3.7. KNAP TIME!

Identifying novice flintknapping at the E18 Tvedestrand-Arendal sites

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INTRODUCTION

People are not born flintknappers. Flint working is a skill that requires learning and practice. Skill in this context is a combination of theoretical knowledge and practical know-how, where the latter requires muscle memory which can only be acquired through practice (Pelegrin 1990; *cf.* Apel 2001; Bamforth & Finlay 2008; Bleed 2008; Nonaka *et al.* 2010). Studies of prehistoric flint working skill tend to focus on the expertly fashioned artefacts, as such studies are often linked to discussions of, for example, specialisation and social complexity (*cf.* Dobres 2006; Finlay 2008; Olausson 2008). Low quality products, on the contrary, are rarely studied. As a result, learning processes are still inadequately examined archaeologically (Bamforth & Finlay 2008; Finlay 2015). However, one thing is certain: mastering flint work includes a lot of trial and error. Accordingly, learning this craft should have material consequences.

The majority of artefacts uncovered in a "complete" state on archaeological settlement sites were, when deposited, probably regarded as unsatisfactory in some way. For example, arrowheads fulfilling the prehistoric idea of what an arrowhead should look like would have been utilized and thereby risk being damaged or lost. On the other hand, arrowheads *not* fulfilling the idea of what an arrowhead should look like would, to a higher degree, have been discarded in close proximity to the production area. Debris from unsuccessful production, potentially including novice products, is likely to be preserved, and possibly even over-represented in the archaeological material (*cf.* Bamforth & Finlay 2008; Högberg & Gärdenfors 2015: 118).

Most of the finds collected from the Stone Age sites investigated within the E18 Tvedestrand–Arendal project conform well to our taxonomical expectations of the respective periods. Every now and then during the classification work, however, finds were encountered that challenged our preconceptions concerning what an ideal representative of a certain find category should look like. The main objective of this article is to draw attention to possible traces of novices' work in the E18 Tvedestrand–Arendal material and to propose a method for confronting and examining this material without having to resort to time-consuming refitting of large assemblages.

THEORETICAL DEPARTURE

Stone is a well-suited medium for studying different skill levels, due to the reductive character of flaking industries, where every action leaves a visible trace (*cf.* Pigeot 1990: 126). Therefore, novice flintknapping should be identifiable in the archaeological material, even though the identification of individual knappers might be beyond the scope of archaeology (Foulds 2010).

Four different learning processes have been identified by Hildebrand (2012): *apprenticeship*, *learning*, *play* and *imitation*. These processes should result in different empirical patterns. The apprenticeship is a formal type of learning clearly separate from the other learning processes, which are more informal. The informal learning processes vary from individual *acquisition* of knowledge to having a formal element in the shape of *transmission*. Between these two, there are varying degrees of verbal instruction between the teacher and the novice (Pigeot 1990; Kamp 2001: 12–14; Ferguson 2008; Lancy 2012), with scaffolding (assisted learning) dramatically increasing the success rate of production (Ferguson 2008).

By identifying different levels of skill in the archaeological material one could eventually start to discuss group composition and habitational organization on Stone Age sites (*cf.* Bodu *et al.* 1987), which is an important key to understanding site function. Potentially, this perspective could cast light on questions concerning the social composition at the sites and if, and how, this changes over time.

ANALYSED MATERIAL AND SOURCE CRITICAL ASPECTS

The present study incorporates all the sites excavated within the E18 Tvedestrand–Arendal project (for a selection of presented sites, see chapters 2.2.1–2.5.5, this volume). This includes a total of 913 flint cores, core fragments and core maintenance flakes. Of these, 202 are bipolar cores that have been reevaluated within the frame of this study, leading to measurement of 112 cores. Furthermore, the presence of single-edged and tanged arrowheads shorter than 0.7 cm has been noted as potential miniature versions of tools, i.e. toys (*cf.* Darmark & Viken, chapter 3.8, this volume). The studied material derives from 21 different sites. These are chronologically placed between *c.* 9000 cal. BC and 1700 cal. BC, i.e. they span the period from the Early Mesolithic (*EM2* according to Bjerck 2008d) to the Late Neolithic. This period of roughly 7000 years includes several technological shifts in lithic production with regard to both conceptual and operative knapping schemes (Inizan *et al.* 1999: 16; *cf. e.g.* Eigeland 2015; Damlien 2016; Reitan 2016), which will be briefly and generally described below.

The Early Mesolithic

The Early Mesolithic encompasses the period between *c.* 9500 and 8300/8200 cal. BC (Jaksland 2014; *cf.* Damlien 2016). Of the 21 sites within the study, more than half (12), containing 39 % (N = 358) of the total investigated artefacts, are placed within this period, and represent the later phase of the interval. The sites are considered relatively free from later occupations, the exception being *Kvastad A2*, which also includes both Middle Mesolithic and Neolithic phases (Stokke & Reitan, chapter 2.5.5, this volume). The Early Mesolithic technology is in general directed towards blade production from one-sided cores with either single or dual platforms. The blades are struck at an acute angle primarily by direct percussion (*cf.* Eigeland, chapter 3.6, this volume). Blades are commonly segmented using *microburin technique* to produce a variety of arrowheads and microliths (Damlien 2016: 29, 388–389).

The Middle Mesolithic

The Middle Mesolithic, in the region argued to date between *c.* 8300/8200 and 5600 cal. BC according to a recently published study by Reitan (2016), is characterized by a tangible technological shift towards blade production from conical or sub-conical, single platform cores. Blades are standardized and regular, produced at an angle approaching 90°, and usually segmented without the use of microburin technique. The technique employed for blade detachment is primarily pressure and indirect percussion (Damlien 2016: 29–30, 388–389; Eigeland, chapter 3.6, this volume). Of 21 analysed sites, only two – *Hesthag C4* and *Hesthag C2* – are chronologically placed in the Middle Mesolithic, the former from the earlier part of the period (Viken, chapter 2.3.1, this volume), and the latter from the later part of the period (Viken, chapter 2.3.2, this volume). In the Hesthag C2 material traces of Late Mesolithic activity have also been identified. These sites have a high find density, and contain 27 % (N = 248) of the total material.

The Late Mesolithic

The technology of the Late Mesolithic, *c.* 5600–3900 cal. BC (*cf.* Reitan 2016), is heavily reliant on production of standardized microblades from handle cores or conical cores primarily by pressure technique (*cf.* Jaksland 2001: 36–37; Bjerck 2008d; Eigeland 2015: 376). Projectile points are virtually absent in the early phase (*Nøstvet phase*, *c.* 5600–4500 BC, *cf.* Reitan 2016), whereas drills and knives made of flakes are characteristic for the same phase (Jaksland 2001:37). A variety of projectile points are introduced in the later *Kjeøy phase*, beginning with transverse arrowheads from *c.* 4500 cal. BC (Jaksland 2001: 37; Glørstad 1998a, 2004; Reitan 2016: 40–41). The introduction of arrowheads coincides with an increase in the production of blades and a gradual decrease in the production of microblades (Glørstad 2004b: 43; Reitan 2016: 34, table 8). The two E18 Tvedestrand–Arendal sites from the Late Mesolithic, *Krøgenes D1* and *Krøgenes D2*, comprise 26 % (N = 239) of the analyzed material. While Krøgenes D2 is dominated by an assemblage of a Late Mesolithic (Nøstvet phase) character (Mansrud *et al.*, chapter 2.4.1, this volume), Krøgenes D1 shows a continuation into the Late Mesolithic Kjeøy phase as well as the Early- and Middle Neolithic (Reitan & Solberg, chapter 2.5.2, this volume).

The Neolithic

The Early Neolithic technology of Southeast Norway seems to be directed towards flake production and bipolar technology (Solheim 2012a: 171–176; Eigeland 2015: 374–378). Cylindrical cores are sometimes found, predominantly on Middle Neolithic sites (e.g. Coulson 1986; Østmo 2008), but they also occur on Early Neolithic sites (e.g. Ingstad 1970; *cf.* Glørstad 2004a: 38, 57; Sundström *et al.* 2012; Sundström & Glørstad 2014; Reitan 2014a, 2015). The cylindrical cores are reduced by indirect percussion as described by Bergsvik (2010: 113–114). The Late Neolithic is characterized by a transition to bifacial technology, where pressure flaking is an integral part (e.g. Mjærum 2012a; *cf.* Apel 2001; Vandkilde 2007). Five of the E18 Tvedestrand–Arendal project's sites are dated to the Neolithic. Of these *Krøgenes D7* and *Krøgenes D10* are considered Early Neolithic (*c.* 3900–3300 cal. BC, see Stokke & Reitan, chapter 2.5.1, this volume), and *Krøgenes D5* Middle Neolithic (*c.* 3300–2300 cal. BC, see Reitan & Solberg, chapter 2.5.3, this volume). Lastly, both *Mørland D11* and *Hesthag C6* are Late Neolithic (*c.* 2300–1700 cal. BC, see Darmark, chapter 2.5.4; Reitan *et al.*, chapter 3.9, this volume), the latter containing an early Middle Mesolithic phase as well (Reitan 2017a). Together these five Neolithic sites comprise 7 % (N = 68) of the analysed material.

Source critical aspects

As shown, the different chronological phases are somewhat unevenly represented, and some of the sites included are multi-phased (table 3.7.1). In addition, the sites are excavated to different extents and by diverse methods, and the lithic assemblages display varying degrees of thermal alteration, which obstructs technological analysis.

A further source-critical point is that perception of the same artefact can vary with different levels of experience, technological knowledge and research tradition. The initial find registration has been executed by different project staff members, and parts of the core material have been reevaluated during our survey.

An obvious difficulty is also the presence of major technological shifts within the time period studied, something which especially hampers the creation of variables relevant for a diachronic study of skill. It is also clear that the selection of cores deviating from an envisioned ideal operational scheme (i.e. beginner cores) is characterized by a rather high degree of subjectivity and emic thinking. This is problematic when it comes to quantification and identifying trends in the material. Heavily burnt core material was excluded from the study. It could have diverted our attention from the better preserved assemblages.

METHODOLOGICAL ASPECTS

A truly reliable identification of unskilled knapping on a site would require a comprehensive, in-depth study of the operational chain manifest at the site, including refitting studies, combined with a good grasp of the technology in question (*cf.* Bodu *et al.* 1987; Pigeot 1990). Instead of taking an assemblage perspective, we have chosen to focus on artefactual evidence (*cf.* Stapert 2007). Through an identification of possible novice knapping errors, the potential for identifying unskilled flintknapping without refitting will be discussed in this article.

We have used two different levels of systematic enquiry:

1) Possible novice knapping errors, primarily stacked hinges and incipient cone fractures on cores and core fragments.
2) Height measurement of bipolar cores. This is complemented by more incidentally noticed artefacts of interest for the subject, as well as the inclusion of possible miniature arrowheads.

Cores can be studied effectively, as they usually make up a limited amount of material but still yield a large amount of technological information (*cf.* Stapert 2007; Assaf *et al.* 2016). There is a multitude of attributes that can be identified in order to evaluate skill (see, for example, Bamforth & Finlay 2008; Högberg 2008; Sternke & Sørensen 2009; Darmark 2010; Donahue & Fischer 2015; Eigeland 2015: 176–177; Finlay 2015; Assaf *et al.* 2016), and one must, of course, bear in mind that the same person can produce conflicting skill signatures (Finlay 2008). Initially, we have focused our attention on identifying a limited number of attributes related to a low level of skill. These are:

1) Traces of unsuccessful reduction, e.g. hinges. Stacked hinges are particularly of interest, as hinges *per se* do not necessarily signal lack of skill. Striking repeatedly into a hinged flake scar (i.e. stacked hinges) is, however, viewed as a sign of limited understanding of knapping (Bamforth & Finlay 2008; Finlay 2008, 2015; Sternke & Sørensen 2009; Darmark 2010; Eigeland 2015: 176–177; Assaf *et al.* 2016).
2) Traces of battering near the platform edge (Assaf *et al.* 2016) or mishits and hammermarks, i.e. incipient cone fractures anywhere on the core (Bamforth & Finlay 2008; Finlay 2008, 2015; Sternke & Sørensen 2009), are also something that could be produced by skilled knappers (Finlay 2008), but which are to be seen as a mistake and thus point to a lack of skill.
3) Rounded/crushed core. An inability to create a suitable platform for further reduction will result in a rounded core, often exhibiting crushing (Eigeland 2015: 141–144).

In the following, cores displaying more than one of the attributes listed above will be termed beginner cores.

The raw material quality has been noted for each core, since the possibility for learning is dependent upon raw material availability (Pigeot 1990; Bamforth & Finlay 2008; Ferguson 2008: 53–54). Furthermore, skill-level is harder to determine on coarse flint (Eigeland 2015: 192). The raw material quality was determined as either *fine*, *grainy* or *coarse*.

Bipolar cores, the technology being as simple as it is (Patterson & Sollberger 1976; Hayden 1980; Knight 1991), are challenging to use in a discussion on matters of skill. However, the cores have been used in discussions of juvenile knapping (e.g. K. Knutsson 1986). The first assumption here is that the cores were held between the index finger and the thumb and not in a holding device. The second assumption, being more of a leap of faith, is that the core is not discarded until the knapper risks hitting his/her own thumb with the hammerstone. Emanating from these assumptions, the distance between the poles of bipolar cores can be used as a measure to argue for the presence, if not the absence, of children using bipolar technology. A child's thumb can be approximated to have a width of 10–15 mm, with no difference between the sexes (Hohendorff *et al*. 2010), while the thumb of an adult, with greater difference between the sexes, is considered here as 15 mm and upwards (see also K. Knutsson 1986).

Miniature versions of tools have been argued to be an indicator of children, as children tend to imitate grown-up behaviour (K. Knutsson 1983; Park 2006; Stapert 2007). Based on this idea, we have chosen to include Early Mesolithic arrowheads in this study.

Site	Core/fragment ratio	Stacked hinges	Battering	Rounded/ crushed core	Beginner cores/ frag.	Fine flint (quality)	Bipolar cores	BP <15 mm	Total
Sagene B2	7/34	7/18	3/36	0	7	26/39	1/1	0	63
Sagene B4	3/3	2/6	0/4	0	0	6/6	0	-	6
Sagene B6	4/1	0/5	0/5	0	0	4/5	1/1	0	6
Sagene B1	8/24	8/15	1/27	1	4	23/32	2/3	0	53
Kvastad A1	1/15	3/7	2/12	0	2	9/16	0	-	110
Kvastad A2*	8/50	6/32	4/56	0	6	27/58	1/3	0	38
Kvastad A3	1/2	1/2	0/2	0	0	1/3	1/1	0	4
Kvastad A4	5/15	3/14	1/16	1	2	12/20	3/8	0	57
Kvastad A5-6	0/3	0/2	0/2	0	0	1/3	0	-	7
Kvastad A7	0/1	0/0	0/1	0	0	1/1	0	-	1
Kvastad A8	0/1	0/0	0/1	0	0	0/1	5/5	0	7
Kvastad A9	2/3	2/2	0/5	0	0	2/5	0	-	6
Total number of observations EM sites	39/152	31/103	11/167	2	21	112/189	14/21	0	358
TECHNOLOGICAL SHIFT									
Hesthag C4	3/15	4/10	1/2	0	2	9/16	14/19	4	42
Hesthag C2*	33/43	9/45	1/24	0	7	17/53	54/75	12	206
Total number of observations MM sites	36/58	13/55	2/26	0	9	26/69	68/94	16	248
TECHNOLOGICAL SHIFT									
Krøgenes D1*	5/7	2/10	1/10	0	0	4/10	14/38	0	60
Krøgenes D2	32/31	17/60	2/16	0	7	25/61	5/25	0	179
Total number of observations LM sites	37/38	19/70	3/26	0	7	29/71	19/63	0	239
TECHNOLOGICAL SHIFT									
Krøgenes D7	1/7	1/1	0/8	1	1	5/8	0/3	0	16
Krøgenes D10	2/3	1/1	1/4	0	2	3/4	0/2	0	8
Krøgenes D5	0/5	0/1	0/4	0	0	4/5	7/15	1	29
Krøgenes D11	-	-	-	-	-	-	2/2	0	2
Hesthag C6*	1/5	½	1/1	1	1	1/5	1/2	0	13
Total number of observations Neo sites	4/20	3/5	2/17	2	4	13/22	10/24	1	68

Table 3.7.1: All observations of stacked hinges, battering, rounded cores, flint quality and small bipolar cores at the E18 Tvedestrand–Arendal sites. Observations of hinges, stacked hinges or battering are noted as N observations/of N possible observations. Sites with several use-phases (marked with *) are placed in the most representative use phase.

These are plentiful at our sites and (for example at Sagene B2 where arrowheads constitute a notable 1.1 % of all finds, see Darmark, chapter 2.2.1, this volume) are dealt with in more detail in another chapter (Darmark & Viken, chapter 3.8, this volume). Following the arguments there, tanged and single-edged arrowheads with a maximum width of 0.8 cm are very small. In this context, arrowheads narrower than 0.7 cm are viewed as possible miniatures, i.e. toys.

ANALYSIS

Platform cores and core maintenance flakes

Production flaws, in the form of stacked hinges and/or battering, have been observed on the majority of the sites, regardless of which time period they belong to (see table 3.7.1). Five of the twelve Early Mesolithic sites, both the Middle Mesolithic and both the Late Mesolithic sites and two of the five Neolithic sites have cores with both these traits. The subjectively selected "beginner cores" constitute about 6 % of the core material during the Early Mesolithic, 4 % during the Middle Mesolithic, 3 % during the Late Mesolithic and 6 % during the Neolithic.

Since the Middle- and Late Mesolithic periods are characterized by technological systems focused towards the production of blades through pressure, the amount of stacked hinges and battering is surprisingly high. This is also true when taking into account the fact that the quality of the flint used is lower during these periods, which would make it harder to spot incipient cone fractures. According to our finds, "battering" actually shows a slightly increasing trend throughout

Site	Coordinates	Layer	Item	Stacked hinges	Battering/ hammer-marks	Flint quality	Comment
B2	710x275y NØ	7	Core fragment	Yes	No	F	Secondary bipolar reduction.
B2	710x277y NV	3	Irregular core	Yes	No	F	Rounded core, unsuitable striking-angles, crushing.
B2	711x273y SV	1	Core fragment	-	Yes	F	Part of a core tablet removing incipient cone fracture.
B2	709X278Y NV	2	Platform core	Yes	Yes	F	Exhausted prismatic core with hammermarks and stacked hinges.
B2	712X277Y SV	1	Core fragment	-	No	F	Platform rejuvenation flake, secondary bipolar reduction, redundant preparation.
B2	726X282Y NV	1	Core fragment	Yes	No	F	Redundant preparation, crushing
B2	709X278Y NV	2	Platform core	Yes	No	F/G	
B1	474x156y NØ		Platform core	Yes	No	F	Crushed base. Preparation towards the platform.
B1	496x158y NV		Core fragment	Yes	No	F	Stacked hinges and preparation towards platform.
B1	498x158y NV		Platform core	Yes	No	F	Deviating core. Crushed base.
B1	501x138y NØ		Irregular core	Yes	Yes	F	Compact, rounded core. Crushing and hammermark.
A1	-	F1334	Core fragment	-	Yes	F	Unclear, but deviating reduction, possible hammermark.
A2	946X132Y NV		Core fragment	No	Yes	F	Over-shot blade with facetted platform. The impact marks are clustered at the dorsal side of the blade.
A2	953X142Y NV		Platform core	Yes	Yes	C	Core with opposing platforms, but worked on multiple sides. Facetted platform.
A2	960X170Y NV		Core fragment	-	Yes	F	Proximal blade fragment. Abrupt distal end, possibly a result of previous mistake (hammermark).
A2	966x176y SØ		Core fragment	-	Yes	F	Platform rejuvenation flake removing incipient cone fracture
A2	969x172y SØ		Core fragment	No	Yes?	F	
A2	980x167y NØ		Platform core	Yes	No	F	Deviating core
A4	972X107Y SV	1	Core fragment	-	Yes	F	Small core tablet removing incipient cone fracture
A4	975X118Y NV	1	Irregular core	Yes	No	F	Compact rounded core

Site	Coordinates	Layer	Item	Stacked hinges	Battering/ hammer-marks	Flint quality	Comment
C4	5991x872y SØ	1	Core fragment	Yes	-	C	Beach flint, unsystematically worked, redundant preparation
C4	5992x873y NØ	2	Core fragment	No	Yes?	F	Resembles a conical core, but reduced by direct technique.
C2	160x161y NV		Conical core	Yes	-	F/G	Secondary bipolar reduction.
C2	162x159y SØ		Platform core	No	No	?	Miniature core. Redundant preparation, crushed base
C2	163x163y SV	1	Irregular core	Yes	No	Burnt	Bipolar?
C2	165x160y NØ		Platform core	Yes	No	F	Deviating core. Beach flint.
C2	165x159y SV		Platform core	-	-	F, burnt	Redundant preparation, miniature.
C2	166x159y SV		Conical core	Yes	-	Burnt	Problematic core.
C2	178x162y SØ	1	Irregular core	Yes	Yes	F	Secondarily used blade core. Two different knappers?
D2	930x287y		Handle core	Yes	-	C	Overhang and redundant preparation
D2	930x287y		Platform core	Yes	-	G	Beach flint nodule. Crushed base.
D2	936x298y	2	Core fragment	Yes	-	G	Whole core, crushed base, secondary use? Unskilled reduction.
D2	929x286y NØ	Step 1	Core fragment	Yes	No	G	Formerly good blade core/platform rejuvenation flake, secondarily unsystematically modified. Traces of use?
D2	933x286y SV	Step 1	Core fragment	Yes	No	G	Platform rejuvenation flake which has removed problematic stacked hinges. Traces of secondary bipolar reduction. Traces of use?
D2	937x297y	2	Core fragment	No	Yes	G	Decortication flake from nodule, cluster of impact marks centrally on dorsal side.
D2	933x293y		Irregular core	Yes	Yes	F	Four refittable fragments. Stacked hinges and hammer-marks
D7	69x72y		Platform core	Yes	No	F	Problematic round core.
D10	826x207y	1	Irregular core	-	Yes	F	Split beach flint nodule/flake. Hammermarks.
D10	828x208y	1	Irregular core	Yes	No	G	Beach flint nodule.
C6	252x326y NØ		Irregular core	Yes	Yes	F	Block-shaped core, a cortex-covered side used as platform. Impact marks centrally on flat surfaces, far from edges. Worked on anvil.

Table 3.7.2: All identified beginner cores and core maintenance flakes from the E18 Tvedestrand–Arendal sites.

the Stone Age, from 7 % in the Early Mesolithic to 12 % in the Neolithic, as does the presence of "rounded/crushed cores", which range from less than 1 % during the Early Mesolithic to 6 % during the Neolithic.

Early Mesolithic beginner cores

Beginner cores were identified on five Early Mesolithic sites (see table 3.7.1 and table 3.7.2): Sagene B2, Sagene B1, Kvastad A4, Kvastad A1 and Kvastad A2 (see Darmark, chapter 2.2.1; Viken, chapter 2.2.3; Darmark *et al.*, chapter 2.2.6; Stokke *et al.*, chapter 2.2.5; Stokke & Reitan, chapter 2.5.5, this volume).

The irregular core from Sagene B2 is a rounded core of fine flint (fig. 3.7.3 a). Stacked hinges are present on more than one side, and there are no good striking angles. Crushing is visible on the base of the core, which suggests that the core may have been placed on an anvil while being reduced. Hammermarks are not visible, but they would also be hard to distinguish on this opaque flint, which bears signs of burning.

The dual-platform, prismatic core from Sagene B2 is a skilfully produced blade core of fine flint (fig. 3.7.3 b). It does, however, show several production flaws: stacked hinges on the front and one of the sides, and hammermarks on one of the platforms as well as on the front and back of the core. The position of the hammermarks, as far as 1 cm from the nearest edge, shows that the knapper had a low degree of knowledge

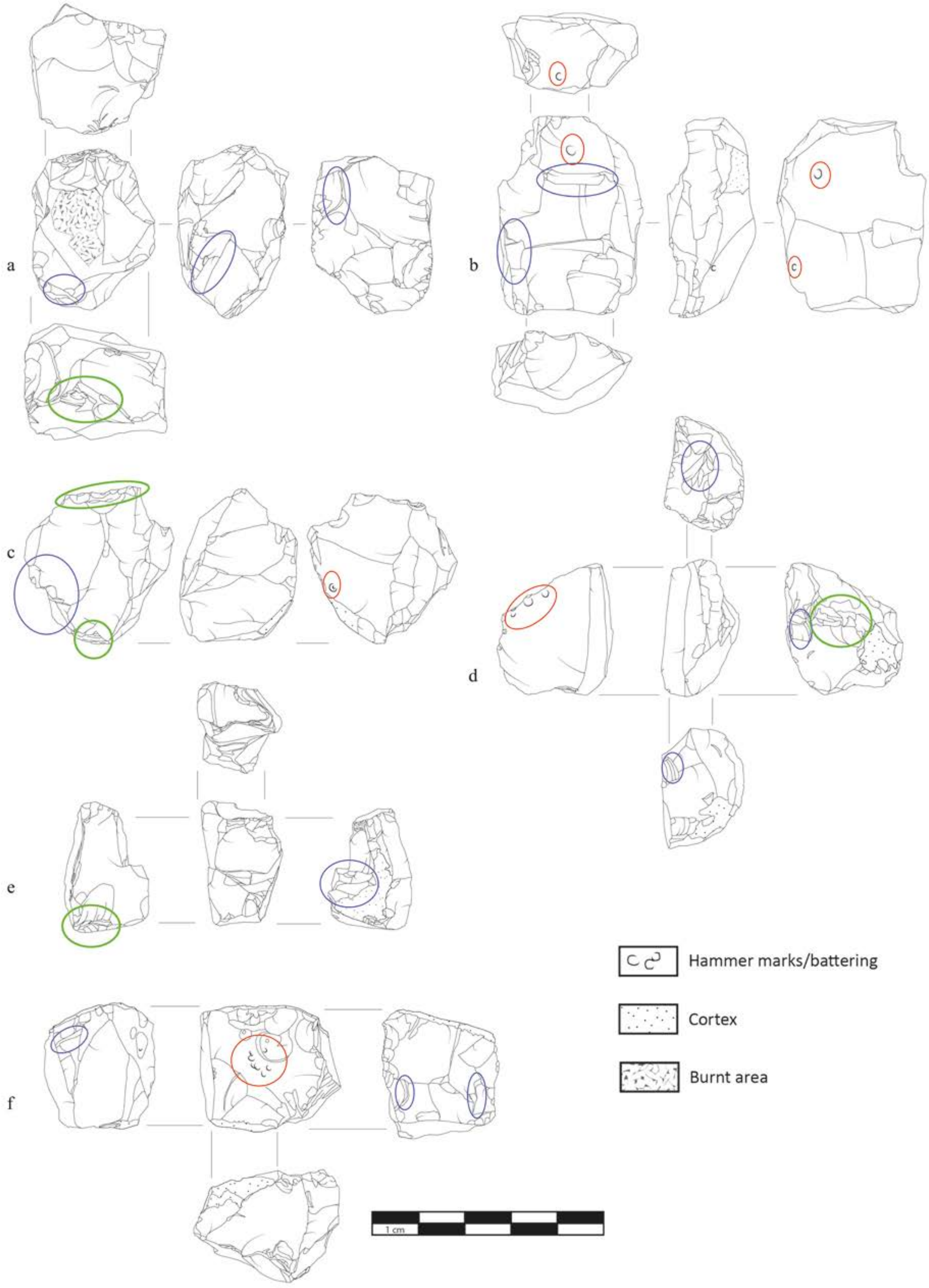

Figure 3.7.3: Selected cores from the E18 Tvedestrand–Arendal sites showing various signs of unskilled craftsmanship. Blue circle: Stacked hinges. Red circle: Battering/hammermarks. Green circle: Crushing. Ill.: S. Viken / KHM.

and know-how, and lacked coordination. Presumably, the core was viewed as exhausted by the blade producer, and then reworked by an unskilled knapper.

Another irregular, round core was found on Sagene B1 (fig. 3.7.3 c). This core is of high quality flint and displays stacked hinges, as well as a hammermark. Signs of crushing are visible on two opposing sides, indicating bipolar crushing. Negatives from an earlier stage of the reduction further suggest that this was initially a blade core.

Middle Mesolithic beginner cores

Beginner cores were identified on both of the Middle Mesolithic sites (table 3.7.1 and table 3.7.2); Hesthag C4 is the older of the two (Viken, chapter 2.3.1, this volume), while Hesthag C2 is the younger and with younger elements in the inventory (Viken, chapter 2.3.2, this volume).

A microblade core from Hesthag C2 has been reused by an unskilled knapper, resulting in an irregular core with traces of battering on one side (see fig. 3.7.3 d). On the opposing side, crushing indicates that the core was placed onto a hard surface. The core has been turned around, and display stacked hinges at what was previously a platform for microblade production. Stacked hinges are also present on the base and on the partly cortex-covered side. In addition, the side opposing the microblade-front seems to have been used as a scraper. This core has had three "lives": a quite large, partly cortex-covered flake was retouched and used as a scraper. When the scraper was exhausted, it was turned into a narrow-fronted microblade core. After the microblade core was discarded, it was reworked by an unskilled knapper.

At Hesthag C4, a core resembling a conical microblade core was identified. This core displays techniques deviating from the expected operational chain, as direct percussion was used.

Late Mesolithic beginner cores

Krøgenes D2 is the only Late Mesolithic site with beginner cores. This site has been revisited several times over a period of at least 300 years in the Late Mesolithic (Mansrud *et al.*, chapter 2.4.1, this volume).

One of the cores (fig 3.7.3 e) has a front from which a few narrow blades have been detached, using direct technique. The core seems to have been supported, judging from extensive crushing of the base. The back of the core shows the removal of a flake that has plunged deep into the core and several subsequent flaking attempts into the same negative. Parts of the platform display redundant preparation, resulting in unsuitable angles. At some point, a ridge created by the removal of a blade has possibly been used as a scraping edge.

Neolithic beginner cores

Beginner cores were identified on three Neolithic sites: Krøgenes D7, Krøgenes D10 and Hesthag C6 (Reitan 2017a; Reitan *et al.* chapter 3.9, this volume; Stokke & Reitan, chapter 2.5.1, this volume). Three cores and one opened/tested beach flint nodule bear signs of unskilled knapping.

An irregular, block-shaped core from Hesthag C6 (fig. 3.7.3 f) serves to illustrate the Neolithic beginner cores. The core has traces of battering centrally on one side. Two cone-shaped protrusions are visible on the same side, indicating that the core has been battered at an earlier stage as well, resulting in deep latent fractures. On the opposing side crushing is visible, suggesting that the core was placed on a hard surface during the battering. The core has been reduced from multiple platforms, including a cortex-covered one. Stacked hinges and crushing appear on more than one side.

Bipolar cores

All the cores categorized as bipolar during the initial find registration have been reanalysed for this article, to produce reliable pole-to-pole measurements. The find group can potentially encompass both bipolar cores (where flakes are the desired product) and scalar pieces (a wedge-like tool) (Hayden 1980; K. Knutsson 1986; for discussions on cores/wedges, see also e.g. Fossum 2014b: 186; Eigeland 2015: 160–161; Solheim 2013a: 269). A large number of the objects originally designated as bipolar cores have been removed from the analysis, either due to uncertainties regarding the presence of two opposite poles, or because the object was reclassified, frequently as a bipolar flake. We noted whether the cores had been rotated during reduction, and whether they display retouch or visible use wear.

A total of 111 bipolar cores were measured during the reanalysis. The sites contain varying numbers of bipolar cores, a variation which seems to be chronologically dependent (Jaksland 2001; Reitan 2016). The vast majority of the cores (68) come from the two Middle Mesolithic sites (Hesthag C2 and Hesthag C4), while the seven Early Mesolithic sites with bipolar cores (Kvastad A2, A3, A4, A8 and Sagene B1, B2 and B6) only contain a total of 14 cores. The Late Mesolithic sites (Krøgenes D1, D2 and D3) have a total of 19 cores, and the three Neolithic sites (Krøgenes D5, Mørland D11 and Hesthag C6) have 10 cores.

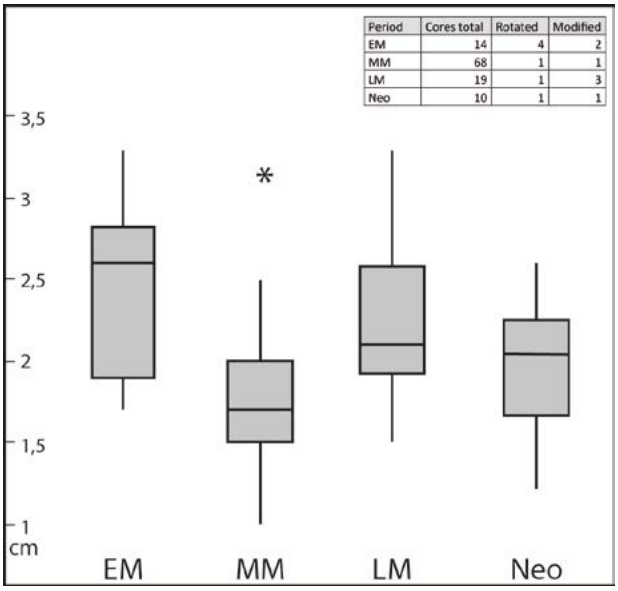

Figure 3.7.4: Boxplot showing bipolar core height (pole-to-pole measurements) in centimetres, grouped according to periods (Abbrev.: "EM" = Early Mesolithic, "MM" = Middle Mesolithic, "LM" = Late Mesolithic, "Neo" = Neolithic). Table in upper right corner shows the number of cores within each period, as well as the amount of "rotated" and secondarily modified cores at the E18 Tvedestrand–Arendal sites.

The size of the cores clearly varies between the chronological periods (see fig. 3.7.4). The Early Mesolithic cores are generally the largest, with an average height of 2.5 cm. The size drops significantly during the Middle Mesolithic, before the core size again increases somewhat in the Late Mesolithic and the Neolithic. A total of 17 cores (15 %) are smaller than 1.5 cm. With one exception, all of these are from the Middle Mesolithic sites (Hesthag C2 and Hesthag C4), the remaining one being from one of the Neolithic sites (Krøgenes D5). This might indicate the presence of children on the Middle Mesolithic sites excavated within the project. Both the Middle Mesolithic Hesthag sites have been interpreted by the excavator as residential sites, albeit differing in intensity (Viken, chapters 2.3.1 and 2.3.2, this volume).

Miniature tools

The single-edged and tanged arrowheads from the Early Mesolithic are in general surprisingly small and it is proposed that the smallest specimens might have been used in connection with lateral inserts (see Darmark & Viken, chapter 3.8, this volume), but alternatively they could be viewed as non-functional miniatures. Plotting the length against width of complete arrowheads shows a strong positive correlation between the two variables, with a clustering of points within the dimensions 1.5–2.5 x 0.6–1.1 cm (see Darmark & Viken, chapter 3.8, this volume fig. 3.8.4). A few outliers are larger than this, and even fewer are smaller. No obvious groups form, that could be ascribed the function of "toys", unless the majority (i.e. the central cluster) are to be seen as such. However, it is of interest to note that the smallest arrowheads (with the limit set at < 0.7 cm width) are from the sites Kvastad A2 and -A4, and Sagene B1, -B2 and -B6. With the exception of the last site, all these sites also have cores that are interpreted as evidence of unskilled knapping (see "Discussion" passage below).

Additional observations

On the Early Mesolithic site Sagene B2, a sandstone nodule has been worked into a core preform. Some flakes have been struck from the intended platform, and a corner of the stone is worked to prepare for a crested blade. The preform shows that the knapper was not completely inexperienced, as he/she had some basic understanding of how cores were prepared. However, the natural surface is not removed on large parts of the nodule, and it would need to be shaped further to create a proper platform and good striking-angles. The person creating the preform thus seems to have by-passed some important core production stages. The fact that sandstone is not commonly used for blade production further signifies that the preform could be the result of an unskilled knapper practising flint technology on a locally available raw material.

Two secondarily modified flake axes were found together on the Early Mesolithic site Sagene B1. They have several hinges as a result of being knapped from obtuse striking-angles. These axes are unsymmetrical and are interpreted as the result of unskilled knappers practising knapping on discarded axes. From the same area of the site, two core preforms of quartz were identified. These preforms are quite similar to the core preform from Sagene B2, as they each have one side prepared for a crested blade. The preforms were discarded at an early stage (Viken, chapter 2.2.3, this volume).

On the Middle Neolithic site Krøgenes D5 two beginner cores were discovered among the flake material. The cores are discarded flakes which have been worked from several angles, and both have several hammermarks clustered centrally on the ventral side of the flake. One of these cores displays similarities with an experimental beginner core (see Eigeland 2015: 182, figure 7.6). This experiment involved a novice attempting blade production by direct percussion. Oral instruction and advice was given by a skilled flintknapper, but the novice had to do all the knapping (Eigeland 2015: 181–183).

DISCUSSION

Cores showing traits that indicate manipulation by beginners were identified on several sites, spanning from the oldest Early Mesolithic site to the Neolithic sites (table 3.7.5). Early Mesolithic sites with beginner cores are Sagene B1 and -B2, and Kvastad A1, -A2 and -A4. These are among the larger Early Mesolithic sites excavated. Both Middle Mesolithic sites (Hesthag C2 and -C4), one Late Mesolithic site (Krøgenes D2) and three Neolithic sites (Krøgenes D7 and -D10, and Hesthag C6) also have beginner cores. All these sites were interpreted as small or large settlement sites by the excavation leaders.

Based on the Early Mesolithic beginner cores, it seems unskilled knappers often found discarded pieces/cores and used these to practise knapping by imitating adults (*cf.* Högberg 2008). However, some core tablets (from Sagene B2 and Kvastad A4) which have removed platforms with impact marks also indicate scaffolding – that is, skilled knappers helping beginners to correct mistakes (*cf.* Ferguson 2003, 2008). Bipolar technology does not seem to be imitated to the same extent. Since the investigation hints at this being a rather marginal practice during the Early Mesolithic, a low level of bipolar imitation is perhaps to be expected. The Early Mesolithic practice seems to be oriented towards learning blade production.

During the Middle Mesolithic, many of the same characteristics as in the preceding phase are visible on the identified beginner cores. Beginners receiving help in correcting mistakes have not been identified in the material from this period. Discarded microblade cores are reused by unskilled knappers, but the operational scheme seems to involve bipolar reduction to a larger extent.

Site	"Beginner cores"	Small bipolar cores	Miniature tools
Sagene B2	Yes	No	Yes
Sagene B4	No	–	–
Sagene B6	No	No	Yes
Sagene B1	Yes	No	Yes
Kvastad A1	Yes	–	No
Kvastad A2	Yes	–	Yes
Kvastad A3	No	No	–
Kvastad A4	Yes	No	Yes
Kvastad A5–6	No	–	–
Kvastad A7	No	–	–
Kvastad A8	No	No	–
Kvastad A9	No	–	No
Hesthag C4	Yes	Yes	–
Hesthag C2	Yes	Yes	–
Krøgenes D1	No	No	–
Krøgenes D2	Yes	No	–
Krøgenes D7	Yes	No	–
Krøgenes D10	Yes	No	–
Krøgenes D5	No	Yes	–
Mørland D11	–	No	–
Hesthag C6	Yes	No	–

Table 3.7.5: Identified beginner cores, small bipolar cores and possible miniature tools at the sites investigated within the E18 Tvedestrand–Arendal project.

In the Late Mesolithic, apart from reusing discarded microblade cores, pieces unsuitable for microblade production have been used by unskilled knappers, such as decortication flakes from beach flint nodules. One platform rejuvenation flake from Krøgenes D2 has removed a problematic area with stacked hinges from a core, which could indicate scaffolding.

It is difficult to determine whether or not the Neolithic beginner cores have been blade cores at an earlier stage. However, beach flint nodules seem to be the starting point for two out of four beginner cores. Therefore, discarded blade cores do not seem to have been available for the unskilled knappers. This could be taken as a sign of the raw material, imported high quality flint, being under control during this period.

Many of the beginner cores from the E18 Tvedestrand–Arendal project show evidence of having been supported against/placed on a hard surface, resulting in crushing at the base of the core. Such behaviour is often observed in experiments when children knap (*e.g.* Sternke & Sørensen 2009; Eigeland 2015: 164–165). Experimental studies have also demonstrated that children's learning abilities are strongly affected by a lack of concentration, a limited understanding of striking-angles (Finlay 2015), and the absence of a necessary plan of action (Geribàs *et al.* 2010). The latter two characteristics are observable through the investigated novice attributes on beginner cores from the E18 Tvedestrand–Arendal project, and we find it likely that the identified beginner cores are in fact children's products. Ethnography, although reflecting significant variation on the subject, seems to support a family-based, quotidian learning system with an informal form of learning based on the child's observation and participation. Children start their learning process by playing and imitating adult behaviour. When they are about 10–12 years old, they begin learning by acquiring varying degrees of instruction (*cf.* Keith 2006, with references; Park 2006, with references). However, this is by no means a rule (*cf.* Bamforth & Finlay 2008).

Based on the analysed material, we suggest that play and imitation have played an important role when beginners practised flintknapping on the studied sites (*cf.* Högberg 2008). Even though some core maintenance flakes in the studied material indicate scaffolding, the presence of rounded and crushed cores at some of the sites indicates a degree of autonomous practice. The impression of play and imitation as important learning mechanisms on the E18 sites might also be the result of the method applied in this article. Ferguson (2003: 126) notes that unskilled knappers who are monitored closely by a teacher during training leave no obvious traces in the archaeological record. As a consequence, evidence of scaffolding may be challenging to recognize. If material from the sites with identified beginner cores was refitted (*cf.* Bodu *et al.* 1987; Pigeot 1990), traces of, for example, scaffolding

Figure 3.7.6: Implicitly we tend to ascribe the lithics found at Stone Age sites to adult, often male, production. Ill.: J. Jäger.

could become more visible. Scaffolding can function as a risk-minimizing strategy, in terms of reducing raw material waste, allowing novices to develop skills by performing only the tasks they are capable of (*cf.* Ferguson 2003: 126, 2008: 53). Possible traces of the raw material being under control have been observed in the E18 material. In the Early Mesolithic, this is visible through the discussed use of sandstone for practising core preparation at Sagene B2 and the quartz core preforms at Sagene B1. The Neolithic sites contain blades and tools made of high quality flint, but two out of four identified beginner cores are made of beach flint nodules. In other words, there is an observable difference between the raw material used by skilled knappers and that used by novices on the Neolithic sites.

The investigation of bipolar cores has revealed that, even though bipolar technology is present from the earliest times onwards (*cf.* Ballin 1999b; Damlien 2016: 29), there is a tangible increase in the number of bipolar cores around 8000 cal. BC. At the same time, it seems that the focus of the technology shifts in a manner that leaves smaller cores, which have seldom been rotated or secondarily modified, at the sites. It would also seem that the Middle Mesolithic sites are the only sites that give clear indications of bipolar knapping done by children. The impression from our material is that the bipolar cores at the Middle Mesolithic sites are often exhausted bipolar cores. At sites from other periods, the bipolar cores more often seem to be what would be called scalar pieces, i.e. a tool type (*cf.* Knight 1991: 60).

Miniature versions of tanged and single-edged arrowheads are challenging to define on the basis of their size distribution. The smallest arrowheads seem to occur together with larger ones at the (mostly larger) sites singled out as having high frequencies of "beginner cores". A problem in this respect is that the smaller sites to a considerable extent lack complete arrowheads. A future approach to this theme could be to compare complete (unused) arrowheads with fragmented or impact fractured (used) ones from a skill perspective, to see whether there is any substance to the ideas proposed earlier in this article.

Dugstad (2010: 65) states that the common understanding of the Mesolithic is based on the notion

Figure 3.7.7: A skill perspective on lithics could alter our perception and nuance the view of Stone Age craftsmanship. Ill.: J. Jäger.

of grown men hunting big game (fig. 3.7.6). Of course, children were members of Stone Age societies (Hildebrand 2012). However, an investigation of flint-working skill concerns more aspects than identifying children in order to give a more complete, engendered vision of the past (*cf.* Dugstad 2010; Kamp 2001; Hildebrand 2012; Cunnar 2015). It is not at all certain that all Stone Age sites were populated by groups comprising men, women and children (*cf.* Viken, chapter 3.5, this volume), although see Dugstad (2010:65) for another viewpoint. Several site assemblages included in our study do not contain any beginner cores. These are seven Early Mesolithic sites (Sagene B4 and -B6, and Kvastad A3, -A5-6, -A7, -A8 and -A9), one Late Mesolithic site (Krøgenes D1) and one Neolithic site (Krøgenes D5). The sites lacking beginner cores in our study are primarily interpreted by the individual excavation leader as task specific, short lived sites. However, two beginner cores were, as mentioned above, found in the flake material from the Neolithic site Krøgenes D5. This site also had one further indication of children, in the shape of a small bipolar core. As a consequence, this site could be seen as a small family based settlement site. As demonstrated by Eigeland (2015: 380), smaller sites lacking traces of unskilled knapping are likely to have been used primarily by task groups on, for example, hunting expeditions. We see two possible explanations for the absence of unskilled knapping at sites used by task groups: either, unskilled knappers (children) did not join task groups on expeditions, or task groups only brought a limited amount of raw material and kept it safe from children's wasteful experimentation.

CONCLUDING REMARKS AND IMPLICATIONS FOR FUTURE RESEARCH

The E18 Tvedestrand–Arendal project has generated thousands and thousands of new finds of knapped stone, from sites ranging from the Early Mesolithic to the Late Neolithic, from a geographically restricted area. The main objective of this article has been to illuminate skill in lithic production using sites from the present project. We have highlighted certain traits that can be identified in order to rapidly categorise an assemblage as potentially including beginner products. The study indicates that beginner products are likely to be present on settlement sites from all periods of the Stone Age, but unlikely to be observed on task specific sites such as hunting stations (see also Donahue & Fischer 2015; Eigeland 2015: 380). Future research could focus on Early Mesolithic sites from the pioneer phase. Conceivably, a pioneer phase would be characterized by scouting task groups, not involving children, but this remains to be tested.

By actively looking for the artefacts deviating from the expected technological scheme during finds registration, one could open up for new perspectives on Stone Age sites, since an examination of artefact variability might allow for the recognition of children in the archaeological record (*cf.* Flenniken 1984: 198–200; Ferguson 2008). These finds are important in that they have the potential of highlighting an aspect of prehistoric craftsmanship so easily forgotten, namely that the crafts practised had to be learnt, and that these episodes of learning have had material consequences (fig. 3.7.7).