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Use-wear analysis of Early Mesolithic flake axes from South-eastern Norway

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ABSTRACT

The flake axe is one of the most debated stone tools of the Scandinavian Mesolithic. Few analysis have however been carried out in order to investigate the actual function and use of the tool. In this paper we present the results from use-wear analysis of 42 flake axes from nine Early Mesolithic sites (9200–8400 cal. BC) from South-eastern Norway. This study demonstrates that the flake axe was a multi-tool used for several tasks and for working different raw materials. The results from the use-wear analysis are related to morphological variation among the analysed specimens. This suggests that there is no clear cut relation between morphological variation and function.

1. Introduction

1.1. Background and aims

The flake axe is one of the most debated stone tools of the Scandinavian Mesolithic. During the last 130 years, the function of the tool has been widely discussed and numerous suggestions to its use and function have been made (Table 1). Today, the most agreed-upon hypothesis is that the flake axe primarily was used for butchering and scraping the skin and blubber of sea mammals (e.g. Schmitt, 2013; Bang-Andersen, 2013). In a recent paper, however, Glørstad (2013) suggests that the flake axe was related to the Early Mesolithic groups' marine adaptation and, more specifically, to make log boats. Glørstad's main argument is the close relationship between the distribution of flake axes in Norway and Sweden and the Preboreal coastlines (Fig. 1). This theory is criticised, as several researchers consider the axes as unfit for woodworking (Bang-Andersen, 2013: 26; Wikell and Petterson, 2013: 40–41; Schmitt et al., 2009).

Even though the use of Mesolithic flake axes has been heavily debated, detailed analyses of the use and functionality of the tool type has been few. Numerous papers discuss what the axes were used for and, maybe even more eagerly, what they not were used for. To our knowledge, only three use-wear analysis of flake axes from the Scandinavian Mesolithic, that can provide insight to the tool's function in greater detail, have been carried out (Juel Jensen, 1988; Thorsberg, 1985; Knutsson, 1982).Thus, most of the presented evidence is circumstantial relying on factors such as geographic distribution and analogies to modern and ethnographic tools, or a combination of the two (Schmitt et al., 2009: 14; Fuglestvedt, 2012; Bang-Andersen, 2003: 13).

Within this background we have carried out use-wear analysis of 42 Early Mesolithic flake axes from South-eastern Norway. Here we present results from the use-wear analysis combined with results from technological and morphological investigations including raw material studies. The main aims are to 1) identify use-wear on Early Mesolithic flake axes, 2) analyse what contact material that caused use-wear, 3) investigate if use-wear traces related to different activities could be identified on the same tool, and 4) investigate if different use and function could be related to morphological differences.

2. Materials and methods

2.1. Definition, chronology and distribution of flake axes

In Norway and Western Sweden the flake axe is dated to the Early Mesolithic period, c. 9400–8300 cal. BC, and is considered a chronological marker (Bjerck, 2016; Schmitt, 2015). The tool type is an integrated element of the Early Mesolithic groups' tool kit and is regularly found at sites dated to the period (Bjerck, 2016; Åstveit, 2014; Waraas, 2001).

The flake axe is one of few formal macro tools of the Early Mesolithic in Norway, and several efforts have been made to provide a standardised definition of the tool. Attempts have also been made to divide the tool into subcategories based on differences in shape, symmetry, trimming, edge angles, production concepts etc. These variances have traditionally been linked to chronological differences (Troels-Smith, 1937, 1939; Lidén, 1938; Fredsjö, 1953; Althin, 1954; Brinch

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Table 1
During the last 130 years researchers have suggested various functions for the flake axe. Some of the most central works are referred to in the table. In the last decade the interpretation of the flake axe as an ulu has gained increasing popularity.

Author	Interpretation
Müller (1888)	Cleaver
Kjellmark (1903)	Adze
Rydbeck (1916)	Chopper/axe
Mathiassen (1937, 1948)	Axe (Knife, scraper)
Troels-Smith (1937)	Woodworking tool, chopper/axe
Fredsjö (1953)	Shellfish knife
Knutsson (1982)	Scraper, knife, wood, raw hide
Juel Jensen (1988)	Butchering tool
Thorsberg (1985)	Scraping (hide), wood working
Kindgren (1995)	Scrapers (hide)
Bang-Andersen (2003)	Ulus/skin scraper, marine resources
Fuglestvedt (2012)	Clubs/hatchets, reindeer
Havstein (2012)	Ulus/skin scraper/butchering tool, marine resources
Schmitt (2013), Schmitt et al. (2009)	Ulus/skin scraper, marine resources
Glørstad (2013)	Woodworking tool, log boats

Petersen, 1966; Andersson et al., 1975). There is a general agreement that a flake axe is made of a large flake or disc, and that some of the flake or disc's original ventral surface must be part of the axe's working edge. The working edge may be modified and re-sharpened by detaching the worn-out edge with a blow to its side (Andersson et al., 1975: 16; Bjerck, 1983: 17). Flake axes in general display large morphological variation related to differences in tool blank size and form (raw material availability), and also to later modifications of the tool (edge rejuvenation) (Eymundsson et al., 2017).

Despite morphological variation and a pragmatic adaptation to blank size and shape, the flake axe production concept (*schéma opératoire*) is surprisingly stringent. Generally, a flake axe is produced and shaped by applying two techniques: side edge flaking and thinning. The lateral sides of the axe are shaped by removing diagnostic side edge flakes either from the dorsal side or the original ventral surface side, of which the latter is less common. To reduce the thickness, the dorsal side is often modified by the removal of thinning flakes. This production concept usually results in an axe with a trapezoid cross section (Fig. 2).

Most flake axes are found at sites in the coastal region (cf. Fig. 1). They are distributed from Østfold County in southeast, along the southern coast to western Norway, up along the northwestern coast and all the way north to Finnmark (Breivik and Callanan, 2016: 12; Granados, 2011: 68, 75; Bjerck, 1994, 1995). North-western Norway, South-western Norway and the Oslo fjord region represents the main concentration areas both in sheer numbers but also regarding number of sites containing flake axes. In some parts of coastal Norway, such as the c. 120 km long stretch from Sognefjorden to Stad, no axes have been found. The lack of axes in this specific area can partially be explained by the rising sea level during the Holocene and that the Early Mesolithic sites are buried under beach sediments (Bjerck, 1986: 105–107; Bjerck, 1994: 46).

2.2. Archaeological data

2.2.1. Axes and sites

A total of 42 axes and edge flakes were chosen for analysis. The flake axes and edge flakes that are included originate from nine excavated sites in South-eastern Norway, dated between 9200 and 8400 cal. BC (Table 2). Eight sites are situated in Telemark and Vestfold Counties and one in Oslo.

2.2.2. Technology, morphology, raw materials

Some researchers have suggested that the flake axes display morphological changes over time, with more extensive flaking and thinning as well as the introduction of so-called flake chisels at sites younger than 9000 cal. BC. Also, the length of the flake axe's working edge appears to decrease towards the end of the Early Mesolithic (Nyland and Amundsen, 2012: 152, 157; Jaksland and Fossum, 2014). This trend has also been noticed on axes from the latest part of the Early Mesolithic in southern Scandinavia (Johansson, 1998: 114). The differences in working edge length could indicate functional differences between axes dated to the beginning of Early Mesolithic and axes from the latter part of the period (Jaksland and Fossum, 2014).

The axes analysed in this study are found at sites dated within an 800-year time span, covering large parts of the Early Mesolithic period. The morphology of the analysed axes varies, but is in accordance with the above-mentioned definition of a flake axe. The majority of the axes are made of larger flakes, which vary in length and in thickness. Eight axes have an unmodified original ventral surface, and the lateral sides are shaped from the ventral side. The lateral sides of the remaining axes were shaped from the dorsal side. The majority of axes are thinned by flaking, but the extent of flaking varies. Some display a more extensive thinning and may resemble core axes. This applies especially to the narrow-edged axes, termed flake chisels. Most of these axes are from sites dated to the latter part of the Early Mesolithic, and are in line with the chronological tendencies as described above. Evidently, the tool blank size and shape have guided the shaping of the axes, and this shows the flexibility of the flake axe production concept. Even though it appears to be chronological differences with regard to the extent of thinning, the production concept is rather persistent. We interpret the noted morphological differences as related to raw material availability but this should be further explored by analysing a larger data set.

Different flint types have been used for axe production, and the types are divided into subgroups based on the flint's grain size: Fine (translucent), fine (matte), medium, and coarse. Fine-grained translucent flint and medium-grained flint are most common and make up 38% and 44%, respectively. Few axes are made of coarse flint (13%) and matte fine-grained flint (6%). The variation in raw material composition applies to the earliest Early Mesolithic sites as well as to sites from the latter part of the period (Table 2). Many axes have eroded cortex on the dorsal side, indicating that the blanks were detached from (small) beach nodules.

The working edge is the most essential part of the tool, and establishing a functional edge appears to be more significant than where it was placed on the original blank. Most axes have an unsymmetrical working edge (88%), and the edge is strait (42%) or convex (36%). The angle measurements of the working edge have a largest and a smallest value, and the difference between these two values varies. This suggests that the axes were not produced in order to establish and maintain a uniform working edge. The working edge length varies between 10.8 and 69.3 mm, and variation is apparent within axe assemblages from the different sites. Flake chisels are identified at three sites. These have a particular narrow edge, and the edge length is often less than the actual width of the tool's body.

2.3. Use-wear analysis

Helena Knutsson conducted the use-wear analysis. All microscopic analysis for the present study was carried out with a Nikon Epiphot incident light microscope, using mainly magnifications of 50 × and 400 ×. The wear features were documented using a microscope camera (Nikon Ds−U2) and related software (NIS-Elements D 3.0). This allows for a sequence of digital photographs taken at different heights to be combined into one extended focus micrograph. When multiple use-wear traces were identified a stereomicroscope of type Nikon SMZ 800 Nikon with 10 × and 69 × enlargement was used.

All axes passed through standard cleaning routines. The specimens were first kept in weak (1–3%) HCl-solution for 24 h. Furthermore, they were rinsed with tap water and put into an ultrasonic bath in distilled water for 2 min. The purpose of the acid treatment and ultrasonic bath