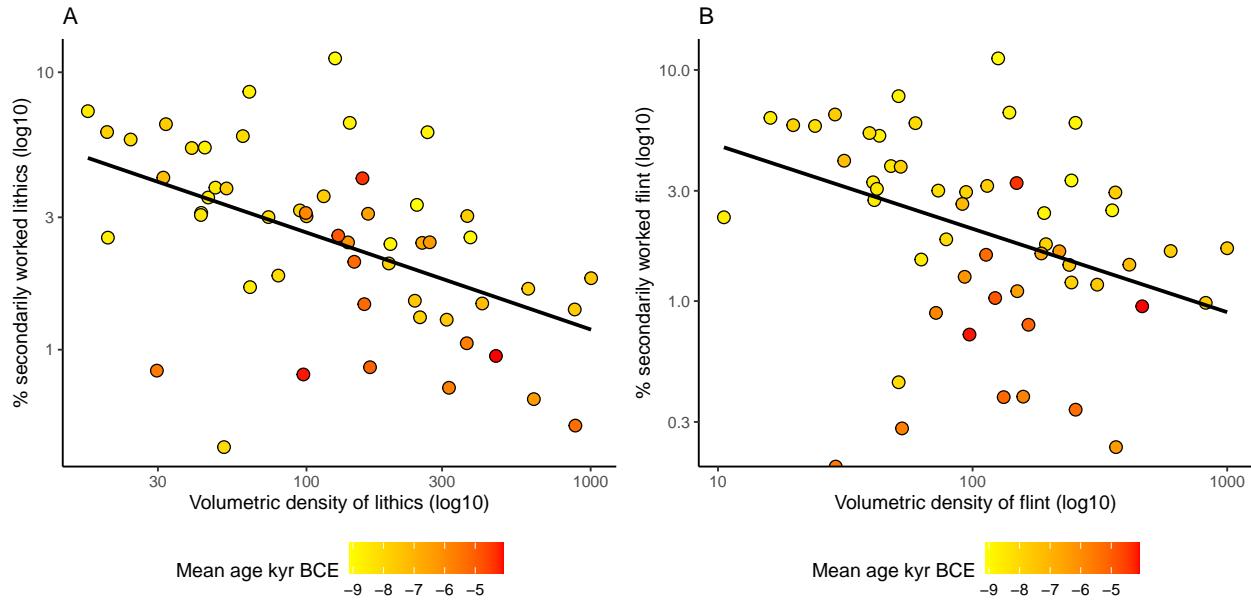


Figure 7: Relative frequency of secondarily worked lithics plotted against the volumetric density of artefacts (artefact count / excavated m³) for A) All lithics, B) Flint. The logarithm is taken to base 10 on all axes.

To get more directly at this temporal trend, a curation index based on VDL and RFSL was devised by first performing a min-max normalisation of the two variables, scaling them to take on values between 0 and 1. The values for artefact density was then made negative to reflect its relationship with degree of curation. The mean was then found for each site on these two normalised values. To account for the temporal uncertainty associated with the dating of the sites, a simulation-based approach was also adopted (e.g. Baxter and Cool, 2016; Crema, 2012; Orton et al., 2017). A LOESS curve was fit to the curation index and site age for each simulation run, where the age of each site was drawn as a single year from the date ranges associated with the sites as provided in Figure 1. For sites with radiocarbon age determinations the dates were drawn from the associated summed posterior density estimates, while ages for sites dated with reference to relative sea-level change and typology were drawn uniformly from the associated date range. This simulation was repeated 1000 times, the results of which is visualised in Figure 8A. Disregarding the edge-effects at either end of the plot, the general tendency is a relatively high degree of curation among the earlier sites, followed by a marked drop around 8000 BCE. This has stabilised by around 7000 BCE and remains stable without any major fluctuations for the rest of the Mesolithic. The variation in degree of curation is also markedly higher after 8000 BCE, potentially reflecting variation in associated mobility patterns. Figure 8B displays the result of running the same procedure on the flint data. The general pattern follows the same trajectory, but the result for some individual sites is markedly different. This is discussed below.

5 Discussion

The results of the CA does appear to align well with previous research, and the employed artefact categories are clearly capturing a temporal component. One possible implication of this close correspondence could be

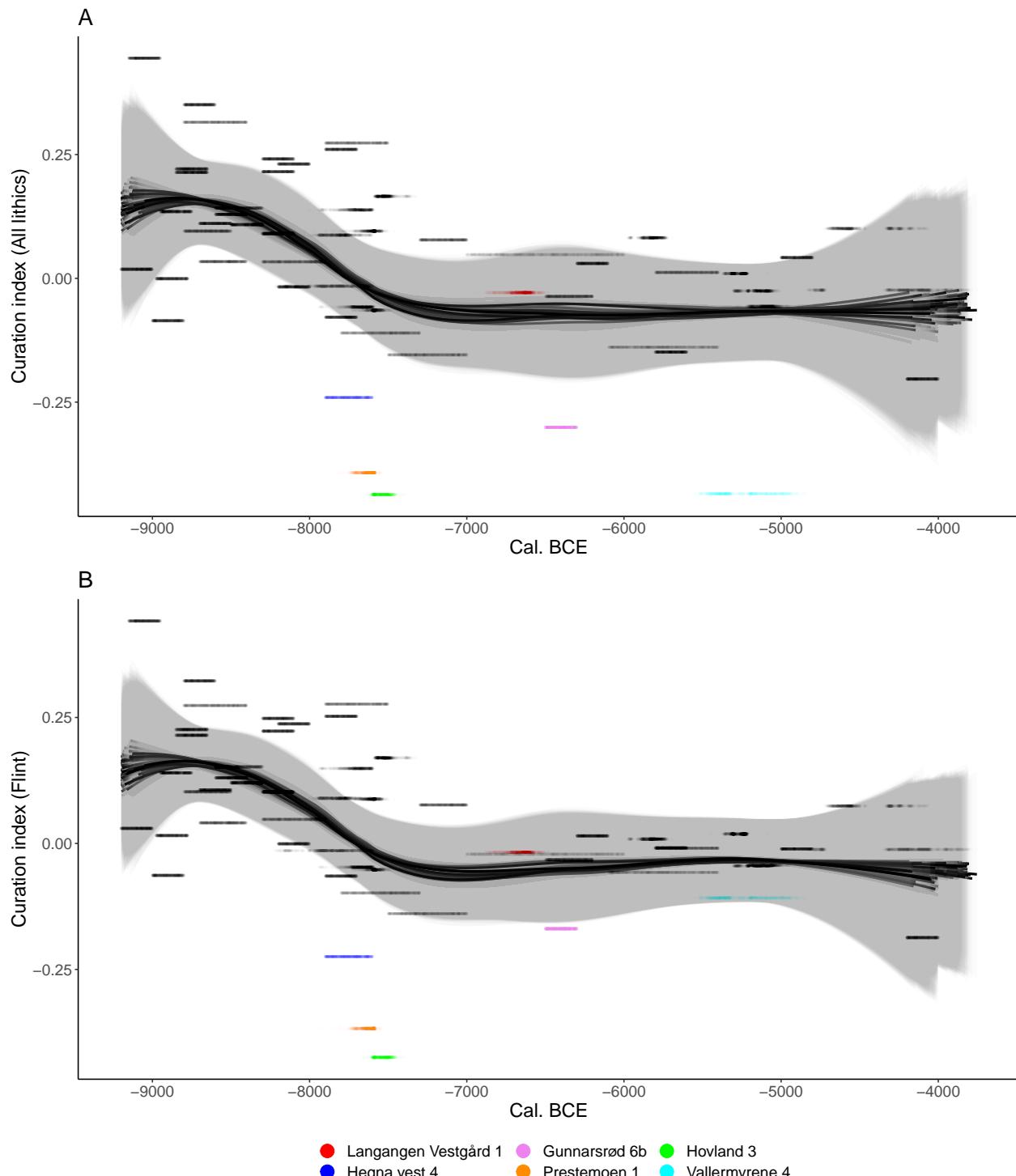


Figure 8: Temporal variation in the curation index for A) All lithics, and B) Flint. The temporal uncertainty is handled by means of a simulation approach where the site ages are drawn from their respective age determination probability density functions given in Figure 1B. A LOESS curve has been fit to the distribution for each of the 1000 simulation runs. Each simulation run is plotted with some transparency. Sites mentioned in the text are given colour.

379 that the aggregation of artefact categories might have been overly conservative. However, it is also evidently
380 clear, in the words of Kruskal (1971, p. 22), that ‘time is not the only dimension.’ The results of the CA do
381 most certainly correspond to more pervasive cultural change than a purely typo-chronological development of
382 artefact morphology, which is also made evident by some of significant deviances from the overall pattern.
383 Unpicking and aligning these patterns with any specific behavioural and technological dimensions using the
384 coarse CA results is, however, another task entirely. This follows most clearly from the fact that for the
385 most part we do not know what individual lithic objects in the assemblages has been used for, leaving the
386 behavioural and social significance of the employed units of analysis unclear. The results of the CA can,
387 however, be used in conjunction with the part of the analysis that has attempted to get at more specific
388 behavioural dimensions to nuance or explain discrepancies in this data.

389 The relevance of the relationship between frequency of secondarily worked lithics and volumetric density of
390 lithics was here identified by means of an exploratory approach, and is in part investigated further because
391 they align with suggestions from previous research — clearly representing a possible case of both confirmation
392 bias and circular reasoning. However, some inferential merit can be achieved by invoking what has been
393 termed consilience. Consilience involves “the interlocking or coherence of causal explanations across multiple
394 problem domains” through a clear operationalisation of explanatory terms and concepts (Clark, 2009, p.
395 30). Thus, the overlap in results presented here and those repeatedly reported from a range of different
396 context does speak to the general applicability and comparability offered by the measures, and gives an initial
397 indication that they might be capturing the social dimensions of interest also in a Norwegian Mesolithic
398 setting.

399 The curation index has relatively high values until some time before 8000 BCE, before it drops and stabilises
400 around 7000 BCE for the rest of the Mesolithic. This pattern is evident in both the flint data and when all
401 lithics are treated in aggregate. Furthermore, the variation in degree of curation in Figure 8A could indicate
402 that the sites were associated with a more varied mobility pattern after around 8000 BCE. The five sites that
403 have values on the curation index below c. -0.25 could in this perspective have predominantly functioned as
404 base camps within a logistic settlement pattern (*sensu* Binford, 1980). That these assemblages reflect stays
405 of a longer duration was suggested for all five sites in the original reports (Carrasco et al., 2014; Eigeland
406 and Fossum, 2017; Persson, 2014; Solheim and Olsen, 2013), with the exception of for Vallermyrene 4, which
407 was argued to be a specialised axe production site, not necessarily associated with lower degrees of mobility
408 (Eigeland and Fossum, 2014). This highlights a possible issue pertaining to raw-material variability, as the
409 coarse non-flint material used for the production of axes generally results in a relatively large amount of
410 waste per produced tool, possibly skewing the curation index when compared to assemblages dominated by
411 flint. Referring back to the CA, the difference is most marked for the sites in the later part of the Mesolithic
412 where non-flint material become more dominating parts of the assemblages. As can be seen in Figure 8B,
413 the degree of curation is markedly higher for both Gunnarsrød 6b and Vallermyrene 4 when the non-flint
414 material is excluded, although they remain more expedient than that of contemporary assemblages. Thus, the
415 degree of expediency for assemblages dominated by non-flint materials might be somewhat exaggerated when
416 the non-flint material is included, while its exclusion would likely lead to its underestimation. One possible
417 approach could be to weigh the curation index by proportion of non-flint material in the assemblages. This
418 is not explored further here, however, as the overall tendencies are relatively robust to this effect. Another
419 case also worth commenting on is Langangen Vestgård 1, which, on the grounds of an overall large number
420 of artefacts and the possible presence of a dwelling structure was argued to reflect a more permanent site
421 location in the original report (Melvold and Eigeland, 2014). However, the relatively high value on the
422 curation index could mean that Langangen Vestgård 1 reflects the aggregation of stays which predominantly
423 have been of a comparable duration to those on contemporary sites, while the possible dwelling structure, if
424 taken as an indication of longer stays, could in this perspective represent a remnant from one or a few visits
425 of longer duration that constitute a smaller fraction of the use-life of the site as a whole (cf. Barton and
426 Riel-Salvatore, 2014).

427 While there are certainly nuances in the material that might lead one to question the applicability of the VDL
428 and RFSL measures for any individual site, the overall pattern for curation does appear relatively robust. It
429 seems clear that there is a marked drop starting some time just before 8000 BCE, which has stabilised around
430 7000 BCE. This corresponds well with a chronological framework where the Early Mesolithic, or Flake axe

431 phase, is defined as lasting from c. 9200–8200 BCE (Reitan, 2016). The beginning of the phase is set to start
432 with the first human occupation in Norway, which is widely held as originating from South-Scandinavian
433 and North-European regions, and which is to be directly reflected by similarities in the artefact inventories
434 (Bang-Andersen, 2012; Bjerck, 2008; Fuglestvedt, 2012; Glørstad, 2016). Previous research has proposed that
435 the Early Mesolithic is characterised by a relatively high degree of mobility, and low variation in site types
436 and associated mobility patterns (e.g. Bjerck, 2008; Breivik and Callanan, 2016; Fuglestvedt, 2012). This
437 corresponds very well with the findings reported here, where the earliest assemblages are characterised by
438 relatively high and uniform values on the curation index. The transition to the subsequent Middle Mesolithic,
439 or Microlith phase, at around 8200 BCE has been linked to changes in blade (Damlien, 2016) and subsequently
440 axe technology (Eymundsson et al., 2018; Solheim et al., 2020), which in turn has been associated with
441 changes in population genomics and related migration events hailing from the Eurasian Steppes (Günther et
442 al., 2018; Manninen et al., 2021). The radiocarbon record points towards a coinciding population decline
443 in southern Norway around this time (Nielsen, 2021). Although this does not appear to be evident in the
444 regional data for south-eastern Norway, taphonomic loss associated with these early dates is an issue (Nielsen,
445 2021; Solheim, 2020; Solheim and Persson, 2018). In the chronological framework of Reitan (2016), the
446 Microlith phase is defined as lasting until around 7000 BCE. Referring back to the increasing expediency in
447 the curation data between c. 8200 and 7000 BCE, the Microlith phase could thus represent a transitional
448 period where migrating people and new living practices were propagating through societies in south-eastern
449 Norway — a process that in light of the curation data would have concluded around 7000 BCE.

450 The Microlith phase is followed by the Pecked adze phase, characterised by a more dominating presence of
451 non-flint macro tools and associated production waste in the assemblages (Reitan, 2016). As is evident from
452 both the CA and the curation data, if we disregard Nedre Hobekk 2, the earliest of the assemblages treated
453 here with this kind of compositional profile is site 40, Gunnarsrød 6b, dated to c. 6500–6300 BCE (Carrasco et
454 al., 2014). The curation data remains stable from around 7000 BCE through the next typological transition at
455 c. 5600 BCE, which, following Reitan (2016), signifies the onset of the Nøstvet adze phase. While previously
456 defined as having a slightly longer duration, the Nøstvet phase has traditionally been seen as representing the
457 onset of more varied settlement systems and stable mobility patterns in south-eastern Norway (e.g. Jakslund,
458 2001; Lindblom, 1984), and has been explicitly linked to an expedient technological organisation (Glørstad,
459 2011; 2010, p. 161) — albeit with the term being somewhat vaguely invoked (Eigeland, 2015, pp. 127–130).
460 In recent years it has been suggested that the transition to a decrease in mobility and more varied land-use
461 patterns can be traced back to the Middle Mesolithic (Solheim and Persson, 2016). The curation index
462 employed here clearly supports this notion, and suggests that the mobility patterns of the Nøstvet phase
463 were well established in preceding periods.

464 The subsequent Transverse arrowhead phase (c. 4500–3900 BCE) is characterised by a dramatic decrease in
465 axe finds, and the introduction of transverse-, tanged- and single-edged points (Reitan, 2016). It has recently
466 been suggested that a dispersal of people from southern Scandinavia into southern Norway takes place in this
467 period (Eigeland, 2015, p. 379; Nielsen, 2021), which could follow after a preceding population decline at
468 c. 4300 BCE (Nielsen, 2021). The continued stability of the curation index could indicate that these changes
469 are not related to major shifts in land-use and mobility patterns in the material treated here. However, it
470 is also worth highlighting the strained sample size for the later parts of the Mesolithic, which could mean
471 that the effect is simply missed, especially if the signal is weaker than that for the transition from the Early
472 Mesolithic.

473 As it stands, the main hypotheses resulting from the present analysis would be that settlement patterns in
474 the earliest parts of the Mesolithic were characterised by relatively high and uniform degrees of mobility,
475 which then drop before levelling off at around 7000 BCE. These then remain relatively stable throughout the
476 rest of the period, despite variation pertaining to other aspects of the lithic inventories, as evidenced by the
477 CA. Although the precise nature of this transition would require further consideration, the quite dramatic
478 fall in curation levels and parallel increase in variation would seem to correlate well with a transition from a
479 predominantly residential to logistical settlement system (Barton et al., 2011; Binford, 1980).

480 6 Conclusion

481 The results of the CA align fairly well with results of previous research in south-eastern Norway. This
482 would indicate that in general, meaningful chronological patterning is associated with the employed artefact
483 categories. These tendencies are already well-established when it comes to the formal tool types and some
484 debitage categories, but have been given less focus in light of entire assemblages. Precisely what behavioural
485 implication the development in the occurrences of the tool and debitage categories have are less clear, but
486 appears to follow a different and more complex development over time than that of curation, as operationalised
487 here.

488 The temporal trends associated with the curation index corresponds surprisingly well with trajectories of
489 cultural development previously suggested in the literature, and does therefore, in my view, suggest that
490 shifts in land-use and mobility patterns are the main drivers behind this empirical pattern — in line with
491 the framework of Barton et al. (2011). Another perspective would be that this is not surprising at all (cf.
492 Kuhn and Clark, 2015, p. 14), and that the previously demonstrated relevance of these measures across
493 a wide range of contexts points to their pervasive relevance for the organisation of lithic technology, and,
494 therefore, that there should be little reason to think Mesolithic south-eastern Norway should be any different.
495 However, the conclusion that these these measures apply to and appear to capture the dimensions of interest
496 in a controlled empirical setting, reached by means of an exploratory analysis can only constitute a first
497 analytical step. As Elster (2015, p. 12) has pointed out, the human mind seems to have a propensity to settle
498 for an explanation that *can* be true, as soon as this has been reached. This, however, can only constitute the
499 absolute minimum of what is required of a proposed explanation. Subsequent steps should be to probe and
500 challenge this explanatory framework, also in light of alternative hypotheses. The empirical relationship does
501 nonetheless hold great potential for large scale comparative studies in Mesolithic Scandinavia and beyond.
502 Furthermore, the temporal trends associated with the curation index was here simply narratively associated
503 with the most immediate chronological trends emphasised in the literature concerned with the Mesolithic
504 of south-eastern Norway. The explicit quantification does, however, offer the possibility to conduct formal
505 comparisons with a wide range of environmental, demographic and cultural dimensions across multiple scales
506 of analysis.

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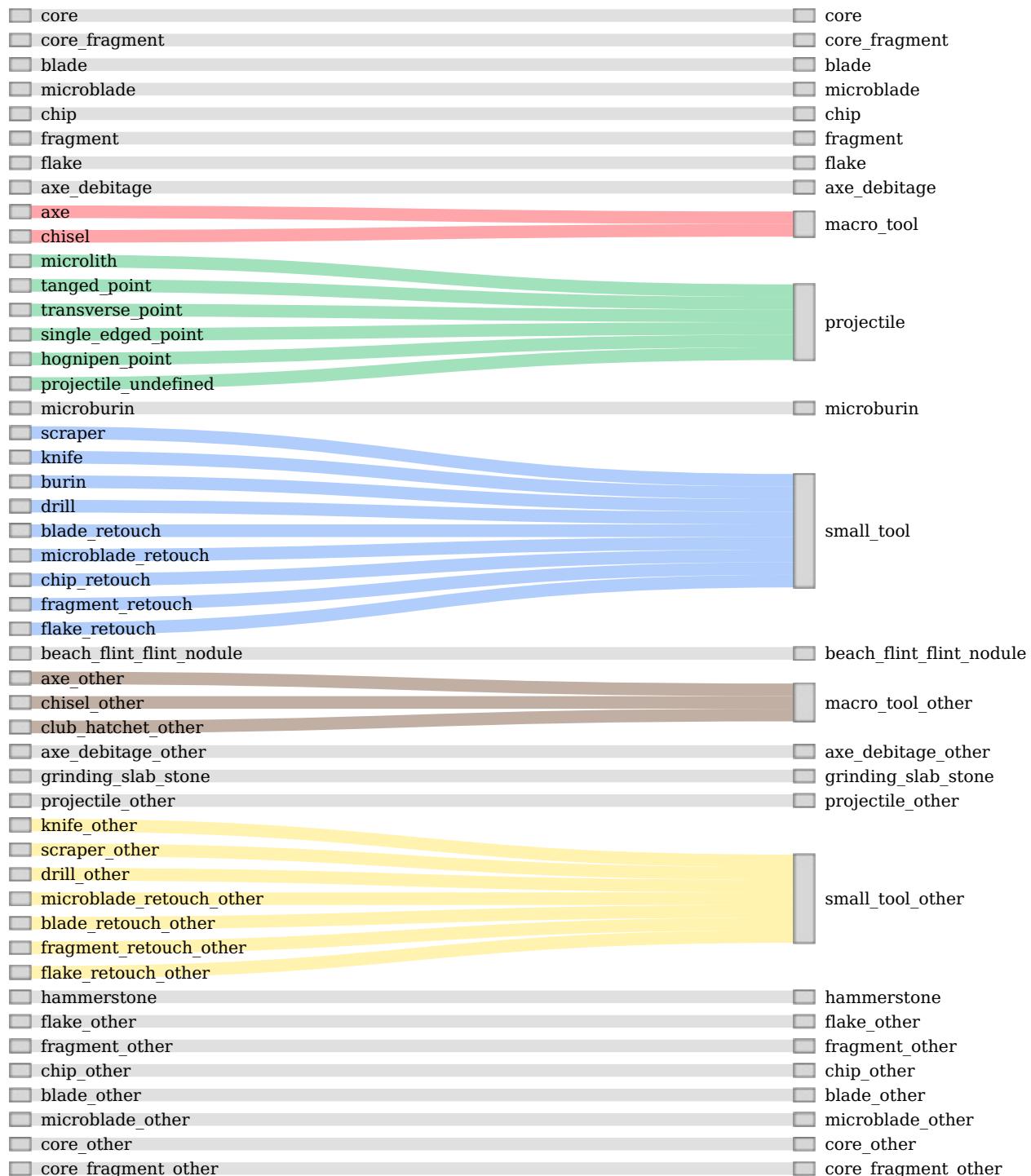
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780 8 Supplementary material A. Radiocarbon dates.

Site name	Material	Lab code	C14-age	Error
Hovland 5	Hazel (<i>Corylus</i>), nutshell	Ua-45490	8775	52
Hovland 4	Burnt bone	Ua-45500	8747	64
Hovland 4	Hazel (<i>Corylus</i>), nutshell	Ua-45499	8630	49
Hovland 4	Birch (<i>Betula</i>)	Ua-45493	8568	51
Hovland 4	Birch (<i>Betula</i>)	Ua-45494	8526	52
Hovland 1	Hazel (<i>Corylus</i>)	TRa-3410	8465	55
Hovland 1	Aspen/willow (<i>Populus/Salix</i>)	Ua-45675	8623	50
Hovland 1	Birch (<i>Betula</i>), resin	AAR-16884	8582	33
Hovland 3	Birch (<i>Betula</i>)	Ua-45507	8609	54
Hovland 3	Hazel (<i>Corylus</i>), nutshell	Ua-45515	8606	50
Hovland 3	Birch (<i>Betula</i>)	Ua-45509	8594	48
Hovland 3	Rowan (<i>Sorbus</i>)	Ua-45508	8591	50
Hovland 3	Birch (<i>Betula</i>)	Ua-45504	8584	49
Hovland 3	Rowan (<i>Sorbus</i>)	Ua-45514	8552	50
Hovland 3	Hazel (<i>Corylus</i>), nutshell	Ua-45517	8540	51
Hovland 3	Rowan (<i>Sorbus</i>)	Ua-45505	8467	53
Hovland 3	Birch (<i>Betula</i>)	Ua-45511	8465	48
Hovland 3	Rowan (<i>Sorbus</i>)	Ua-45506	8458	48
Hovland 3	Hazel (<i>Corylus</i>), nutshell	Beta-325802	8450	40
Hovland 3	Hazel (<i>Corylus</i>), nutshell	Ua-45516	8428	50
Hovland 3	Hazel (<i>Corylus</i>), nutshell	Ua-45522	8398	49
Hovland 3	Hazel (<i>Corylus</i>), nutshell	Ua-45520	8387	47
Hovland 3	Hazel (<i>Corylus</i>), nutshell	Ua-45519	8383	47
Hovland 3	Birch (<i>Betula</i>)	Ua-45503	8376	51
Hovland 3	Birch (<i>Betula</i>)	Ua-45512	8348	47
Hovland 3	Hazel (<i>Corylus</i>), nutshell	Ua-45518	8291	48
Torstvet	Hazel (<i>Corylus</i>), nutshell	TRa-3406	8460	55
Torstvet	Hazel (<i>Corylus</i>), nutshell	TRa-3407	8425	55
Prestemoen 1	Hazel (<i>Corylus</i>), nutshell	Ua-45176	8671	45
Prestemoen 1	Burnt bone	Ua-45177	8620	45
Prestemoen 1	Hazel (<i>Corylus</i>), nutshell	Ua-45178	8593	46
Langangen Vestgård 1	Burnt bone	TRa-1994	7785	40
Langangen Vestgård 1	Burnt bone	TRa-1995	7760	40
Langangen Vestgård 1	Pine (<i>Pinus</i>)	TRa-2243	7780	70
Langangen Vestgård 1	Birch/rowan (<i>Betula/Sorbus</i>)	TRa-4114	7870	45
Langangen Vestgård 1	Hazel (<i>Corylus</i>)	TRa-4115	7740	45
Langangen Vestgård 1	Hazel (<i>Corylus</i>)	TRa-4116	7800	45
Langangen Vestgård 1	Pine (<i>Pinus</i>)	TRa-4117	8030	55
Langangen Vestgård 1	Willow (<i>Salix</i>)	TRa-4118	8005	45
Langangen Vestgård 1	Birch/hazel (<i>Betula/Corylus</i>)	TRa-4119	7850	45
Langangen Vestgård 1	Hazel (<i>Corylus</i>)	TRa-4120	7875	45
Langangen Vestgård 1	Birch/willow (<i>Betula/Salix</i>)	TRa-4121	7945	45
Langangen Vestgård 1	Burnt bone	TRa-4122	7795	40
Langangen Vestgård 1	Burnt bone	TRa-4123	7745	35
Vallermyrene 4	Burnt bone	Ua-45169	6489	50
Vallermyrene 4	Burnt bone	Ua-45170	6381	37
Vallermyrene 4	Pine (<i>Pinus</i>)	Ua-45172	6197	40
Vallermyrene 4	Pine (<i>Pinus</i>)	Ua-45171	6067	41
Vallermyrene 1	Pine (<i>Pinus</i>)	Ua-45182	5770	35
Vallermyrene 1	Pine (<i>Pinus</i>)	Ua-45181	5748	35

Vallermyrene 1	Birch (Betula)	Ua-45180	5373	34
Langangen Vestgård 3	Pine (Pinus)	TRa-2246	5400	55
Langangen Vestgård 3	Pine (Pinus)	TRa-2247	5325	50
Langangen Vestgård 3	Pine (Pinus)	TRa-2248	5910	10
Langangen Vestgård 3	Pine (Pinus)	TRa-4126	5095	40
Langangen Vestgård 3	Birch (Betula)	TRa-2249	5325	45
Langangen Vestgård 3	Birch (Betula)	TRa-2250	5325	50
Gunnarsrød 4	Birch (Betula)	UBA-19159	6941	36
Hegna vest 2	Pine (Pinus)	Ua-50497	8708	38
Hegna vest 1	Aspen/willow (Populus/Salix)	Ua-50485	8788	34
Hegna vest 1	Willow (Salix)	Ua-51462	8732	40
Hegna vest 3	Aspen/willow (Populus/Salix)	Ua-51471	8679	39
Stokke/Polland 8	Birch (Betula)	Ua-51840	6215	35
Hegna øst 2	Pine (Pinus)	Ua-50501	6318	26
Stokke/Polland 5	Pomoideae (Malinae)	Ua-48257	6098	40
Stokke/Polland 5	Hazel (Corylus)	Ua-48258	6177	42
Stokke/Polland 5	Alder (Alnus)	Ua-50501	6196	40

781 9 Supplementary material B. Aggregation of variables for the cor-
 782 respondence analysis.



783

784 **9.0.1 Colophon**

785 This report was generated on 2021-07-08 10:43:01 using the following computational environment and
786 dependencies:

```
787 #> - Session info -----
788 #>   setting  value
789 #>   version R version 4.1.0 (2021-05-18)
790 #>   os        Linux Mint 19.3
791 #>   system   x86_64, linux-gnu
792 #>   ui        X11
793 #>   language en_US
794 #>   collate  en_US.UTF-8
795 #>   ctype    en_US.UTF-8
796 #>   tz       Europe/Oslo
797 #>   date     2021-07-08
798 #>
799 #> - Packages -----
800 #>   package      * version date      lib source
801 #>   abind         1.4-5   2016-07-21 [1] CRAN (R 4.1.0)
802 #>   assertthat     0.2.1   2019-03-21 [1] CRAN (R 4.1.0)
803 #>   backports      1.2.1   2020-12-09 [1] CRAN (R 4.1.0)
804 #>   bitops         1.0-7   2021-04-24 [1] CRAN (R 4.1.0)
805 #>   bookdown       0.22    2021-04-22 [1] CRAN (R 4.1.0)
806 #>   broom          0.7.6   2021-04-05 [1] CRAN (R 4.1.0)
807 #>   cachem         1.0.5   2021-05-15 [1] CRAN (R 4.1.0)
808 #>   callr          3.7.0   2021-04-20 [1] CRAN (R 4.1.0)
809 #>   car             3.0-10  2020-09-29 [1] CRAN (R 4.1.0)
810 #>   carData        3.0-4   2020-05-22 [1] CRAN (R 4.1.0)
811 #>   cellranger     1.1.0   2016-07-27 [1] CRAN (R 4.1.0)
812 #>   checkmate       2.0.0   2020-02-06 [1] CRAN (R 4.1.0)
813 #>   class           7.3-19  2021-05-03 [4] CRAN (R 4.0.5)
814 #>   classInt        0.4-3   2020-04-07 [1] CRAN (R 4.1.0)
815 #>   cli              2.5.0   2021-04-26 [1] CRAN (R 4.1.0)
816 #>   cluster         2.1.2   2021-04-17 [4] CRAN (R 4.0.5)
817 #>   colorspace      2.0-1   2021-05-04 [1] CRAN (R 4.1.0)
818 #>   crayon          1.4.1   2021-02-08 [1] CRAN (R 4.1.0)
819 #>   curl             4.3.1   2021-04-30 [1] CRAN (R 4.1.0)
820 #>   data.table      1.14.0  2021-02-21 [1] CRAN (R 4.1.0)
821 #>   DBI              1.1.1   2021-01-15 [1] CRAN (R 4.1.0)
822 #>   dbplyr          2.1.1   2021-04-06 [1] CRAN (R 4.1.0)
823 #>   desc             1.3.0   2021-03-05 [1] CRAN (R 4.1.0)
824 #>   devtools         2.4.2   2021-06-07 [1] CRAN (R 4.1.0)
825 #>   digest           0.6.27  2020-10-24 [1] CRAN (R 4.1.0)
826 #>   dplyr           * 1.0.6  2021-05-05 [1] CRAN (R 4.1.0)
827 #>   DT               0.18    2021-04-14 [1] CRAN (R 4.1.0)
828 #>   e1071            1.7-7   2021-05-23 [1] CRAN (R 4.1.0)
829 #>   ellipsis          0.3.2   2021-04-29 [1] CRAN (R 4.1.0)
830 #>   evaluate          0.14   2019-05-28 [1] CRAN (R 4.1.0)
831 #>   factoextra      * 1.0.7  2020-04-01 [1] CRAN (R 4.1.0)
832 #>   FactoMineR      * 2.4   2020-12-11 [1] CRAN (R 4.1.0)
833 #>   fansi             0.5.0   2021-05-25 [1] CRAN (R 4.1.0)
834 #>   farver            2.1.0   2021-02-28 [1] CRAN (R 4.1.0)
835 #>   fastmap          1.1.0   2021-01-25 [1] CRAN (R 4.1.0)
```

```

836 #> flashClust      1.01-2  2012-08-21 [1] CRAN (R 4.1.0)
837 #> forcats        * 0.5.1   2021-01-27 [1] CRAN (R 4.1.0)
838 #> foreign         0.8-81   2020-12-22 [4] CRAN (R 4.0.3)
839 #> fs              1.5.0    2020-07-31 [1] CRAN (R 4.1.0)
840 #> generics        0.1.0    2020-10-31 [1] CRAN (R 4.1.0)
841 #> GGally          * 2.1.1   2021-03-08 [1] CRAN (R 4.1.0)
842 #> ggmap           3.0.0    2019-02-05 [1] CRAN (R 4.1.0)
843 #> ggplot2         * 3.3.3   2020-12-30 [1] CRAN (R 4.1.0)
844 #> ggpubr          0.4.0    2020-06-27 [1] CRAN (R 4.1.0)
845 #> ggrepel          0.9.1    2021-01-15 [1] CRAN (R 4.1.0)
846 #> ggridges         * 0.5.3   2021-01-08 [1] CRAN (R 4.1.0)
847 #> ggsignif         0.6.1    2021-02-23 [1] CRAN (R 4.1.0)
848 #> ggsn            0.5.0    2019-02-18 [1] CRAN (R 4.1.0)
849 #> glue             1.4.2    2020-08-27 [1] CRAN (R 4.1.0)
850 #> gt              * 0.3.0   2021-05-12 [1] CRAN (R 4.1.0)
851 #> gtable           0.3.0    2019-03-25 [1] CRAN (R 4.1.0)
852 #> haven            2.4.1    2021-04-23 [1] CRAN (R 4.1.0)
853 #> here             1.0.1    2020-12-13 [1] CRAN (R 4.1.0)
854 #> highr            0.9      2021-04-16 [1] CRAN (R 4.1.0)
855 #> hms              1.1.0    2021-05-17 [1] CRAN (R 4.1.0)
856 #> htmltools         0.5.1.1  2021-01-22 [1] CRAN (R 4.1.0)
857 #> htmlwidgets       1.5.3    2020-12-10 [1] CRAN (R 4.1.0)
858 #> httr              1.4.2    2020-07-20 [1] CRAN (R 4.1.0)
859 #> igraph            1.2.6    2020-10-06 [1] CRAN (R 4.1.0)
860 #> jpeg              0.1-8.1  2019-10-24 [1] CRAN (R 4.1.0)
861 #> jsonlite          1.7.2    2020-12-09 [1] CRAN (R 4.1.0)
862 #> KernSmooth        2.23-20  2021-05-03 [4] CRAN (R 4.0.5)
863 #> knitr             1.33     2021-04-24 [1] CRAN (R 4.1.0)
864 #> labeling           0.4.2    2020-10-20 [1] CRAN (R 4.1.0)
865 #> lattice            0.20-44  2021-05-02 [4] CRAN (R 4.1.0)
866 #> leaps              3.1      2020-01-16 [1] CRAN (R 4.1.0)
867 #> lifecycle          1.0.0    2021-02-15 [1] CRAN (R 4.1.0)
868 #> lubridate          1.7.10   2021-02-26 [1] CRAN (R 4.1.0)
869 #> magrittr           2.0.1    2020-11-17 [1] CRAN (R 4.1.0)
870 #> maptools           1.1-1    2021-03-15 [1] CRAN (R 4.1.0)
871 #> MASS               7.3-54   2021-05-03 [4] CRAN (R 4.0.5)
872 #> Matrix              1.3-4    2021-06-01 [4] CRAN (R 4.1.0)
873 #> memoise            2.0.0    2021-01-26 [1] CRAN (R 4.1.0)
874 #> mgcv                1.8-36   2021-06-01 [4] CRAN (R 4.1.0)
875 #> modelr              0.1.8    2020-05-19 [1] CRAN (R 4.1.0)
876 #> munsell            0.5.0    2018-06-12 [1] CRAN (R 4.1.0)
877 #> networkD3          * 0.4     2017-03-18 [1] CRAN (R 4.1.0)
878 #> nlme                3.1-152  2021-02-04 [4] CRAN (R 4.0.3)
879 #> openxlsx            4.2.3    2020-10-27 [1] CRAN (R 4.1.0)
880 #> oxcAAR              * 1.1.0   2021-02-23 [1] CRAN (R 4.1.0)
881 #> patchwork           * 1.1.1   2020-12-17 [1] CRAN (R 4.1.0)
882 #> pillar              1.6.1    2021-05-16 [1] CRAN (R 4.1.0)
883 #> pkgbuild            1.2.0    2020-12-15 [1] CRAN (R 4.1.0)
884 #> pkgconfig            2.0.3    2019-09-22 [1] CRAN (R 4.1.0)
885 #> pkgload              1.2.1    2021-04-06 [1] CRAN (R 4.1.0)
886 #> plyr                 1.8.6    2020-03-03 [1] CRAN (R 4.1.0)
887 #> png                  0.1-7    2013-12-03 [1] CRAN (R 4.1.0)
888 #> prettyunits          1.1.1    2020-01-24 [1] CRAN (R 4.1.0)
889 #> processx            3.5.2    2021-04-30 [1] CRAN (R 4.1.0)

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890 #> proxy          0.4-25  2021-03-05 [1] CRAN (R 4.1.0)
891 #> ps             1.6.0   2021-02-28 [1] CRAN (R 4.1.0)
892 #> purrr          * 0.3.4  2020-04-17 [1] CRAN (R 4.1.0)
893 #> R6              2.5.0   2020-10-28 [1] CRAN (R 4.1.0)
894 #> RColorBrewer    1.1-2   2014-12-07 [1] CRAN (R 4.1.0)
895 #> Rcpp             1.0.6   2021-01-15 [1] CRAN (R 4.1.0)
896 #> readr            * 1.4.0  2020-10-05 [1] CRAN (R 4.1.0)
897 #> readxl           1.3.1   2019-03-13 [1] CRAN (R 4.1.0)
898 #> remotes          2.4.0   2021-06-02 [1] CRAN (R 4.1.0)
899 #> reprex            2.0.0   2021-04-02 [1] CRAN (R 4.1.0)
900 #> reshape           0.8.8   2018-10-23 [1] CRAN (R 4.1.0)
901 #> RgoogleMaps      1.4.5.3  2020-02-12 [1] CRAN (R 4.1.0)
902 #> rio               0.5.26   2021-03-01 [1] CRAN (R 4.1.0)
903 #> rjson             0.2.20   2018-06-08 [1] CRAN (R 4.1.0)
904 #> rlang              0.4.11   2021-04-30 [1] CRAN (R 4.1.0)
905 #> rmarkdown          2.9     2021-06-15 [1] CRAN (R 4.1.0)
906 #> rnaturalearth     * 0.1.0   2017-03-21 [1] CRAN (R 4.1.0)
907 #> rprojroot          2.0.2   2020-11-15 [1] CRAN (R 4.1.0)
908 #> rstatix            0.7.0   2021-02-13 [1] CRAN (R 4.1.0)
909 #> rstudioapi          0.13    2020-11-12 [1] CRAN (R 4.1.0)
910 #> rvest               1.0.0   2021-03-09 [1] CRAN (R 4.1.0)
911 #> scales              1.1.1   2020-05-11 [1] CRAN (R 4.1.0)
912 #> scatterplot3d       0.3-41   2018-03-14 [1] CRAN (R 4.1.0)
913 #> sessioninfo         1.1.1   2018-11-05 [1] CRAN (R 4.1.0)
914 #> sf                  * 0.9-8   2021-03-17 [1] CRAN (R 4.1.0)
915 #> sp                  1.4-5    2021-01-10 [1] CRAN (R 4.1.0)
916 #> stringi              1.6.2   2021-05-17 [1] CRAN (R 4.1.0)
917 #> stringr              * 1.4.0   2019-02-10 [1] CRAN (R 4.1.0)
918 #> testthat             3.0.2   2021-02-14 [1] CRAN (R 4.1.0)
919 #> tibble              * 3.1.2   2021-05-16 [1] CRAN (R 4.1.0)
920 #> tidyverse             * 1.1.3   2021-03-03 [1] CRAN (R 4.1.0)
921 #> tidyselect            1.1.1   2021-04-30 [1] CRAN (R 4.1.0)
922 #> tidyverse             * 1.3.1   2021-04-15 [1] CRAN (R 4.1.0)
923 #> units                0.7-1    2021-03-16 [1] CRAN (R 4.1.0)
924 #> usethis              2.0.1    2021-02-10 [1] CRAN (R 4.1.0)
925 #> utf8                 1.2.1    2021-03-12 [1] CRAN (R 4.1.0)
926 #> vctrs                 0.3.8    2021-04-29 [1] CRAN (R 4.1.0)
927 #> webshot              0.5.2    2019-11-22 [1] CRAN (R 4.1.0)
928 #> withr                 2.4.2    2021-04-18 [1] CRAN (R 4.1.0)
929 #> xfun                  0.24     2021-06-15 [1] CRAN (R 4.1.0)
930 #> xml2                  1.3.2    2020-04-23 [1] CRAN (R 4.1.0)
931 #> yaml                  2.2.1    2020-02-01 [1] CRAN (R 4.1.0)
932 #> zip                   2.2.0    2021-05-31 [1] CRAN (R 4.1.0)
933 #>
934 #> [1] /home/isak/R/x86_64-pc-linux-gnu-library/4.1
935 #> [2] /usr/local/lib/R/site-library
936 #> [3] /usr/lib/R/site-library
937 #> [4] /usr/lib/R/library
938 The current Git commit details are:
939 #> Local:    master /home/isak/phd/meso_assemblages/exploring-assemblages-se-norway
940 #> Remote:   master @ origin (https://github.com/isakro/dialpastrepository.git)
941 #> Head:     [a798ec2] 2021-07-07: Minor edits to text and added color to Slinkey plot

```