A TECHNOLOGICAL CROSSROADS: EXPLORING DIVERSITY IN THE PRESSURE BLADE TECHNOLOGY OF MESOLITHIC LATVIA

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SUMMARY:

A long-standing debate in archaeology concerns the sources of technological diversification among prehistoric hunter-gatherers. This includes the study of the emergence and spread of pressure blade technology in Northern Europe during the Early Holocene. Until now, there has been little technological study of lithic collections from the East Baltic region, and our knowledge of the development and spread of this technology in the area is inadequate. This article presents for the first time a technological analysis of lithic assemblages from seven Early and Middle Mesolithic sites in the territory of present-day Latvia, offering new possibilities for discussing pressure blade technology and research objectives connected with it. Furthermore, variation in technological elements of this technology is explored in relation to raw-material characteristics through experimental flint knapping. Finally, the factors influencing diversity in craft traditions, as well as large-scale communication and shifting spheres of interaction within Northern Europe during the Mesolithic are discussed.

INTRODUCTION

Studies of lithic technology offer an important step towards explaining material culture diversity among Stone Age hunter-gatherers and tracking continuity and change in craft traditions through time and space. One prominent example is the effort to map the emergence, spread and development of pressure blade technology (e.g., Desrosiers (ed.) 2012; Sørensen *et al.* 2013). Blades were the principal blanks used for lithic tools in much of Northern Europe during the Late Palaeolithic and Mesolithic. Blade production by pressure technique is seen as a marker of a particular craft tradition that emerged in the Mongolian area around 20,000 years ago and spread from east to west during the last glacial maximum (Inizan 2012), reaching the Baltic Sea region and Scandinavia in the Mesolithic (Sørensen *et al.* 2013). So far, technological studies of blade collections from the East Baltic region are few, and our knowledge of the development and spread of pressure blade technology in this area inadequate. Traditionally, the Mesolithic of Northern Europe has been studied employing typological approaches to formal tool types on a local and national geographical scale. This research tradition has led to the construction of a mosaic of archaeological cultures (Sørensen *et al*. 2013), hampering interregional studies of large-scale interaction dynamics and understanding of culture-historical multiplicity.

A technological approach using the material remains of lithic blade production as a proxy allows further exploration of these research objectives. Here we present the results of a technological analysis of lithic assemblages from seven Early Mesolithic (9000–8300 BC) and Middle Mesolithic (8300–6000 BC) settlement sites in present-day Latvia, representing the first attempt at such an investigation in this region. Since specific ways of producing blades can be seen as expressions of culturally transmitted knowledge embedded within social traditions, a central objective of this article is to investigate lithic blade technology during the Mesolithic of Latvia in an interregional perspective. Furthermore, given that homogenous flint is not locally available in Latvia, variation in lithic technology is explored in relation to raw-material characteristics through experimental flint knapping. In this article we explore the factors influencing diversity in craft traditions, as well as large-scale communication and shifting spheres of interaction within Northern Europe during the Mesolithic.

RESEARCH BACKGROUND

In the Early Mesolithic, the Final Palaeolithic Swidry find complex in Latvia was replaced with a new taxonomic unit – the Kunda Culture, centred on today's Estonia, Latvia, Lithuania, Belarus and north-east Poland (Ostrauskas 2000) (Fig. 1). Human settlement shifted from the major river valleys to the inland lake regions, where the earliest Mesolithic sites have been discovered (Loze 1988; Zagorska 1993). Changes are also seen regarding the extraction and processing of lithic raw materials, technology and tool morphology (Zagorska 1993; Sulgostowska 1999). The Early Mesolithic artefact material consists mainly of a rich bone and antler inventory – harpoons with large, widely-spaced barbs, slotted and needle-shaped points, daggers, etc. The lithic inventory shows less diversity, comprising mostly flint end-scrapers and blade inserts. Tanged points are rare (Zagorska 2009). A typical feature is the use of imported high-quality Cretaceous flint, originating from areas to the south (Kriiska and Lõugas 2009). The archaeological material shows clear similarities with the Early Mesolithic finds assemblage from the Pulli site in western Estonia. Accordingly, the Early Mesolithic period in Latvia is referred to as the Pulli stage (Zagorska 1993).

In the Middle Mesolithic, the settlements concentrate in inland lake basins (Lakes Lubāns, Usma and Burtnieks), the most extensively excavated site being Zvejnieki II (upper layer) in the northern part of the country. The artefact assemblage includes a rich bone and antler inventory, comprising fish spears of Kunda type, slotted points and arrowheads with a conical tip (Zagorska 1993). Due to intensive investigations in recent years, the number of Middle Mesolithic settlement sites in the western, coastal part of Latvia has increased significantly. Compared to the Early Mesolithic, the sites are richer in lithic inventory, dominated by side- and end-scrapers, inserts and some burins, largely made on blades. Mainly local raw material has been used. The artefact assemblages display similarities to finds from sites in Estonia (Kunda-Lammasmägi), north-western Russia (Sokolok) as well as sites in the northern parts of Lithuania (Timofeev 1993; Zagorska 1993).

The origin and development of the Kunda Culture and its cultural affiliation with contemporaneous find complexes in the west and east has been a matter of debate (e.g., Indreko 1948; Zagorska 1993; Koltsov and Zhilin 1999; Sulgostowska 1999; Ostrauskas 2000; 2006; Kozlowski 2007; Johanson *et al.* 2013), which began soon after the discovery of the eponymous site in northern Estonia. Indreko (1948) viewed the Kunda Culture as developing in typological terms from the Palaeolithic of Western and Central Europe, later indicating eastern influences as well (River Don basin) (Johanson *et al.* 2013). Late Palaeolithic influences in the bone inventory were noted (Zagorska 1993), and East European origins stressed (Jaanits 1990). Later, the importance of environmental conditions and the possibilities of obtaining raw material were underlined (Sulgostowska 1999).

The area of origin of the Kunda Culture has been placed in present-day southern Lithuania, north-eastern Poland and north-western Belarus – in the area with outcrops of high-quality Cretaceous flint (Ostrauskas 2000). Another opinion is that the Kunda Culture formed in a wider region of Eastern Europe, also including present-day Estonia (Johanson *et al.* 2013) and Latvia. Based on typological and technological similarities with Final Palaeolithic and Early Mesolithic inventories from today's western Russia – the Butovo in the Upper Volga region and Veretye around Lake Onega (also called "eastern Kunda") – an eastward affiliation has been suggested (Koltsov and Zhilin 1999; Sulgostowska 1999; Sørensen *et al.* 2013). Kozlowski (2007) considers the eastern Baltic region during the Middle Mesolithic as "classic Kunda", and sees technological and typological homogeneity of assemblages in the region between the Ural Mountains and the Baltic Sea, calling this the "north-eastern technocomplex". On the other hand, it has been stressed that the presence of microliths and possibly also microburin technique indicates influences from western complexes – such as the Maglemosian in southern Scandinavia and Komornica in Poland (Ostrauskas 2006).

So far, this discussion has primarily been based on typological-morphological studies of formal tools. A technological approach, comparing the complete lithic assemblages from a larger number of sites, offers new possibilities for discussing cultural relations as well as establishing whether there are chronological and regional differences.

LITHIC TECHNOLOGY AS SOCIAL TRADITION

Drawing on the French technological approach along with the concept of *chaîne opératoire*, we argue that material culture such as lithic technology represents a manifestation of culturally transmitted knowledge that is learned and shared among a group of people and transmitted between generations, thereby reflecting social traditions (e.g., Mauss 1973 [1935]; Pelegrin 1990; Leroi-Gourhan 1993 [1964]; Lemonnier 1993; Schlanger 1994). In this approach, each artefact stands as an output of a distinctive operational sequence, with specific choices made at each stage of production. These choices can be defined as culturally derived traits or elements that are observable on the artefact as specific physical attributes. A technological element refers to a single action, consisting of the combination of a raw material, a tool, a gesture and an intention (Darmark 2012), relating to one stage in the operational chain – for instance, preparation of the blade core platform (e.g., Pelegrin 1990). The specific combinations of these elements can be argued to make up particular kinds of end products, such as blades, and the associated craft tradition, i.e., the production concept (Eriksen 2000; Sørensen 2012b; Apel 2008; Jordan 2015). For instance, in blade production the complete operational chain from the procurement of the raw material to the finished tool, including all the knowledge and know-how involved in the process, refers to the production concept that is shared by a specific social group or tradition (Apel 2008; Sørensen 2012b; Damlien 2016).

The hierarchal organization of techniques gives the operational chain both its stability and its flexibility (Leroi-Gourhan 1993 [1964]). Flexibility is provided by allowing context-specific choices at an operational level, such as those related to adjustments set by the raw material or individual expressions of a knapper, to be combined with stability at the conceptual level, such as the craft tradition of the knapper (Pelegrin 1990; Stout 2011). Information can flow up and down within these hierarchies. For instance, in order for a context-specific choice to become an integral part of the craft tradition, the information created during the production process has to be brought from the operational chain to the production concept. According to Stout (2011, 1051) this dynamic interaction is an important mechanism supporting the learning and adaptability of complex behaviours such as stone tool making. This interplay is also essential for understanding the dynamic relationship between tradition and adaptation in lithic technology, as well as the causes that direct the source of continuity and change in craft traditions (Damlien 2016).

Whereas the implementation of a complex craft such as blade production, involving a large amount of know-how, requires time to learn and needs perfection through practice, certain technological elements, such as the morphology of tools, can more easily be copied (Apel 2008; Darmark 2012; Tostevin 2012). Thus, only if contact was intimate enough and included direct social learning could the details of the production concept be transmitted. While complete production concepts are more likely to be learned and passed unchanged through many generations, single technological elements can more easily be transmitted within a generation or peer group and may be more prone to variation and change (Darmark 2012).

Consequently, through the recording of physical attributes on the artefacts, *chaîne opératoire* analysis can identify socially meaningful analytical units representing culturally transmitted knowledge embedded in social traditions (Damlien 2016; Berg-Hansen 2017). Furthermore, it also serves as a means to identify significant differences and similarities in that knowledge, which can illuminate social relations in time and space.

Here, a dynamical technological classification is employed as a methodological basis. The method focuses on the identification of the blade production concept. This approach identifies the methods and techniques used for blade production through a simplified *chaîne opératoire* analysis including the complete assemblages as well as attribute classification of a selection of the artefacts from each site (Schild 1980; Sørensen 2006).

LITHIC BLADE INDUSTRIES IN EARLY AND MIDDLE MESOLITHIC LATVIA

The concepts of blade production at seven sites dated to the Early and Middle Mesolithic periods (Fig. 2, Table 1) were investigated and defined. The majority of the sites are located in a small area of western Latvia connected with occupation in the southern part of the former Ventspils Bay. From the shore of the palaeolake Burtnieki in northern Latvia, the Early and Middle Mesolithic cultural layers of the settlement site Zvejnieki II have been analysed.

An assessment was made of the complete assemblages, focusing on the identification of methods and techniques for blade blank and tool production as well as raw-material procurement and use, whereas the attribute classification included a selection of artefacts from the different stages of the production process (Table 2).

Early Mesolithic blade technology

In order to investigate the concepts of blade production within the Early Mesolithic, the lithic assemblage from the lower layer of Zvejnieki II was analyzed. The analysis demonstrated that flint of variable workability and provenience was exploited for making regular blade products from conical and sub-conical cores (Fig. 3). The raw material consists mainly of imported Cretaceous flint, as well as smaller frequencies of flint of more variable quality, probably procured from glacial till deposits in the vicinity. The absence of waste material from the primary stage of production indicates that raw materials were brought to the site as prepared cores, blade blanks or tools.

The blade core assemblage is small, heterogeneous and fragmented. Most cores lack potential for further reduction due to size, shape, quality or damage. Blades from the early stages of production indicate that core preparation was carried out primarily by detachment of cortex blades from the platform as well as unilateral removals from crested ridges at the sides of the core. Cresting appears to have been a common strategy for preparing cores and retaining core geometry throughout the production sequence. The core fronts were generally maintained narrow throughout reduction, and the majority show one-sided front exploitation. The shape and character of the core back varies. In most cases the back was partly flaked, commonly by the detachment of flakes from one or two crested ridges along the sides of the core.

The strategy for preparation of the core platform prior to blade detachment consisted of both edge trimming and abrasion, and preparation of the platform surface (74% of core platforms). The most common strategy was faceting the platform surface by removing a series of small flakes terminating in hinges towards the centre of the platform. The striking platform was formed and repeatedly rejuvenated by detachments of core tablets by a single blow to the front or side of the core. The core tablets are usually feathered at the centre of the platform surface, but some terminate in hinges. The latter can be interpreted as a deliberate strategy aimed at preventing the core tablet from plunging, thereby retaining a platform-to-front angle close to 90° (Rankama and Kankaanpää 2011). Successful pressure technique requires a platform-to-front angle close to 90°.

Blade production involved a gradual reduction of the core, obtaining progressively narrower blades. The majority of the blades display features diagnostic of blades produced by pressure and indirect percussion (Pelegrin 2006; Sørensen 2013; Damlien 2015) (Table 3). They are regular to very regular, straight with ideal termination and an interior platform angle around 90°. Blades commonly have lips and bulbs, and absence of bulbar scars and cone formation. The low frequency of proximal twisting indicates that the cores were mechanically fixed during production. In addition, a small selection of blades displays characteristics indicative of production by direct percussion. The variation in knapping techniques appears, however, to be related to different stages in the production process. Direct and indirect percussion techniques were used in the early stages of production, for corrections as well as in situations where pressure technique became too demanding. Pressure technique was used in the middle and final stages of the production sequence, while the core was mechanically fixed.

In general, blade tools are represented mostly by straight, regular blades with semi-abrupt retouch along one lateral edge: knives, end-scrapers with a convex working edge and an arrowhead of Pulli type – with a broken distal part and tang, and preserved symmetrical, retouched barbs. There are also blade fragments, used as inserts in slotted bone points. Such points with grooves along one or both margins have been found at Zvejnieki, even with preserved inserts (Zagorska 1993).

Middle Mesolithic blade technology

In order to investigate the concepts of blade production during the Middle Mesolithic, lithic assemblages from five sites were analyzed: the upper layer of Zvejnieki II, and the sites Lapiņi, Vendzavas, Celmi and Pāvilostas Baznīckalns in western Latvia. Additionally, an assessment was made of the complete assemblages from the Priednieki site.

In general, the blade production concept is common to all sites, and displays clear similarities with the concept documented for the Early Mesolithic layer of Zvejnieki II, namely blade production from single-platform conical and sub-conical cores. Contrasting with the Early Mesolithic layer of Zvejnieki II, however, raw-material use at the Middle Mesolithic sites primarily involved local raw materials. The frequency of imported Cretaceous flint is in general low. In western Latvia, locally obtainable flint in the form of small, rounded pebbles, occurring on the beaches along this part of the coast, was exploited, whereas raw-material use at Zvejnieki II is dominated by flint of variable quality, probably procured from nearby glacial till deposits, as well as quartz.

Beach flint pebbles, precores as well as blades from the primary stages of blade production provide additional information as to how the cores were initially prepared. A concave platform was created by detachment of a single large flake. Initial preparation of the core front and sides was then carried out primarily by detachment of cortex blades from the platform and/or with unilateral or bifacial removals from the sides of the core. The shape and character of the core front, sides and back varies. The fronts were generally maintained wide throughout the reduction, and the majority have three-quarter and one-sided front exploitation. The sides and back could be left unprepared, or were partly or completely flaked.

Although there are many similarities, clear regional differences in the strategies for preparing the core platforms were documented. At Zvejnieki II (Fig. 3) this strategy involved both trimming and abrasion of the platform edge, and preparation of the platform surface by faceting, which involved detaching either a series of small flakes that terminated in hinges towards the centre of the platform or large, thin preparation flakes. In some cases preparation was restricted to the edge of the platform surface. The striking platform was formed and repeatedly rejuvenated by detachment of core tablets. The core tablets are usually feathered at the centre of the platform surface, but some terminate in hinges. At the western Latvian sites (Fig. 4), however, preparation of the platform edge in the form of trimming and abrasion is generally less common, and so is preparation of the platform surface by faceting. Platforms were generally left unprepared, while in some cases there was preparation restricted to the edge of the platform surface, with detachment of small, thin flakes. There are few platform rejuvenations (core tablets) in the assemblages. The striking platform was rejuvenated primarily by detachments of large, thin platform preparation flakes.

Common to all sites is, however, gradual reduction of the core in the course of blade production. The majority of the blades display features diagnostic of blades produced by pressure and indirect percussion (Pelegrin 2006; Sørensen 2013; Damlien 2015) (Table 3). They are in general regular to very regular, straight with ideal termination and a ventral angle around 90°. Blades commonly have lips and bulbs, and absence of bulbar scars, cone formation and proximal twisting. In addition, some blades display diagnostic characteristics of direct percussion. Similar to the Early Mesolithic layer of Zvejnieki II, the variation in knapping techniques appears to relate to different stages in the production process.

Tanged points of Pulli type are absent in the Middle Mesolithic assemblages, and inserts in the form of blade fragments with semi-abrupt retouch along one lateral edge dominate. There are also small side- and end-scrapers. Interestingly, however, regional differences are documented. In western Latvia inserts occur in combination with lanceolate and scalene microliths, in some cases produced by microburin technique, in contrast to Zvejnieki II, where microburin technique and microliths are absent.

Chronological and regional variation in pressure blade technology

In terms of the blade production concept employed, there is close similarity between the seven sites. Differences have, however, been demonstrated in specific technological elements, such as raw-material procurement and use, methods for rejuvenating and preparing blade core platforms as well as the morphology of the final blade tools. Whereas imported Cretaceous flint of high quality is the dominant raw material in the Early Mesolithic layer of Zvejnieki II, local raw materials of variable quality dominate at Middle Mesolithic sites, thereby demonstrating increased utilization of local raw-material resources.

Furthermore, significant differences were observed in the methods of rejuvenating and preparing blade core platforms (Fig. 5). Several functional aspects of platform preparation by systematic faceting, as documented for the

Early and Middle Mesolithic layer at Zvejnieki II, have been suggested. The method is considered useful for adjusting the exterior angle between the striking platform and core front in order to make platform preparation for the next blade removal easier and more controlled. This strategy is, thus, also suggested to be more raw-material economizing than, for instance, platform rejuvenation by the removal of core tablets, which will reduce the size of the core severely (Sørensen 2013; Sørensen *et al.* 2013). However, as shown for the Early and Middle Mesolithic layers of Zvejnieki II, platform preparation by systematic faceting occurs in combination with repeated removals for platform rejuvenation, thereby challenging the notion of this method as a strictly economizing strategy. The method is also suggested as a strategy for shaping and strengthening the platform edge, so that more force can be applied (Sørensen 2013), and for isolating a point of impact by reducing the area of contact between the pressure tool and the platform surface, so that longer, thinner blades can be produced with less force. The larger (wider and thicker) the point of impact, the more the pressure will spread across the platform surface during blade detachment, requiring more force to initiate fracture. As force is generally limited in most modes of pressure technique, the knapper will avoid unnecessary effort by restricting the size of the impact point (Pelegrin 2012).

When unprepared platforms are favoured, the pressure tool is generally placed just behind the edge of the core platform, normally after this edge has been prepared to strengthen it, remove overhang from previously detached blades and isolate a point of impact for the pressure tool. Furthermore, in this concept large platform rejuvenations (core tablets) are typically removed as a problem-solving strategy in order to repair the blade core (Sørensen 2013). This appears, however, not to be the case with the blade production concept documented for western Latvia. At sites in this area preparation of the platform edge and platform rejuvenation by the removal of core tablets are uncommon. Whereas this strategy is primarily seen with blade production from local flint in western Latvia, the strategy of systematic faceting and repeated platform rejuvenation was maintained in northern Latvia even when using local raw materials. The strategy of unprepared platforms observed in western Latvia can, thus, potentially be related to the quality and properties of the local raw material in this area. Here, the local flint is in the form of small pebbles, and is generally described as variable in quality and workability (Bērziņš 2002). A central question is, then, whether the raw-material characteristics of the local flint in this area affected technological choices related to the pressure blade technology.

EXPERIMENTAL KNAPPING – THE EFFECT OF LITHIC RAW MATERIALS ON PRESSURE BLADE TECHNOLOGY

In order to explore whether the variation in platform rejuvenation and preparation should be seen as a response to the quality and properties of the local flint in western Latvia, six lithic knapping experiments were conducted, applying the blade production method and techniques reconstructed from the archaeological material on flint pebbles collected along the Baltic Sea coastline in western Latvia. The pebbles are rounded or oval in shape, covered with cortex and small in size, normally measuring 5–6 cm. The aims of the experiments were: 1) to evaluate potential challenges related to the use of this type of flint for blade production by pressure technique, 2) to evaluate whether, and in what ways, the properties of the raw material affected technological choices during the production process, and 3) to explore whether, and in what respect, the choice of platform preparation (unprepared or faceted) affected the production process and the properties of the blades. Pressure technique using a mounting device against the ground and a chest crutch with an antler tip from a standing position was chosen (e.g., Pelegrin 2012). Heat treatment of flint prior to use of pressure technique has been documented in numerous cases (e.g., Desrosiers (ed.) 2012), but is not indicated in the analysed archaeological assemblages from Latvia. Due to this, the flint was not subjected to heat treatment during the experiments.

The experiments showed that it was possible to successfully produce blades from conical cores with both unprepared and faceted platforms by the use of pressure technique on flint from western Latvia. However, the quality of the raw material is highly variable, and the primary factor influencing production was the hardness and brittleness. One of the experiments was terminated at an early stage of the production process because blades could not be produced, and because the tip of the pressure tool had been damaged. Furthermore, in one of the experiments, the brittleness of the raw material caused the platform edge to crumble, making the blades break or hinge. At a more general level, however, the brittleness of the raw material was experienced as a positive factor, i.e., making it easier to detach blades with less force, compared to fine-grained, more compact Cretaceous flint, for instance, which requires more force.

During the experiments the brittleness of the raw material did necessitate platform edge preparation by trimming and abrasion in order to create a solid platform edge as well as to isolate points of impact for the pressure tool. This is, however, not reflected archaeologically, as only low frequencies of blades and cores have traces of platform edge preparation. One might, however, argue that preparation restricted to the edge of the platform surface, as observed in the archaeological assemblages, might have a similar function for isolating points of impact. Based on the experiments, one can conclude that no significant differences with regard to the end product were observed in relation to the choice of preparing the platform surface. This applies both to the ability to successfully detach blades by pressure technique as well as to the morphological properties of the final blades. Regular, thin, straight blades were produced from both unprepared and faceted platforms.

The experiments showed, however, that there was one crucial factor influencing technological choices during the production process: the size and morphology of the raw material. The small size of the pebbles required a knapping strategy where as little mass as possible would be removed before and during blade production. Accordingly, platform rejuvenation by the removal of core tablets was avoided in the experiments due to the small size of the pebbles. This strategy is also reflected in the archaeological assemblages, where platforms appear to have been rejuvenated mainly by the removal of thin platform flakes. The small size and shape of the local flint nodules in western Latvia may have favoured a strategy of keeping platform preparation and rejuvenation to a minimum. Similar strategies are observed at Middle Mesolithic sites in Poland (Płaza and Grużdź 2010) and on Bornholm (Sørensen and Casati 2006; Sørensen 2012a). At these sites local erratic flint from glacial till in the form of small, round nodules was exploited for making regular blades by means of pressure technique from conical cores with unprepared platforms, and this might support the hypothesis that the change in strategies of platform maintenance may be attributed to the properties of the local flint in these areas. Further experimental studies are, however, needed in order to evaluate this.

TECHNOLOGY TRANSFER AND SHIFTING SPHERES OF INTERACTION

Technological studies of lithic assemblages from seven Early and Middle Mesolithic sites in Latvia support recent hypotheses that pressure blade technology was introduced into the East Baltic region in the Early Mesolithic (e.g., Jussila and Matiskainen 2003; Veski *et al.* 2005; Kriiska and Lõugas 2009; Rankamaa and Kankaanpää 2011). Furthermore, our results show that the pressure blade technology in Latvia displays significant similarities with the north-eastern technological tradition, as documented for the Butovo sites in the Upper Volga region and Veretye around Lake Onega in today’s western Russia (Koltsov and Zhilin 1999; Sulgostowska 1999; Sørensen *et al.* 2013; Damlien *et al.* in press). This includes the methods and techniques used for blade blank production as well as the morphology of the final tools, thereby clearly indicating an eastern affiliation of the lithic blade industry associated with the Kunda Culture in Latvia. The use of imported Cretaceous flint from the south at sites in western Russia (Koltsov and Zhilin 1999) may also indicate the existence of a wide communication network during this period. The manufacture of blades by pressure is a complex procedure which involved a large amount of know-how, requiring time to learn the skill and perfect it through practice (Pelegrin 2012). Transmission and maintenance of the technology requires intimate interaction; hence, in conjunction with the movement of raw materials, it indicates the presence of a social network stretching from the eastern Baltic region towards the east during the Early Mesolithic.

Although the pressure blade technology displays continuity in the Early and Middle Mesolithic of Latvia, regional differences in particular technological elements are evident in the Middle Mesolithic. These differences do not, however, merely reflect a local trend. Regional diversity in the methods of core preparation and microlith typology has been documented for Scandinavia and the Baltic Sea region. At Early and Middle Mesolithic sites in today's western Russia, Estonia and northern, central and western Scandinavia the core platform was formed and repeatedly rejuvenated by detachments of core tablets, and by systematically faceting the platform surface (Rankama and Kankaanpää 2011; Knutsson and Knutsson 2012; Sørensen 2012a; Sørensen *et al.* 2013; Damlien *et al.* in press). Formal microliths are generally absent or low in numbers, and blade inserts dominate. This displays clear similarities with the pressure blade technology as documented in our study for the Early and Middle Mesolithic layers of Zvejnieki II in northern Latvia. On the contrary, in western Latvia, as our study shows, as well as in the western Baltic region, across the Polish Plain to the islands of eastern Denmark and the southernmost part of Sweden, the core platforms were generally kept unprepared (Domanska and Wąs 2009; Płaza and Grużdź 2010; Sørensen 2012a; Damlien *et al.* in press). In addition, formal microliths were an integrated element of the lithic tool tradition.

A central question is – how to interpret these observations? Regional variation in pressure blade technology has been seen as the expression of two different culturally derived traditions that existed synchronously in the North European lowland and around the Baltic Sea during the Middle Mesolithic (Sørensen

2012a; Damlien *et al.* in press). Sites containing lithic inventories assigned both to the Kunda and Komornica find complexes have been described in north-eastern Poland, the latter, however, characterized by a very different lithic industry, resembling the Early Mesolithic Maglemosian techno-groups 1 and 2 (Sulgostowska 1996; Sørensen 2012a). Knowledge concerning pressure blade production is suggested to have been transmitted between the two cultural traditions within this shared territory. However, the Maglemose/Komornica tradition of maintaining the core platforms unprepared is retained, suggesting that the pressure blade technology was not adopted completely (Sørensen 2012a). In an earlier study Sørensen *et al.* (2013) suggest that the spatiotemporal distribution of the pressure blade technology along with differences in its execution indicate that the technology was modified in the western Baltic region and transmitted as knowledge into already established Mesolithic societies of today's Polish lowland and southern Scandinavia.

Interestingly, our results show that the strategy of keeping the platforms unprepared occurs in the East Baltic region already in the first half of the Middle Mesolithic, and thus is an even earlier and more widely distributed phenomenon than previously thought, suggesting new explanations for its appearance. Based on our knapping experiments in applying pressure blade technology on local flint from western Latvia, we suggest that a change in the raw-material base to include local flint, which required alteration of the habitual production concept, may serve as an explanatory factor for the development of variation in pressure blade technology. Accordingly, the choice of retaining the platforms unprepared could potentially already have been an integrated element of the blade production concept when knowledge of the technology was transmitted towards the west.

So far, however, we can only conclude that in the Middle Mesolithic of Latvia we observe complex social networks with different directions of communication. Thus, the core platform preparation method and presence of microliths at sites in western Latvia point to increased cultural affiliation towards the west in the Middle Mesolithic. On the other hand, in north-eastern Latvia the eastern technological tradition appears to have been maintained even when changing to the use of local raw materials, thus, highlighting the complex relationship between maintaining tradition and adapting to new raw materials.

Regional differences in the implementation of pressure blade technology in Latvia may further support the hypothesis of the existence of a north-eastern and a south-western sphere of interaction in the Baltic Sea region in the Middle Mesolithic. The changes within pressure blade technology could reflect interaction between groups in overlapping territories, resulting in a mixing of traditional and novel practices as people of different traditions met and interacted (Sørensen *et al.* 2013). A recently published DNA study (Jones *et al.* 2016) of one Middle Mesolithic individual from the cemetery of Zvejnieki, which shows a geographical origin between Eastern and Western European hunter-gatherer samples, might support such a hypothesis.

As the above discussion indicates, there are at the moment several questions left to be answered. So far, there has been little consideration of the time-space relationship between the Early Mesolithic lithic industries related to the Kunda Culture and the potentially synchronous Komornica in Poland. More research on lithic assemblages from the Baltic Sea region is needed in order to clarify the westward spread and development of pressure blade technology. And we may expect that future studies of other proxies will cast further light on hunter-gatherer communication and spheres of interaction within Mesolithic Northern Europe.

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TABLE 1

Mesolithic sites analysed in this study. Conventional radiocarbon ages calibrated using the IntCal13 atmospheric curve (Reimer *et al.* 2013) and OxCal v4.2.4 (Bronk Ramsey 2009). For site locations see Fig. 2.

Site	**Excavation (director, years, total area)**	**Radiocarbon date, ^{14}C yr BP ±1σ**	**Calibrated date BC (95.4% confidence)**	**Archaeological period**	**References**
Zvejnieki II, lower layer	I. Zagorska, 1971–1973, 1975, 1977–1978, 2009 (705 m^2)	9415±80 (Ua-18201) 9170±70 (Ua-19797)	9123–8470 8567–8271	Early Mesolithic	Zagorskis 2004; Zagorska 1993; 2006; 2009; Bērziņš and Zagorska 2010
Zvejnieki II, upper layer		8240±70 (Ua-3634) 8140±120 (Ta-2791)	7465–7078 7481–6714	Middle Mesolithic	
Lapiņi	V.Bērziņš, 2012, 2014; V. Bērziņš and M. Kalniņš, 2015 (172 m^2)	9119±65 (Tln-3477)	8538–8241	early Middle Mesolithic	Bērziņš and Doniņa 2014; Bērziņš *et al.* 2016
Vendzavas	V. Bērziņš, 1996, 1998, 2000 (134 m^2)	8160±60 (Ua-34544) 7815±35 (KIA-40957)	7340–7048 6750–6533	late Middle Mesolithic	Bērziņš 2002; Lõugas 2002

Celmi	N. Grasis, 2000–2001 (130 m^2)	7510±80 (Tln-2917)	6503–6220	late Middle Mesolithic	Grasis 2010
Pāvilostas Baznīckalns	P. Stepiņš, 1939 (small-scale excavation)	–	–	late Middle Mesolithic	Murniece et al. 1999
Priednieki	A. Vasks, 2004 (181 m^2)	–	–	Middle Mesolithic	Vasks 2006

TABLE 2
Analysed artefact types from Mesolithic sites.

Artefact	**Zvejnieki II, lower layer**	**Zvejnieki II, upper layer**	**Vendzavas**	**Celmi**	**Lapiņi**	**Pāvilostas Baznīckalns**
Block/nodule	0	0	0	18	0	0
Core	8	30	45	17	5	0
Core fragment	7	12	10	1	2	0
Platform flake	10	27	19	4	1	1
Flake	1	0	2	0	0	0
Complete blade	13	20	35	25	4	7
Blade fragment	41	89	112	24	25	20
Point/microlith	1	0	1	13	2	1
Scraper	2	1	1	0	1	0
Sum	*83*	*179*	*225*	*102*	*41*	*29*

TABLE 3

Basic descriptive statistics for the main attributes of blades from Mesolithic sites.

Blade attribute:	**Zvejnieki II, lower layer**	**Zvejnieki II, upper layer**	**Vendzavas**	**Celmi**	**Lapiņi**	**Pāvilostas Baznīckalns**
Interior platform angle						
Mean	86	88	85	87	83	87
Blade length (mm)						
Mean	35.4	30.6	28.9	27.4	32.3	31.6
Max	82.5	54.1	51.3	59.2	45.8	46.4
Min	18.9	16.1	9.9	16.6	23.9	21.3
Blade width (mm)						
Mean	10.7	9.4	10.4	10.3	11.8	13.1
Blade thickness (mm)						
Mean	3.7	3.4	3.7	3.6	4.6	4.3
Regularity (%)						
Irregular	20	14	25	2	29	4
Regular	39	55	44	67	43	64
Very regular	41	31	31	32	29	32

Sum	*100%* *(n=51)*	*100%* *(n=106)*	*100%* *(n=134)*	*100%* *(n=60)*	*100%* *(n=28)*	*100%* *(n=28)*
Blade curvature (%)						
Straight	77	65	76	55	71	73
Distal	17	19	11	38	24	18
Even	6	15	9	8	5	9
Sum	*100%* *(n=35)*	*100%* *(n=101)*	*100%* *(n=88)*	*100%* *(n=53)*	*100%* *(n=21)*	*100%* *(n=22)*
Twisting (%)						
No	84	78	95	86	81	89
Yes	16	22	6	14	19	11
Sum	*100%* *(n=51)*	*100%* *(n=99)*	*100%* *(n=128)*	*100%* *(n=56)*	*100%* *(n=21)*	*100%* *(n=27)*
Bulb morphology (%)						
No	8	7	6	7	10	0
Yes	90	93	91	93	90	100
Double	2	0	3	0	0	0
Sum	*100%* *(n=48)*	*100%* *(n=81)*	*100%* *(n=132)*	*100%* *(n=54)*	*100%* *(n=21)*	*100%* *(n=27)*
Lip formation (%)						
No	33	22	22	4	20	0
Yes	67	78	79	96	80	100
Sum	*100%* *(n=48)*	*100%* *(n=82)*	*100%* *(n=130)*	*100%* *(n=54)*	*100%* *(n=20)*	*100%* *(n=27)*
Bulbar scar (%)						
No	92	93	89	83	78	89
Yes	8	7	11	17	22	11
Sum	*100%* *(n=48)*	*100%* *(n=81)*	*100%* *(n=132)*	*100%* *(n=54)*	*100%* *(n=18)*	*100%* *(n=27)*
Cone formation (%)						
None	69	66	51	67	41	67
Ring crack on butt	4	1	1	0	0	0
Ventral proximal fissures	19	12	26	13	27	19
Detached bulb	8	20	22	20	32	15
Sum	*100%* *(n=48)*	*100%* *(n=83)*	*100%* *(n=133)*	*100%* *(n=54)*	*100%* *(n=22)*	*100%* *(n=27)*

CAPTIONS OF ILLUSTRATIONS

Figure 1. Map displaying the archaeological find complexes and sites mentioned in the text outside Latvia. Map: V. Bērziņš.

Figure 2. Map displaying the analysed sites in Latvia. Map: V. Bērziņš.

Figure 3. Selection of cores (1-5) and platform rejuvenations (7-8) with faceted platforms, blades (9-22), blade sections (23-30) and a Pulli point (31) from the Early and Middle Mesolithic layers of Zvejnieki II. Department of Archaeology, National History Museum of Latvia. Photo/illustration: I.M. Berg-Hansen/H. Damlien.

Figure 4. Selection of cores with unprepared platforms (1-7), blades (8-15), microliths (16-17) and microburins (18-19) from Middle Mesolithic sites in western Latvia. Department of Archaeology, National History Museum of Latvia. Photo/illustration: I.M. Berg-Hansen/H. Damlien.

Figure 5. Different types of core platform rejuvenation and preparation. A: Platform preparation by systematic faceting and repeated rejuvenation. B: Unprepared platforms (modified after Sørensen *et al.* 2013, fig. 1).