Lithic Assemblages
A guide to processing, analysis and interpretation

Guide 49
‘How to squeeze blood from stones’
– processing, analysis and interpretation of lithic assemblages

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FOREWORD

In March 2017, the Scottish Archaeological Research Framework (ScARF) organised a lithics workshop in Edinburgh, aiming at teaching anybody with an interest in lithics the basic elements of this specialist field. The author was one of several speakers, and he gave a ‘hands-on’ presentation of the main types of lithic debitage, cores and tools people interested in archaeology may encounter. Following this event, BAJR contacted the author, and it was agreed to transform the author’s presentation into a BAJR guide for British lithics, in collaboration with ScARF. The guide should be perceived as a brief introduction to lithics and ‘how to squeeze blood from stones’ – that is, how to interpret the past through the lithic evidence. If the reader needs more detail or information, he/she should consult more specialized archaeological literature. The guide deals with the processing of lithic finds from the Late Upper Palaeolithic to the Early Iron Age, but not the Lower, Middle, and Early Upper Palaeolithic periods.
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INTRODUCTION

The purpose of this introductory section is to discuss how we generate information on prehistoric societies through analysis of lithic finds, and which approaches and methodologies may be most productive in this context. This process has been referred to as ‘squeezing blood from stones’ (Eriksen 2000, 7), and, as many specialists have experienced, apparent lithic ‘waste’ may offer much information on past lives, if suitable approaches are applied – from recovery, through specialist processing and publication, to final museum deposition.

Although prehistorians occasionally have other find categories to their disposal – such as for example pottery, bone and antler – in Britain, pottery was only produced from the Neolithic onwards, and in most cases bone and antler artefacts have perished. The further back in time we go, the more likely we are only to have lithic artefacts available as a key to prehistoric societies.

In 1954, Christopher Hawkes defined his Ladder of Inference (Table 1). This ladder included four steps, where it was suggested that 1) the lower levels of the ladder would generally be the easiest to deal with, and 2) the different levels would, to a degree, depend on previous levels having been dealt with in a satisfactory manner.

Table 1. Hawkes’ Ladder of Inference (1954).

<table>
<thead>
<tr>
<th></th>
<th>Belief systems (ideology)</th>
</tr>
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<tbody>
<tr>
<td>4</td>
<td>Socio-political Institutions</td>
</tr>
<tr>
<td>3</td>
<td>Subsistence Economics</td>
</tr>
<tr>
<td>2</td>
<td>Production techniques</td>
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</table>

In terms of lithic artefacts, this means that – as most of you may have experienced – it is easier to characterize lithic objects formally, or define the reduction method or operational schema of a specific industry, than to define the political or religious reasons for bringing a piece of Arran pitchstone from an Early Neolithic social territory in central Scotland to a social territory in northern Scotland, such as Orkney, or a piece of Yorkshire flint from north-east England to Cumbria. It is the author’s view, though, that if the analyst’s methodological tool kit is put together in a sensible manner, he or she may be able to produce information relating not only to technological matters, but also to the economical, socio-political and religious world of prehistoric people.

However, the process of selecting a set of analytical approaches is very much a result of the analyst’s personal identity as an archaeologist, and which form of archaeology he or she subscribes to. To many, this is seen as a matter of being either a processual or post-processual archaeologist – that is (put in black and white), an archaeologist who either makes do with the description of artefacts or one who focuses entirely on the interpretation of the past and leaves out the hard work of characterizing the material culture in detail. There may be a third way (we could call this ‘third-way archaeology’, as
opposed to processual and post-processual archaeology), where we characterize and systematize our finds first, and then interpret the past on the basis of the detailed records we produce. Only describing the objects, or only interpreting the past without having carefully processed the lithic finds, are both meaningless pursuits.

Although some colleagues may find this approach a bit ‘un-sexy’, it is in line with cosmologist Carl Sagan’s (1987) suggestion that ‘... it’s OK to reserve judgement until the evidence is in’. To a degree, the author’s stance may have been influenced by his background in Danish archaeology, with many Danish archaeologists blatantly claiming that archaeology is a science, but it doesn’t really matter whether we subscribe to this perception of archaeology or not, as long as we agree on the application of the scientific method (Bright 1952). In an archaeological context, the scientific method could be described as in Table 2.

Table 2. The scientific method applied to an archaeological situation.

<table>
<thead>
<tr>
<th></th>
<th>Characterize the lithic finds and their find contexts, and make observations on this basis.</th>
</tr>
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<tbody>
<tr>
<td>2</td>
<td>Formulate a hypothesis.</td>
</tr>
<tr>
<td>3</td>
<td>Select suitable methods for testing the hypothesis.</td>
</tr>
<tr>
<td>4</td>
<td>Test.</td>
</tr>
<tr>
<td>5</td>
<td>On the basis of the test, either confirm or reject the hypothesis, and if neither is possible then either ‘park’ the hypothesis for the time being, or select a new set of methods, and rerun the test.</td>
</tr>
<tr>
<td>6</td>
<td>If the hypothesis was confirmed, transform the hypothesis into a general theory and move on.</td>
</tr>
<tr>
<td>7</td>
<td>It has been put that an archaeological ‘truth’ has a life-span of approximately five years, after which time it may have been either adjusted (following new discoveries or methodologies) or entirely replaced. This is simply the way of things and should not be perceived by the archaeologist as a defeat.</td>
</tr>
</tbody>
</table>

Our work as lithics specialists could be boiled down to: How do we, by application of the scientific method and a selection of suitable analytical approaches, interpret prehistoric societies on the basis of our lithic finds and their contexts? It should be borne in mind, that archaeology can never become an accurate science, as it deals with people, and as the archaeological record tends to be more or less truncated, and the best we can ever hope to do is – as they say in court – to prove a hypothesis beyond reasonable doubt.

The author perceives himself as a third-way archaeologist, and the following is his suggestion of how lithic finds could most sensibly be used as part of our interpretation of past societies, and which methodologies may be the most fruitful approaches in this context.
The journey of a lithic artefact or assemblage, from recovery to ‘final resting place’ in a museum, is a long one. Although, as a lithics specialist, the author mostly carries out office-bound specialist processing of the finds, it may be fruitful to quickly summarize the full journey. As shown in Table 3, this journey can be subdivided sensibly into three main groups of tasks, namely those dealt with by the specialist (Table 3.2), and those being dealt with before and after the specialist’s work (Table 3.1 and 3.3, respectively).

Table 3. The main stages of lithic artefact processing.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Research project</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Recovery and initial recording</td>
<td>Choice of location</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface collection or excavation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Choice of recovery strategy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Choice of recording detail and recording</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bagging strategy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Production of site notes/DSR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Passing on finds and DSRs to specialist</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Specialist processing</td>
<td>Initial sorting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Examination</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Characterization</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cataloguing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>External input (C\textsuperscript{14}, geological ID, etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interpretation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reporting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Publication</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Post-specialist procedures</td>
<td>Publication</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Returning finds and results to unit</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Treasure Trove processing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Museum</td>
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<tr>
<td></td>
<td></td>
<td>Exhibition or storage</td>
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</tbody>
</table>
As, in Britain (disregarding the Lower, Middle and early Upper Palaeolithic periods, which could be perceived as a parallel specialist field), lithic implements and waste were produced, used, and deposited through the late Upper Palaeolithic, Mesolithic, Neolithic, Bronze Age and Early Iron Age periods – or roughly 11,000 years – we are talking about a lot of objects. The first aims of the fieldwalker, excavator and analyst are 1) to gauge the chronology of a site or assemblage, that is, is the site an undisturbed single-occupation site (and the assemblage subsequently chronologically unmixed) or possibly a palimpsest, and 2) which specific period(s) are we dealing with (Table 4)?

Table 4. Basic chronological schema for Britain’s early prehistory (cal BC). The dates for the earliest periods of the LUP are based on European dates, and they are expected to change as continued research into the period makes more data available. The remainder of the dates are based largely on information from the various SCARF (Scottish Archaeological Research Framework) panel reports (Saville & Wickham-Jones 2012; Brophy & Sheridan 2012; Downes 2012; information on the LUP Sonia Grimm pers. comm.).

<table>
<thead>
<tr>
<th>Period</th>
<th>Phase</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Late Upper Palaeolithic (LUP)</strong></td>
<td>Hamburgian</td>
<td>12,700-12,000</td>
</tr>
<tr>
<td></td>
<td>Federemesser</td>
<td>12,000-10,800</td>
</tr>
<tr>
<td></td>
<td>Ahrensburgian</td>
<td>10,800-9,800</td>
</tr>
<tr>
<td><strong>Mesolithic</strong></td>
<td>Early Mesolithic</td>
<td>9,800-8,500</td>
</tr>
<tr>
<td></td>
<td>Late Mesolithic</td>
<td>8,500-4,000</td>
</tr>
<tr>
<td><strong>Neolithic</strong></td>
<td>Early Neolithic</td>
<td>4,000-3,500</td>
</tr>
<tr>
<td></td>
<td>Middle Neolithic</td>
<td>3,500-3,000</td>
</tr>
<tr>
<td></td>
<td>Late Neolithic</td>
<td>3,000-2,500</td>
</tr>
<tr>
<td><strong>Neo/BA transition (Chalcolithic)</strong></td>
<td>Early BA</td>
<td>2,200-1,550</td>
</tr>
<tr>
<td></td>
<td>Middle BA</td>
<td>1,550-1,150</td>
</tr>
<tr>
<td></td>
<td>Late BA</td>
<td>1,150-800</td>
</tr>
</tbody>
</table>

In terms of period labels, several different terminologies are in circulation, and the analyst must choose which one to use. Particularly the naming of the LUP and Mesolithic periods needs to be discussed.

In Britain, the terminology used to describe the various LUP material cultures has been slightly confusing, and it has been common practice to refer to the pre-Mesolithic periods as (sequenced earliest to latest) the Late Upper Palaeolithic, the Final Palaeolithic, and the Terminal Palaeolithic (Barton & Roberts 1996). Instead, it is suggested to follow Paul Pettitt’s (2008) ‘Europeanist’
approach: If the industries we are dealing with form part of techno-complexes covering large parts of north-western Europe, using the standard north-west European terminology makes more sense and this will make it easier to compare the British material with contemporary related finds on the Continent. As shown in Table 4, the Late Glacial lithic material so far recovered in Britain embraces the (Late) Hamburgian, the Federmesser-Gruppen, and the Ahrensburgian. Single-edged and tanged points from Orkney have been compared with similar pieces from the Scandinavian Fosna-Hensbacka complex, and they are thought to represent a northern ‘spin-off’ from the Ahrensburgian (Ballin & Bjerck 2016).

The terminology used to describe the earlier and later parts of the Mesolithic since the 1970s (eg, Mellars 1976) is equally unhelpful and causes some confusion as to what is and what is not contemporary. It is recommended not to use the terms ‘broadblade’ and ‘narrowblade’ as period-defining terms, as contemporary blades in different parts of Britain (eg, on the Scottish west-coast and on the east-coast) differ in terms of width, with blades from the former region being narrower than those from the latter region due to the availability of differently sized flint pebbles in those areas. Using the terms ‘broadblade industries’ and ‘narrowblade industries’ as periods would mean that the transition between these two periods (if broad and narrow blades are defined by blades broader and narrower than 8mm; below) would differ, with the transition being earliest in the west.

Instead, it is suggested to defined the early and late parts of the Mesolithic (using the neutral terms ‘the Early Mesolithic’ and ‘the Late Mesolithic’) as periods defined primarily by broad and narrow microliths (based on broad and narrow blades), but with the two groups of microliths being characterized not only by different sizes, but first and foremost by different sets of microlith forms. Although idiosyncratic microlith forms occur at all times through the Mesolithic (cf. Butler 2005), the Early Mesolithic period is associated mainly with obliquely blunted points and isosceles triangles (in southern Britain also Horsham and Honey Hill type microliths; Reynier 2005; see definitions below), and the Late Mesolithic period mainly with scalene triangles, crescents and edge-blunted pieces. As a rule of thumb, the transition between the two Mesolithic periods could be defined as the time when isosceles triangles were replaced by scalene triangles.

Recovery

As a principle, the archaeologist should expect to find lithic artefacts throughout the country, apart from those parts made uninhabitable in connection with events such as temporary re-glaciation and marine transgressions. How many pieces we find, and how the assemblages are composed, reflect the types of site we are dealing with, including settlement sites, hunting camps, as well as ritual and burial sites. As a general rule, you would expect many lithics on settlement sites and close to none near stone circles and henges (apart from the southern British ‘giant henges’; Ballin 2011b, 53).

How you deal with the individual sites depends – put in simplified form – on whether your investigation is a research project, driven by specific questions from the outset, or whether it is a commercial project with restricted time and funding. In many cases, a field investigation includes two components, namely a fieldwalking element, aimed at narrowing down where to begin digging and
where to stop, and the actual excavation. Some questions of limited scope may be answered by fieldwalking alone.

Fieldwalking clearly only allows finds on the surface to be recovered, whereas an excavation has as its purpose to recover finds from undisturbed contexts below the upper disturbed layers. The fact that, in the former case, lithics are discovered by walking people, and in the latter case by kneeling people, means that surface collections and excavated assemblages tend to be composed differently. Surface collections usually include relatively large and more spectacular pieces, whereas excavated assemblages (if we are talking about domestic settlements) may include thousands of tiny chips and they may be heavily dominated by mundane production waste.

The recovery of finds may be increased numerically in either case by fine-tuning the recovery policies. In terms of fieldwalking, it should be borne in mind that small hunting camps frequently only measure a few metres across (Fig. 1), and that they therefore may remain unnoticed if the fieldwalking lanes are too far apart. A second walk-over could therefore be useful, for example with the second set of lanes orientated at perpendicular angles to the first set of lanes. Once the finds start appearing it may then be relevant to re-walk the productive areas with the lanes closer to each other, or even crawl across parts of a field to notice small objects (eg, microlithic material) and to define the size and outline of a scatter. In connection with an excavation, sieving of Mesolithic sites is essential, either on the site or in the laboratory, as most microliths, microburins and microblade fragments may otherwise be lost. Many microburins recovered from the Nethermills site in Aberdeenshire (Ballin 2017c) measured as little as 2mm across.

Fig. 1. The small knapping floor at Steinbustølen in the Norwegian High Mountains (Ballin 1998). Distribution of chips (cont. int.: 50 (0-250), 125 (250-750), 250 (750-))/min.: 50). The reason for the more idiosyncratic way of calculating the chip contours of Steinbustølen is the extremely dense central concentration of chips. Calculated in the standard manner, with equidistant contour lines, neither protuberances nor the asymmetrical shape of the concentration would have been detectable. This concentration measured roughly 2.5m across.

Similar concerns are relevant in connection with excavations of Neolithic and Early Bronze Age sites, as prehistoric workshops producing for example bifacial arrowheads may only be detected through sieving, as the waste from the manufacture of these arrowheads is equally tiny.
The trench

It is quite common to discover in the laboratory, or in the specialist’s office, that a site has been somewhat truncated by the trench limits, and that peripheral parts of a lithic concentration may be missing. This is quite understandable, as some site peripheries may be weakly defined, but during excavation of Mesolithic sites in Norway the author developed an approach he found useful. The excavator should simply produce a distribution map of the lithics as the excavation is ongoing (eg, every evening) – either simply counting or weighing the pieces – define some suitable contour levels, and produce a basic contour map. This is not particularly time-consuming, and it would allow the borders of concentrations to be spotted, and avoid truncating the scatters.

Although in many cases, a commercial excavation is partly pre-defined, in the sense that there are fixed amounts of time and money available; that the surface areas concerned are restricted (for example by the route of a planned motorway); and that the methods chosen therefore frequently represents a question of what it is possible to achieve with the resources available, some recovery policies are more productive than others. By choosing certain approaches, at the expense of others, the excavator may in some cases prevent certain questions of being dealt with satisfactorily, or not at all.

Over the last few decades, it has become very popular to talk about prehistoric ‘life ways’ – indicating the archaeologist’s hope that it may be possible to deal with matters at higher levels of Hawkes’ Ladder of Inference (Table 1) – but in many cases we seem to forget that the internal structure of the site itself may be an important interpretational tool, which may allow us to characterize a site in terms of its purpose and activities – on-site behaviour. If we excavate a site – as has been common in the past – with reference to contexts only, and without recording the artefacts’ on-site grid coordinates, we may create a situation where we know close to nothing about the distribution of these objects across the site (if for example the entire floor of a hut is one context), activities taking place there, and the so-called ‘life ways’. If, instead, we excavate the sites in quarter-of-square metres (still making notes on the find contexts, of course), or no less fine than full square metres, it is possible to produce detailed distribution maps (such as contour maps), with the shapes of the produced concentrations frequently being socially diagnostic, and allowing us to define the individual scatter, as well as the site as a whole, in terms of the activities taking place (Fig. 2).
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Fig. 2. Lundevågen 31. Distribution of 1) burnt flint (cont. int.: 3/min.: 3), 2) chips (cont. int.: 20/min.: 20), 3) tools, and 4) average weight per lithic per grid unit (cont. int.: 0.2 gr./min.: min.: 0.4 gr.) (Ballin 2013a). This approach locates the central hearth; the knapping floor (in this case, the pointed-oval shape of Fig. 2.2 indicates the use of pressure-flaking); tool-using activity areas around the hearth; and a peripheral toss zone of large-sized waste.

Washing bagging, labelling lithic finds

It has occasionally been suggested that lithic finds should not be washed before they are sent to the specialist, as this may hamper potential later use-wear analyses. It has also been suggested that lithics should not be washed, as it might be possible to detect residues or even blood on unwashed implements. However, it should be borne in mind that these forms of analyses (use-wear and residue) are not carried out as part of the standard processing of lithic assemblages (they represent additional post excavation costs), and that unwashed lithics cannot be sensibly examined, characterized and typo-technologically classified by the specialist. To allow the artefacts to be characterized, classified, and catalogued, it is essential that they are washed before they reach the specialist.
In terms of bagging the finds before they reach the specialist, it should be attempted to fit the bag size roughly to the size of the finds. Obviously, it happens in the field that diggers run out of certain bag sizes, but a solitary chip (\(\leq 10\text{mm}\)), for example, should not be placed in a 2 litre bag. This is a waste of resources, money, and space. It should also be attempted to use bags of roughly the same size, if this is possible, as this will make boxing the finds easier – for example by allowing a standard box to contain two or three rows of numbered and sequenced bags. Furthermore, please don’t use too thin bags (no matter how cheap), and please use bags with a writing field, as it may otherwise be very difficult for the specialist to write raw material classification, artefact type, etc. on the bags.

Another concern is the bagging of multiple objects within a single bag. Lithics are generally fairly hardy, and storing several artefacts in one bag is not a problem. However, the author has frequently received bags with several kilos of quartz debitage, cores and tools in them, where brittle raw material is slowly being ground into powder and chips by artefacts rubbing against each other.

Pre-specialist recording includes field elements (contexts) and laboratory elements (artefact attributes), where the excavating unit’s post excavation staff prepare the finds for their own purposes, as well as for the handling and investigation by the specialist, museums and future researchers. The recording in the field first and foremost deals with contextual information, but in the field, as well as in the archaeological unit other information is frequently added to the contextual information – and some of this information is, from the specialist’s point of view, unnecessary, and some times it could probably be excluded.

In his catalogues and databases, the present specialist records the size of the artefacts in millimetres (microliths and blades/microblades with one decimal), but on the bags reaching the specialist there may also frequently be information as to the weight of the pieces, simply adding another piece of information on size. This author has never used the weight information indicated on these bags in connection with any form of interpretation, and when the find bags have been processed, finds discarded, and cores and tools bagged individually, the numbers and weight originally written on the bags is now incorrect. It is therefore suggested that, unless the weighing of the finds is important to the unit, in terms of keeping a statistic of their work, the work invested in weighing the finds could be saved.

It is understandable that it may add a bit of ‘spice’ to life in the trenches to attempt to interpret the finds on the spot – we probably all do it – but writing a perception of the lithic raw material or the artefacts’ formal typology on the bags is also a meaningless pursuit, as many of these interpretations turn out to be erroneous, and the specialist then has to write new bags. A piece of ‘jasper’ may be red or brown chert, a ‘blade’ may be an elongated flake, and a ‘scraper’ may simply be a piece with edge-retouch. Occasionally, it may be suggested on a bag that a pointed flake is an arrowhead blank, and we obviously don’t know whether this flake was, in prehistory, intended for one or the other tool form. The short of it is: When find bags are written, it may be most sensible and time-saving to write as little as possible on them and to be as general as possible – raw material, for example, should be kept to ‘lithic’. The details will then be filled in by the specialist.
Software structure

When one or more boxes of lithics have been received from a unit, the specialist has to define a software structure, and Fig. 3 shows the framework generally used by the author.

The first step is always to examine and characterize the artefacts in detail, and produce an Access database with the relevant information. By using Access, there is no need to sort the artefacts in any way at this level, as the software can be asked to sort the artefacts (‘queries’) according to whichever information the analyst finds interesting or useful (although this analyst as a personal preference tends to sequence finds bags according to either original small find number or context). When the information has been sorted, the selected information may then be exported to for example Excel or Surfer, and after manipulation by the application of those programmes, the results can be exported to the report, which would usually be in Word. Excel is useful for the production of tables and diagrams; Surfer allows distribution maps to be produced; and a CAD programme may allow additional illustrations and diagrams to be produced.

Which artefact attributes to record is decided by relevance (Fig. 4), and in some cases the level of detail can be reduced and in other cases extra database fields may need to be added to the form. A fieldwalked collection from a ‘sandblasted’ dune site on the Western Isles (eg, Barabhas on Lewis or RUX6 on North Uist; Ballin 2017a; forthcoming c) would need less detailed characterization, as it would frequently only be possible to define the pieces as worked/not worked or flakes/blades, whereas in
other cases the author has had to increase the level of detail and for example add a field for ‘colour’ to distinguish between sub-categories of raw materials. However, the specialist should always consider the needs of future analysts, who might be interested in other (not yet relevant) research questions, and the level of detail should not be reduced below a certain minimum level.

Fig. 4. General database format (Ballin & Barrowman 2015).

If the analyst needs to process a large number of objects belonging to a ‘special’ formal type, it may be necessary to define special database formats (eg, Fig. 5).

Fig. 5. Special database format (Felsite axeheads; Ballin 2015).
The author’s ‘standard’ report structure (Table 5) gives you an idea of how he works, what details he generally characterizes, and which questions he tends to focus on.

**Table 5. Basic report structure.**

1. Introduction
2. The assemblage
3. Raw materials
4. Debitage
5. Cores
6. Tools
7. Technology
8. Primary technology
9. Secondary technology
10. Spatial distribution
11. Vertical distribution (stratigraphy)
12. Horizontal distribution (activity patterns)
13. Dating
14. Discussion/conclusion/summary
15. Bibliography

In a sense, this report structure relates to Hawkes’ Ladder of Inference (Table 1), where an introduction with site information is followed by a descriptive section (typo-technological details), which is followed by a discussion of the reduction techniques applied at the site, which is followed – if the finds allow this – of a discussion of the on-site distribution of artefacts (eg, ‘site behaviour’). A dating section draws on information from all the previous sections, and in a final general discussion section, additional matters may be discussed, if possible attempting to draw a picture of life on the site or, through comparison, draws a synthetic picture, pointing out details of chronological or regional relevance (eg, territorial structures/exchange networks/other issues).

**Raw materials**

It has been suggested that raw materials form a kind of base-line, in the sense that they are either present in the local area, or they will have to be imported in (procurement issues), and their flaking properties determine which technological approaches are suitable. In a paper on the use of lithic raw materials in Scotland (Ballin 2013b), the author defined a number of areas which lithic raw materials may shed light on (Table 6). This list also includes questions from the different levels of Hawkes’ Ladder of Inference (Table 1).
Table 6. Research questions which raw material analysis may elucidate.

- Typo-technological issues (form and technology)
- Territorial structures (social territories and techno-complexes)
- Procurement sites (where are they and how were they exploited in technological/organisational terms?)
- Raw material exchange (economy and social contacts)
- Dating (eg, in most parts of Scotland systematic pitchstone exchange is an Early Neolithic phenomenon)

It is important when you work with lithics that you have some basic knowledge of geology, but also that you know your limitations – that is, you know when it is relevant to contact a geologist (and the right geologist) for advice. Provenancing may require a specialized scientific input (XRF and other approaches).

Typology

In terms of typology, it is important that we use a standardized formal classification system and agree at least on how we define the basic forms, but there is also a limit to how far we can take this standardisation. Specialists occasionally disagree amongst themselves, and this is reflected in the typologies they use. At some stage, Swedish colleagues recommended that, as quartz fractures/flakes so differently from flint, each raw material should have its own typology, but this probably reflects the simplistic Swedish situation, where many parts of the country only have those two (main) raw materials (eg, Knutsson 1988, although also see Söderlind 2016). In Scotland we have a multitude of raw materials – flint, chert, pitchstone, bloodstone, mylonite, agate, etc. – and if each had its own typology we would not be able to compare the individual assemblages, or even sub-assemblages within one site, and we would not be able to do synthetic analyses. So – one typology will do!

A lithic typology is built up as a hierarchy (a ‘tree’) with types and sub-types (eg, Ballin 1996). Table 7 shows the typology generally used by the author:
### Table 7. Example of typological hierarchy.

<table>
<thead>
<tr>
<th>Debitage</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chips</td>
<td></td>
</tr>
<tr>
<td>flakes</td>
<td></td>
</tr>
<tr>
<td>Blades</td>
<td></td>
</tr>
<tr>
<td>Microblades</td>
<td></td>
</tr>
<tr>
<td>Indeterminate pieces</td>
<td></td>
</tr>
<tr>
<td>Preparation flakes</td>
<td>Crested pieces and core tablets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cores</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Split/flaked (‘tested’) pebbles</td>
<td></td>
</tr>
<tr>
<td>Core rough-outs</td>
<td></td>
</tr>
<tr>
<td>Single-platform cores</td>
<td>Plain, conical, and handle-cores</td>
</tr>
<tr>
<td>Dual-platform cores</td>
<td>Opposed-platform cores / cores with two platforms at angle</td>
</tr>
<tr>
<td>Irregular (multi-directional) cores</td>
<td></td>
</tr>
<tr>
<td>Discoidal cores</td>
<td>Plain discoidal and Levallois-like cores</td>
</tr>
<tr>
<td>Bipolar cores</td>
<td></td>
</tr>
<tr>
<td>Core fragments</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tools</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Microliths and arrowheads</td>
<td>Numerous formal sub-types</td>
</tr>
<tr>
<td>Scrapers</td>
<td>Numerous formal sub-types</td>
</tr>
<tr>
<td>Piercers</td>
<td>Large piercers and drill tips (<em>meche de foret</em>)</td>
</tr>
<tr>
<td>Knives</td>
<td>Numerous formal sub-types</td>
</tr>
<tr>
<td>Burins</td>
<td>Numerous formal sub-types</td>
</tr>
<tr>
<td>Combined tools</td>
<td>Eg, scraper-burins</td>
</tr>
<tr>
<td>Various other retouch</td>
<td>Numerous formal sub-types</td>
</tr>
<tr>
<td>Other flake- and blade-based tools</td>
<td>Numerous formal sub-types</td>
</tr>
<tr>
<td>Axeheads</td>
<td>Numerous formal sub-types</td>
</tr>
<tr>
<td>Daggers and other sophisticated tool forms</td>
<td>Some formal sub-types</td>
</tr>
<tr>
<td>Tools used to produce the lithic assemblages</td>
<td>Hammerstones and anvils</td>
</tr>
</tbody>
</table>

In addition, it is possible to expand or simplify the hierarchy in the individual cases, and you can for example add a technological layer – flakes, for example, can be subdivided into soft percussion, hard percussion and bipolar flakes. If you are characterizing and cataloguing a lithic assemblage, it is recommendable to invest in an illustrated typological encyclopaedia. In Britain, the most commonly used volume is Butler (2005).
Definitions of the most common lithic artefact groups and types

This section is a cursory presentation of the most common artefact groups and types (a typo-technological ‘crash-course’). The author is in the process of producing a more extensive classification system in which the definitions of British lithic types are presented and discussed in greater detail, but if the reader is particularly interested in specific forms, he/she may need to consult the primary archaeological literature.

Usually, lithic artefacts are subdivided into three main categories (Table 7), namely debitage, cores and tools. The term debitage covers unmodified tool blanks and waste detached from cores and include chips, flakes, blades, microblades, indeterminate pieces, and preparation flakes (Ballin 2000a).

Fig. 6. Metrically defined debitage categories (microblades as suggested for Scottish assemblages) (Ballin 2000a).

The main types are defined as follows (also see Fig. 6):

**Chips:** All flakes and indeterminate pieces the greatest dimension (GD) of which is ≤ 10mm.

**Flakes:** All lithic artefacts with one identifiable ventral (positive or convex) surface, GD > 10mm and L < 2W (L = length; W = width).

**Blades and microblades:** Flakes where L ≥ 2W. In Scotland, blades are defined as W > 8mm, and microblades W ≤ 8 mm (Ballin 2000a, 11). In southern Britain, blades and microblades are defined as broader and narrower than W = 12mm (Butler 2005, 35).

**Indeterminate pieces:** Lithic artefacts which cannot be unequivocally identified as either flakes or cores. Generally, the problem of identification is due to irregular breaks, frost-shattering or fire-crazing. Chunks are larger ‘chunky’ indeterminate pieces, and in, for example, the case of quartz, the
problem of identification usually originates from a piece flaking along natural planes of weakness rather than flaking in the usual conchoidal way. The term ‘chunk’ is commonly used as a synonym for ‘indeterminate piece’, but this is not recommended as many indeterminate pieces are small and flat (for example flake fragments which, due to exposure to fire, shed the entire ventral face).

**Preparation flakes** include crested pieces (Fig. 7) and core rejuvenation flakes, where the former were detached in connection with the initial shaping of the core, as well as during the reduction process, while the latter were detached during the reduction process to adjust the platform and the flaking-angle.

Fig. 7. Crested piece (Ballin et al. forthcoming/artist: M. O’Neil).

Chips (‘micro-flakes’), flakes and blades are defined by being relatively flat lithic objects and having a ventral as well as a dorsal face. The ventral face of a flake is a smooth and unbroken, usually slightly convex (positive) surface, which is the face created when the piece was struck off its parent core. The dorsal face usually has a number of arrises, or ridges, separating the concave (negative) scars left when previous flakes were detached. Occasionally, this face also has remains of the cortex, or outer skin, of the original nodule. Fig. 8 shows the various elements which define chips, flakes and blades as artefacts rather than ‘geofacts’.

Fig. 8. The main elements of flakes and blades – terminology and orientation (Ballin et al. forthcoming/artist: M. O’Neil).
**Cores** are artefacts shaped by continuous reduction (removal of debitage), with only dorsal (negative or concave) faces (Figs 9-12). They were reduced to produce flake and blade tool blanks, and these removals are referred to as debitage (above). This category includes core preforms; platform cores; as well as bipolar (anvil-struck) cores. In southern Britain (where good-quality flint is readily available and anvil-struck cores almost entirely absent) opposed-platform cores are referred to by some analysts as bipolar cores. It is recommended to abandon this practice as it may cause some confusion. Platform cores are generally subdivided into pieces with one, two, or multiple platforms, but they also embrace flat discoidal cores, which were reduced by striking the cores’ circumference. Levallois-like cores (Fig. 13) are easily recognizable and highly diagnostic later Neolithic discoidal cores from which blade and flake blanks were struck (Ballin 2011a).

Cores are distinguished from split pebbles by having had three or more flakes removed, whereas split/flaked pebbles have fewer than three flake scars. Cores would commonly be reduced and gradually transformed following this formula: Single-platform cores ⇒ dual-platform cores ⇒ irregular (multi-platform) cores ⇒ bipolar cores. The latter stage is usually only included in regions with insufficient (in terms of amount and nodule size) supplies of raw material (Ballin 1999). Occasionally, small pebbles are reduced entirely by the application of bipolar technique.


**Fig. 13.** Levallois-like flake- and blade-core (Cameron & Ballin 2017/artist: J. Dunbar).
**Tools** are modified blanks (pieces of debitage), that is, implements shaped by secondary flaking/retouch (which may be edge-retouch or invasive retouch), grinding/polishing or pecking. The main tool categories are: Arrowheads and microliths, scrapers, knives, piercers, burins, combined tools, tools with various other forms of retouch, axeheads, and various sophisticated tool forms like daggers, sickles, etc. It is possible to subdivide all these categories according to specific shape and size, blank type, form of retouch, etc. The following is an attempt to define the main tool types; for a discussion of the many sub-types see Butler (2005) and Ballin (forthcoming a).

**Arrowheads** are defined as the piercing and cutting lithic implements inserted into the front end of arrowshafts. Arrowheads would usually have served their function in a solitary capacity, whereas the usually much smaller microliths, which served the same general function, usually formed parts of composite tools involving several lithic parts. Arrowheads may be subdivided into LUP tanged arrowheads (Figs 14-23; Ballin 2017b), which in Britain were based on blade blanks and modified by edge-retouch, and Neolithic and Early Bronze Age bifacial points (Figs 24-35; Green 1980; Clark 1934c; Ballin 2011b), which were modified by more or less extensive invasive retouch (apart from some plain chisel-shaped arrowheads).

In Britain, tanged arrowheads include Creswellian angle-backed points (Jacobi 2004), Hamburgian Havelte points (Ballin et al. 2010; forthcoming), *Federmesser-Gruppen* backed points (Saville & Ballin 2009), Ahrensburgian tanged points (Ballin & Saville 2003), and Fosna-Hensbacka single-edged points (Ballin & Bjerck 2016). In connection with his presentation of the lithic assemblage from Gough’s Cave in Somerset, Jacobi (2004, Fig. 23) shows a variation of backed points associated with the Creswellian, including the well-known trapezoidal points, triangular *Dreieckmesser vom Kent Type* (Schwabedissen 1954, 9), and curved-backed points (Figs 14-15).

![Figs 14-15. Creswellian angle-backed points (David 2007/artist: A. David).](image-url)
The Late Hamburgian (Havelte phase) tanged points from Howburn have asymmetrical tangs (one retouched side of the tang short, the other long) (Fig. 16). In addition, many of these pieces have a notch-and-spur at the top of one side of the tang, probably a hafting device, and obliquely truncated tips.

![Fig. 16. Late Hamburgian (Havelte) tanged point (Ballin et al. forthcoming/artist: M. O’Neil).](image)

The *Federmesser-Gruppen* period is characterized by the absence of tanged points and the presence of many backed points. Some of those are curve-backed and some angle-backed, but in Britain most are straight-backed (Figs 18-21). The classic *Federmesser* point has one fully modified lateral side and a base defined by a short retouch which meets the fully retouched side at an acute angle (Fig. 17).

![Fig. 17-21. Federmesser-Gruppen backed points (Ballin et al. forthcoming/artist: M. O’Neil; Saville & Ballin 2009/artist: M. O’Neil).](image)

The Ahrensburgian is first and foremost characterized by tanged points with a symmetrical tang and although some of those arrowheads have an oblique truncation at the tip, many have an unmodified tip. They tend to be somewhat smaller than the Hamburgian points. It is possible to define highly recognizable sub-types, such as the piece in Fig. 22 (from Balevullin on the Isle of Tiree in the Inner Hebrides) and it has a tang which is as long as half of the total piece, with one lateral side being fully retouched and frequently angled (Ballin & Saville 2003). However, the period is also defined by the
presence at some sites of so-called Zonhoven points, some of which are almost identical to Early Mesolithic obliquely blunted pieces, whereas others have triangular or trapezoidal outlines (Vermeersch 2015). In contrast to their Mesolithic ‘cousins’, Zonhoven points tend not to have been produced by the application of microburin technique.

**Fig. 22.** Ahrensburgian tanged point (Ballin & Saville 2003/artist: O’Neil, redrawn from Morrison and Bonsall 1989, fig.3).

A point from the far north of Scotland has been identified as a Scandinavian single-edged Fosna-Hensbacka point (Ballin & Bjerck 2016). Single-edged points (Fig. 23) probably represent a further development of pieces like the Balevullin point (Fig. 22), but the fully retouched lateral side may be curved as well as angled. The key defining point of the Scandinavian single-edged points is that many had their tips manufactured by the application of microburin technique, whereas traditional Ahrensburgian points did not.

**Fig. 23.** Fosna-Hensbacka single-edged point (Ballin & Bjerck 2016/artist: M. O’Neil).

The Neolithic and Early Bronze Age arrowheads include leaf-shaped, chisel-shaped, oblique, and barbed-and-tanged points. Early Neolithic leaf-shaped arrowheads are generally based on flake blanks, and in their typical forms they are characterized by invasive retouch across both faces. They vary in a number of ways (Green 1980; Butler 2005), with some pieces being small and some large; some are elongated and others squat; and some are drop-shaped, with others being double-pointed (Figs 24-29). Pieces with two angled lateral sides are referred to as kite-shaped (Figs 25-28), and pieces with a concave delineation of their lateral sides near their tip are called ogival points (Fig. 29). Kite-shaped pieces tend to be late within the Early Neolithic period. Some plain pieces were clearly function implements for daily use, whereas other ‘fancy’ pieces may have been used for display or for particular ceremonial or burial contexts.

**Figs 24-29.** Drop-shaped, double-pointed, and kite-shaped leaf points from Elgin Museum in Moray (Ballin 2014d/photo: L. Demay), and ogival point (Fig. 29) from Auchategan in Argyll (Ballin 2006/photo: B. Ballin Smith).
A group of arrowheads are referred to as *petit tranchet derivative* points (PTDs), as Clark (1934c) saw these pieces as having developed from the Mesolithic *petit tranchet* points (transverse arrowhead). Early (Middle Neolithic) types are referred to as chisel-shaped arrowheads, and later ones (Late Neolithic) as oblique arrowheads. Although these pieces almost certainly make up a formal sequence (Fig. 30), it is interesting that at some stage some-one decided to functionally re-define the pieces, from points with a transverse tip to ones with an acutely pointed tip. This ‘switch’ happens between Types D and E.

![Fig. 30. Clark’s 10 main PTD forms. Types E and F have been rotated to bring their orientation into line with present consensus on their likely hafting form. Re-drawn by the author (Ballin 2011b), after Clark (1934c, Figs 1-2).](image)

Barbed-and-tanged arrowheads (BATs) are, as the name implies, defined by having a central tang, which allows the lithic tip to be inserted into the arrowshaft, as well as two more or less well-defined lateral barbs (Figs 31-35). This category was discussed in great detail by Green (1980), who sub-divided the BATs according to size and morphology. He suggested a divide between large and small BATs at 8 grammes and L = 50mm, but the author suggests to focus entirely on length, as the two measurements are basically two ways of measuring the same thing – size. The main purpose of this division is to allow a distinction to be made between his Ballyclare Type and his Sutton Type. Green also distinguished between ‘miscellaneous’ (ordinary) forms and ‘shaped’ or ‘fancy’ forms, where the latter are regionally and/or chronologically diagnostic. A summary of these types is presented in Butler (2005).

![Figs 31-35. Barbed-and-tanged arrowheads from Elgin Museum in Moray (Ballin 2014d/photo: L. Demay).](image)
In the archaeological literature, the term ‘microlith’ is defined in a number of different ways, adding some confusion to the discussion of the category and its dating. In the present guide, ‘microlith’ is defined as in the author’s previous reports on early prehistoric assemblages (eg, Ballin et al. 2010):

**Microliths** are small lithic implements manufactured to form part of composite tools, either as tips or as edges/barbs, and which conform to a restricted number of well-known forms, which have had their (usually) proximal ends removed (Clark 1934a, 55). This definition secures the microlith as a diagnostic (pre Neolithic) type. Below, microliths sensu stricto (ie, pieces which have had their usually proximal ends removed) and backed microblades (with surviving proximal ends) are treated as a group, as these types are thought to have had the same general function, but backed bladelets are fairly undiagnostic and may be recovered from Mesolithic as well as Early Neolithic contexts.

![Diagram of microlith production](image)

The most frequently used microlith typologies, such as those of Clark (1934a) and Jacobi (1978), include numerous sub-types, characterized by various forms of fine ancillary edge-retouch (also see Butler 2005). It is, however, the author’s view that most of these forms of additional modification represent the finer shaping of the pieces, determined by the specific original shape of the individual microlith blanks, and that this fine retouch has little relevance to the understanding of the category, the assemblage or the site. The main formal types, on the other hand, may generally represent mental templates of the flint-knapper, and they may be chronologically or regionally diagnostic. The most common microlith types are: Obliquely blunted points, isosceles triangles, scalene triangles, crescents and edge-blunted pieces (Figs 37-44). In central and southern Britain, the microlith type spectrum also includes Early Mesolithic forms like Horsham and Honey Hill microliths (Figs 45-46). Waste from microlith production includes discarded preforms (Fig. 36) as well as microburins (Fig. 42).


Most scrapers have a convex modified terminal or lateral working-edge, which is too steep to have been functional as a cutting-edge. However, scrapers with straight or concave working-edges are also known, and scraper-edges may be somewhat acute as well as steep, depending on whether they were used to process skin/hide or hard materials like wood, bone or antler (Juel Jensen 1994). In many cases, scraper-edges are also defined by robust use-wear, in the form of over-hanging working-edges. The scraper category includes: Discoidal scrapers, short end-scrappers, blade-scrappers, double-scrappers, side-scrappers, end-/side-scrappers, as well as hollow and concave scrapers (Figs 47-51).
Piercers are defined by having a relatively narrow projection used for drilling into, or through, soft or hard materials. Moreover, piercer tips are defined by having no less than two lateral modified edges which meet to form the (more or less) acutely pointed working-part of these tools. This category includes traditional flake- or blade-based piercers with an acutely pointed working-part at the (usually) distal end; large core piercers; 

Becks; Zinken; and meches de foret (Figs 52-55). Becks are robust flake-based piercers associated with British LUP industries. Zinken are blade-based piercers with a curved tip (occasionally two opposed curved tips), and they are associated exclusively with Hamburgian assemblages. Mech de foret are small Mesolithic drill tips with one, or two opposed, tips; they were previously referred to as needle points and listed amongst the microliths. For discussion of some of the piercer sub-forms (becks, Zinken, meches de foret), see Ballin et al. (forthcoming) and Jacobi (1980).
Knives occur as four fundamentally different types, namely 1) pieces with a cutting-edge formed by the original unmodified acute edge of the tool blank (backed knives and pieces with oblique truncations); 2) pieces with a cutting-edge formed by acute invasive lateral retouch (scale-flaked and plano-convex knives; Clark 1932b); 3) bifacial knives (laurel leaves and foliate knives; Clark 1960; Ballin 2012) and 4) pieces with a cutting-edge formed by grinding/polish (polished-edge flake and blade knives and discoidal knives; Clark 1932a; Manby 1974, 88).

Backed knives (Fig. 56) usually have curved backing along one lateral side, although the protective blunting may also be straight. Pieces with oblique truncations (Fig. 559) usually only have modification at their distal end, although they may have additional protective blunting, or retouch to facilitate hafting. Scale-flaked and plano-convex knives form a continuum (Figs 57-8), both having had one or both lateral sides transformed into cutting-edges by (mostly) unifacial invasive retouch; where scale-flaked knives tend to only have limited invasive retouch along one or both edges, plano-convex knives have more extensive invasive retouch, giving these pieces their name (flat ventral face, convex dorsal face). Bifacial knives are relatively rare in Britain, the best-known pieces being laurel leaves and foliate (i.e., leaf-shaped) knives. Pieces with polished cutting-edges include flakes and blades with polished cutting-edges (Fig. 60), and discoidal knives (Fig. 61), which are bifacial pieces of various shape with partial or full polish. Backed and truncated pieces are basically undiagnostic; scale-flaked and plano-convex knives are known from the Neolithic and Early Bronze Age periods; laurel leaves from the Early Neolithic; foliate knives from the Early Bronze Age; and polished-edge knives from the later Neolithic.

Fig. 56-59. Knives – backed (Cameron & Ballin forthcoming/artist: J. Dunbar), scale-flaked (Manby 1974/artist: T. Manby), plano-convex knives (Ballin 2014c/artist: J. Dunbar), and a truncated piece (Ballin 2014c/artist: J. Dunbar).
In older archaeological literature, burins were referred to as ‘gravers’ (Lacaille 1938; Butler 2005, 51), and it is thought that the main function of these Palaeolithic and Mesolithic implements was to cut grooves in bone and antler, for example in connection with the production of slotted bone points. Generally, burins are poorly understood, even by specialist, and people find them difficult to identify, for which reason they tend to be either under- or over-represented in assemblages from hunter-gatherer sites.

Burins were produced by removing a burin spall (Fig. 65), usually from the lateral side of a blank, by using a relatively flat area as a platform for the burin-strike. In most cases, a platform was produced by snapping a robust flake or blade, or an end of a blank could be truncated, with this retouch then forming the platform. The most common burin types are angle-burins (mostly burins on break, with the burin-edge at one corner of the break facet [Fig. 62]), dihedral burins (burins with the burin-edge formed by two crossing burin strikes, with the burin-edge positioned roughly at the centre of the blank’s long axis [Fig. 64]), and burins on truncations (burin-strike directed at a retouched end or break; Fig. 63). However, a burin-strike could also be directed towards a natural end of a piece, or a lateral side. Burins occasionally have more than one burin-edge (double- or multi-burins).

In Britain, almost all Mesolithic burins are ‘burins on breaks’, whereas many Late Upper Palaeolithic specimens are ‘burins on truncations’ (approximately one-third of the 40 burins from the Hamburian site Howburn in South Lanarkshire; Ballin et al. forthcoming). Dihedral burins are also commonly found in LUP assemblages, whereas they are rare in Mesolithic contexts.

![Fig. 60-61. Polished-edge knife and discoidal knife (Manby 1974/artist: T. Manby).](image)

![Fig. 62-65. Burins: Angle-burin (Ballin et al. forthcoming/ artist: M. O’Neil), burin on truncation (Ballin et al. forthcoming/ artist: H. Martingell), dihedral burin (David 2007/artist: A. David), and burin spall (Saville & Ballin 2009/artist: M. O’Neil).](image)
**Combined tools** are implements which combine several functionally different working-parts, such as scraper-burins, scraper-knives, scraper-piercers, etc. **Tools with various other forms of retouch** include pieces with retouched notch(es), serrated pieces, denticulates, and pieces with edge-retouch. Serrated pieces (or microdenticulates) have very fine teeth along one or both lateral sides (Figs 66-67), whereas denticulated pieces are cruder implements with relatively large teeth. The former are most common in Neolithic contexts (Saville 2002; 2006), whereas the latter are most common in later Bronze Age contexts (Ballin 2002).

![Figs 66-67. Serrated piece; full-size and close-up (Ballin 2011a/photo: B. Ballin Smith).](image)

**Other flake- and blade-based tools** embrace categories like strike-alights (fabricators) and fire-flints, rods, and polished-edge implements. The distinction between strike-a-lights and fire-flints is that the former made fire by striking a piece of pyrite, whereas the latter was struck by a steel strike-a-light (Ballin 2005). The term ‘rod’ describes a robust elongated type of implement, which has been associated with British flint mining locations, with some apparently dating to the later Neolithic (Saville 2011, 26) and others to the Middle Bronze Age (Saville 1981, 62). Polished-edge implements are flakes and blades with heavily abraded working-edges, ridges or corners, and most are associated with the later Neolithic (Ballin 2011b). Pieces from certain later Neolithic contexts tend to have mirror-like polish.
Flint axeheads include two main groups of implements, namely Mesolithic axeheads and adzes (eg, Clark 1954; Vang Petersen 1993), and Neolithic ones (eg, Clough & Cummins 1979). Mesolithic flint axeheads are generally absent in Scotland.

The most common Mesolithic flint axehead is the core axehead (Fig. 68), most of which are tranchet axeheads. These pieces are called core axeheads (manufactured by removing flakes across both main faces) to allow them to be distinguished from flake axeheads (based on flake blanks). Flake axeheads (Fig. 69) are generally absent (or very rare) in Britain, although their presence should not be ruled out in northernmost Scotland, where they could be associated with hunter-gatherers linked to the Scandinavian Fosna-Hensbacka Complex (Ballin & Bjerck 2016). The core axeheads are generally characterized by a blunt butt, which would be inserted into a shaft, a sharp cutting-edge, two lateral sides each defined by a knapping seam, and a pointed-oval, rhomboid or trapezoidal cross-section. Flake axeheads have a clearly definable ventral lower face, a dorsal upper face, and retouched lateral sides.

Fig. 68-69. Core axehead and flake axehead (Evans 1897:artist: J. Swain).
Neolithic flint axeheads may be subdivided in the same manner, namely into axeheads or adzes. In contrast to Scandinavian flint axeheads, which almost all have a four-sided cross-section (see for example Vang Petersen 1993), almost all British flint axeheads have a pointed-oval cross-section, occasionally with a very narrow side facet (see for example Evans 1897; Clough & Cummins 1979). A large number of general and local types are known, and it has been attempted to describe those through a variety of different classification systems.

A number of easily recognizable forms have been defined, such as symmetrical ovates of Cissbury Type (Fig. 70; occasionally with rounded or weakly defined edge corners) (cf. Barber et al. 1999, 10), and the spectacular Seamer/Duggleby axeheads/adzeheads with their concave lateral sides and broad butts and edges (Fig. 71; Manby 1974, 99). The former are associated with the flint mines of southern England and they date to an earlier stage of the Neolithic; the latter are associated with the later Neolithic. Both are found as unground pieces, as well as ground and/or polished pieces. When ground/polished, the Cissbury axeheads may be partially or all-over polished, and the latter edge- or partially polished.

Fig. 70-71. Cissbury axehead (Evans 1897:artist: J. Swain) and Seamer axehead (Manby 1974/artist: T. Manby).
The category ‘various sophisticated tool forms’ includes pieces like daggers, curved sickles, and tribrachs (all described in Evans 1897). British daggers (Grimes 1932) are bifacial cutting implements associated with the Beaker period, and they were thinned by the application of pressure-flaking (Fig. 72). They are generally up to 180mm long and 60mm wide. They tend to have two opposed pointed ends (although in a few cases one end may be blunt) but, in an almost counter-intuitive manner, the more acutely pointed end is the handle-end and the other the actual tip. Both lateral sides are convex, with the broadest point being near the tip. Some daggers have, at the narrower end, one or more notches in their lateral edges, indicating that they were inserted into a haft. In contrast to Danish flint daggers, British ones have no marked handle.

British curved single-piece sickle blades are well-executed, bifacially retouched, usually asymmetrical pieces, with the longer lateral edge being convex and the opposite edge concave (Fig. 73). The former edge tends to be relatively thick, and the latter relatively acute. It is thought that the convex edge would have been inserted into a wooden handle, whereas the concave edge was the cutting-edge. One end is generally pointed, and the other either slightly less pointed or rounded. These implements are associated with the Early Bronze Age, although it has also been suggested that some may date to the later Neolithic (Clark 1934b, 79; Butler 2005, 173).

Tribrachs form an extremely rare lithic implement form, as only three pieces are known from the British Isles (Fig. 74). The type was described by Evans (1897, 78) with the words: ‘... like three celts conjoining into one ...’. The best known specimen from the Isle of Wight has a diameter of 203mm and a thickness of 23mm at the centre (Field & Lambdin-Whymark 2007, 33), and it has been flaked bifacially, with a knapping seam running down both lateral sides of each arm. The function of these pieces is uncertain.

![Fig. 72-74. A dagger, a sickle and a tribrach (Evans 1897:artist: J. Swain).](image-url)
Tools used to produce the lithic assemblages include hammerstones and anvils, as well as various other lithic and stone implements used in connection with the preparation and maintenance of cores, and the production of blanks and tools. Hammerstones may be in any hard lithic or stone raw material, such as flint, quartz, quartzite, sandstone, and limestone. Anvils are usually in stone, such as quartzite and sandstone. Hammerstones would usually be fist-sized oval cobbles or pebbles and most have not been shaped. They tend to be characterized entirely by crush-marks at the two opposed pointed ends. Anvils are cobbles with a flat surface, and they were used in connection with bipolar reduction: A small pebble would be placed on the flat surface of the anvil and then struck by a hammerstone. After a while, this action would form a hollow in the anvil’s flat surface, a so-called anvil-pit. Anvils were also frequently used as hammerstones (Fig. 75).

Fig. 75. Combined hammerstone/anvil in felsite (Ballin 2017d/photo: B. Ballin Smith).
At its simplest level, lithic technology includes the definition of core preparation and percussion techniques through the presence of technological attributes (bulbs of percussion etc.; cf. Inizan et al. 1992), but over the last few decades the analysis of the technology of a site or industry has developed into something much more complex, namely the definition of operational schemas (chaîne opératoire analyses; Schiffer 1972; Pelegrin et al. 1988), describing the technological choices made by the knapper (his mental templates) from raw nodule to finished tool (Figs 76-77).

**Fig. 76.** The modules and sequences of most operational schemas (Ballin 2008, Illus. 47).

**Fig. 77.** More detailed operational schema (‘master schema’), including all modules of Fig. 76 (Ballin 2008, Illus. 48).
This form of analysis may inform us on the complexity or sophistication of a given industry, but the presence or absence of individual attributes, as well as the specific structure of the operational schema as a whole may also allow us to date sites (e.g., the easily recognisable Middle/Late Neolithic Levallois-like technique; Ballin 2011a), and the operational schema in connection with distribution analysis may inform us on ‘site behaviour’—that is, what took place on the site and in which sequence.

Fig. 78. Binford’s drop- and toss-zones (Binford 1983; Ballin 2013a).
Lithic distribution analysis takes two forms, namely *intra*-site and *inter*-site analysis. Intra-site distribution analysis looks at the distribution of artefacts across an individual site and attempts to define activity zones, such as the dwelling, the hearth, the knapping floor, other activity areas (eg, butchering), and disposal areas (Fig. 2). Binford (1983) introduced the terms drop zone and toss zone, which have proven very useful (Fig. 78). A drop zone is the zone immediately in front of the knapper where chips fell and were not removed as they were not a problem to traffic across the site, whereas the drop zone defines the area of larger rubbish further away from the knapper, where potentially problematic waste like chunky cores and large flakes were tossed to get them out of the way immediately (‘preventive maintenance’).

**Fig. 79.** Sheet from the author’s ‘refitting catalogue’, produced in connection with the refitting of the flint assemblage from the Late Upper Palaeolithic Brommian site Højgaard on Zealand, Denmark (Ballin 1991).

Refitting of lithic artefacts is a useful form of analysis (eg, Cziesla *et al.* 1990; Ballin 2000b), which occasionally allows the analyst to produce distribution maps showing how artefacts moved around within the site (Fig. 79), including: knapping floor (usually by a hearth inside or outside the dwelling), selection of usable blanks, tossing of large lumps of debris, or removal of debris to dedicated dumps/middens, production of tools, removal of tools to dedicated activity areas (microliths/arrowheads to be inserted into shafts, knives for butchering, burins for antler/bone work, scrapers for work on hides/skin, etc.), repair of broken tools, and discard of unrepairable tools. It should be borne in mind that refitting takes time, and time is money! It is therefore essential that this approach is saved for situations where well-defined research questions make the investment of funding into refitting acceptable, or that only limited refitting is carried out to answer selected questions.
Inter-site distribution analysis deals with the distribution of artefacts across the wider landscape, for example from procurement sites to settlement sites, or from one manufacturing settlement site to a recipient settlement site. This is a useful way to gain information on territorial structures and exchange networks (Fig. 80). Occasionally, this requires the investment of time in the search for outcrops, as in the case of the author’s Pitchstone Project. A spin-off of this project was the production, with geologist John Faithfull at the Hunterian Museum in Glasgow, of a gazetteer of pitchstone outcrops on the Isle of Arran in the Firth of Clyde (Ballin & Faithfull 2009).

Fig. 80. The size of three exchange networks through the distribution of raw materials - pitchstone, bloodstone and silcrete (Ballin forthcoming b).
When dating a site or an industry, the analyst would usually like to be as precise as possible, and if the necessary charcoal is available, radiocarbon dating might be attempted (other forms of absolute dating involve TL/OSL, tephra, shoreline displacement, etc.). However, it is possible to date sites and industries in relative terms through a number of diagnostic lithic typo-technological attributes, as well as raw material preferences and operational schemas: for example, isosceles triangles define (with other types) the Early Mesolithic period and scalene triangles the Late Mesolithic; in the Central Belt and East Scotland pitchstone is predominantly an Early Neolithic phenomenon; the use of the distinctive Levallois-like technique is a later Neolithic phenomenon; etc. It should, however, be borne in mind that there is some regional variation in the presence or absence of types, raw materials and technologies – bipolar technique, for example, was commonly used throughout West Scotland’s Mesolithic (eg, Glenbatrick Waterhole; Mercer 1974) and later periods, whereas in East Scotland bipolar technique is practically (although not entirely) absent throughout the Mesolithic and Early Neolithic periods (eg, LM Nethermills and EN Garthdee Road; Ballin 2017c; 2014c), and this technique only becomes common during the later Neolithic period (eg, Stoneyhill Farm; Suddaby & Ballin 2010). It is advisable to supplement any approaches dealing directly with the lithic finds with scrutiny of associated materials, such as pottery, where formal styles, decoration, etc. are frequently diagnostic.

Conclusion

The report should then be completed with a concluding chapter in which the results are summarized, and where additional interesting aspects may be discussed. If relevant, the analyst could apply additional approaches to shed light on other aspects of prehistoric life, such as use-wear analysis, experimental knapping, etc.
Publication

Following the specialist’s processing of the lithic assemblage(s), he/she either produces a publishable report, which is then published by the excavator with other specialist reports, or he/she produces a stand-alone research report and personally submits it for publication.

Generally, one could say that any form of publication is better than none, but some formats are more suitable than others. The most important factors involved in the assessment as to which specific form of publication might be most appropriate are: 1) the numerical size and complexity of a given assemblage, or group of assemblages; 2) chronological integrity (is the settlement a single-occupation site or a palimpsest, and if the latter, is it possible to ‘dissect’ the site into chronologically unmixed zones, or is it impossible to separate the various chronological components); 3) the importance/information value of the finds; and 4) the time and funding available to the specialist.

Simplified, the forms of publication available to the specialist include: 1) Monographs; 2) standard peer-reviewed journals of various rank (eg, international, national, or regional, and general archaeology or specialist); 3) open-access journals, also of various rank; 4) grey literature repositories; and 5) self-publication. We do not inhabit an ideal world, and in most cases compromises may have to be made:

Obviously, the production of a ‘singing-and-dancing’ hardcover monograph on glossy paper is expensive and takes a long time to produce – if the author is keen to get his/her report out while it is still ‘fresh’ and relevant, this may be an avenue to be avoided. If a site or assemblage is of national or international importance, this may be a price worth paying.

Standard peer-reviewed journals are frequently subdivided into international, national and regional journals, and where some cover archaeology as a whole, others focus on specialist issues, methodologies, etc. Which journal to choose is a matter of how important an assemblage may be, and to whom. However, the peer-review process can be onerous (due to the fact that the archaeological world is small and few experts may be available within the individual fields and sub-fields), and the most high-ranking journals can be expensive to the user (with downloads of individual papers frequently costing approximately as much as the purchase of a yearly subscription of the journal), which limits access to the information offered by the paper. It has also become arduous to submit papers, as many top-journals now favour online submission – where in ‘the old days’ it might have taken a quarter of an hour to put a manuscript and associated files on a disc and send it, getting through the online submission process can take days.

Open-access journals clearly have the widest audience, and for example the specialist JOURNAL OF LITHIC STUDIES is peer-reviewed, available to all interested parties throughout the world, free of charge. SCOTTISH ARCHAEOLOGICAL INTERNET REPORTS (SAIR) and the Scottish ARCHAEOLOGICAL REPORTS ONLINE (ARO) are also peer-reviewed and freely available.
If a report has been produced on an assemblage which turns out not to be important enough or informative enough to be accepted for publication in any of the above periodicals, they should still be made available, for example by uploading them to free online repositories. Material associated with completed excavations can be submitted to ADS’ (Archaeology Data Service) Library of Unpublished Field Reports, and published as well as unpublished reports/papers may be uploaded to academic repositories like Academia or Researchgate. The author prefers the former, as it is entirely open to everybody with an interest in archaeology, whereas Researchgate is more exclusive, asking researchers without a firm link to a research institution like a university or a large museum (measured by whether they have an institutional email address or not) why he/she should be allowed in.

As a researcher (particularly if you are self-employed and your livelihood depends on it), it is necessary to have the occasional paper accepted by peer-reviewed journals, simply to be seen as being of ‘some calibre’, but when everything fails, there is still one avenue available – self-publication. This was a route taken by this author after the 2007/8 partial collapse of the Irish economy and Irish commercial archaeology (as part of the general Credit Crunch), where several Irish units had to close, and where large numbers of site assemblages (including lithic finds) and unpublished completed reports were put away in a big warehouse. Over a number of years, the author had produced a large number of reports on Irish/Northern Irish assemblages which would generally have been considered highly interesting (eg, Ballin 2014a; 2014b; 2014e), but as it was unlikely that these reports would ever be taken further, the author chose to update the reports (approximately 15 were selected), transform them into pdfs, and upload them on Academia where they are now freely available – and being regularly consulted by colleagues and other interested parties.

Illustration

Illustration is an essential part of the publication of lithic artefacts and assemblages. It is possible to illustrate artefacts in a number of ways, with drawing (Fig. 81) and photographing (Fig. 82) being the two chief options, but where economical concerns may also be relevant. The main question is which form of illustration will allow a specific piece to be illustrated most accurately, showing most of the (for example technologically) relevant details. In general, most lithics specialists probably agree that drawing is the preferred option, as this presents an object most accurately, but which also allows a (small) level of subjectivity, in the sense that it is possible for the specialist to emphasize the details he/she finds essential.

Fig. 81. Drawing of Juttish handle-core in flint (artist: Leeanne Whitelaw) (Ballin 2016).

Fig. 82. Photo of barbed-and-tanged arrowheads in quartz from the Calanais stone circle, Lewis (Ballin 2008/photo: B. Ballin Smith).
Artists have different styles, and specialists have different tastes. Some artists favour relatively fine lines, whereas others favour thicker lines. If thick lines are combined with close spacing of the dorsal ripples, drawings easily become very dark and harder to interpret, and the author generally prefers relatively thin lines and styles similar to the one shown in Fig. 81.

In terms of photographing artefacts, the use of colour is to be recommended, particularly in a geological setting like the Scottish. In Scottish prehistory, numerous differently coloured lithic raw materials were used (eg, black pitchstone, bluish-grey chert, green bloodstone and brown carnelian), in some cases possibly indicating whether or not the bearer belonged to one or the other social group or territory – in Polly Wiessner’s (1983; 1984) terms, an expression of ‘emblematic style’. In a publication, these colours need to be displayed accurately.

Although a drawing would usually allow technological details to be shown more precisely than a photograph would permit, most artists find it difficult to ‘read’ artefacts in certain raw materials (flake scars, ripples, radial lines, retouch, etc.), and which details would eventually be included in a given drawing might amount to guesswork. Artefacts in quartz, first and foremost, are exceptionally difficult to ‘read’ and draw, due to the raw material’s reflective surfaces, and in these cases photographing the pieces is recommended (Fig. 82). ‘Sand-blasted’ quartz from dune areas/machair is commonly impossible to draw.

However, making the decision as to whether a specific artefact or assemblage should be drawn or photographed may also come down to factors as mundane as time and economy. A project may have run out of time or money, and photographing may be seen as an acceptable (and time-saving) way forward. Or, in commercial archaeology, where many specialists are self-employed, photographing may be the only way of generating a small profit, particularly in these post Credit Crunch times, where research grants may be almost impossible to get. If a lithics specialist is only able to obtain a very small grant, he/she is probably unlikely to spend the entire grant on paying somebody else (an artist) to do a job (illustration), he/she can do him-/herself with a camera.

The solution may not be ideal, but this is the world we live in.

If the specialist is processing the lithic assemblage as part of a personal research project, he/she will publish the find him-/herself, or, if the lithic assemblage is part of a larger collection from an excavation which also includes finds in, for example, pottery, bone, etc., the finds and the specialist’s report are returned to the excavating unit, where the various reports will be collated to form one joint publication. The unit and its lead investigator will then, in due time, submit a final report/paper for publication.
Final archiving and Treasure Trove disposal

The final part of the specialist’s job of processing and reporting on/publishing an assemblage is then to dispose of finds and project archives. This process is different in Scotland and England/Wales/Northern Ireland, partly due to differences in terms of how Treasure Trove is defined. In Scotland, the definition of Treasure Trove is based on Scots common law *bona vacantia* (ownerless goods), and any ownerless objects found by chance or through activities such as metal-detecting, field-walking, or archaeological excavation become the property of the Crown and therefore may be claimed as *treasure trove*. In the rest of Britain, *treasure trove* is defined in The Treasure Act of 1996, which defines finds such as precious metals, coins, metalwork hoards and associated objects as treasure which must be reported to the local coroner.

In *Scotland*, the archive (paper and electronic documents, maps, photos, etc.) would be submitted to Historic Environment Scotland, and the finds deposited with the Treasure Trove Unit. Following submission of the finds, museums may bid for the various assemblages, which will then eventually be allocated to a local or national museum for storage or exhibition. If no museums show an interest in a specific collection, the finder, specialist or unit, would be free to dispose of the finds in which ever manner seems appropriate.

In *England, Wales and Northern Ireland*, all finds are the property of the landowner, unless covered by the Treasure Act of 1996, and written Transfer of Title to the appropriate local museum needs to be obtained prior to archive deposition. Liaison with museums is the responsibility of the individual or organisation carrying out the fieldwork, and should be initiated at the earliest possible stage in the project, in order to determine any particular requirement for packaging, documentation, etc, and to discuss appropriate selection strategies for long-term curation. Physical archives deposited should include both finds and paper records relating to the fieldwork. While some museums accept digital data as well, current best practice is to deposit digital archives with the Archaeology Data Service (ADS).

**At the museum**

Once a museum has acquired a lithic collection, the finds have to be accessioned before anything further can take place, that is, they have to be entered into the institution’s accession catalogue (now usually in electronic form) of what they have in their possession, with the accurate characterisation. Once this has happened, it is decided whether to exhibit the finds or place them into storage. In either case, they are now available for general research.

Lithic assemblages may be exhibited in so many different ways, and this is not the place for a general discussion of archaeological exhibition formats. However, there are general concerns which must be met, namely that all exhibited (as well as stored) finds must be kept in an environment which will not damage them (the right temperature, light, atmospheric conditions, etc.). Thankfully, most lithic materials are exceptionally robust and difficult to damage in other ways than mechanically (ie, they should not be dropped or placed in heaps whereby their edges may become chipped).
Generally, exhibitions are put together taking into account two main concerns, namely education and research or lay visitor experience. These two concerns should not necessarily exclude each other, but in some cases museums have clearly only (or mainly) taken one of these concerns into account, and the finds may be exhibited strictly typologically, showing numerous axeheads, followed by numerous arrowheads, scrapers, etc. (which to a lay visitor may feel almost brain-numbing), or the finds may be displayed in a mixed manner to show how they were used in the prehistoric reality, but without allowing students or researchers to find the specific artefact forms they may be interested in. In either situation, it is common to find that the lighting of the exhibition cases is under-powered, and an interested/enthusiastic visitor may repeatedly bump his/her head on the glass of an exhibition case in an attempt to get close enough to the artefacts to be able to see essential details.

In terms of storage, it is important that the lithic finds are packaged (bagged and boxed) appropriately, to 1) protect the objects, 2) allow the museum to re-find the pieces for future exhibitions, and 3) to allow the finds to be accessed by visiting researchers.

Generally, so-called ‘specials’ (preparation flakes, cores and tools) should be bagged or boxed individually, whereas debitage can be held in bags/boxes with multiple objects in them. However, if for example a grid unit (eg, one square-metre or quarter of square-metre) has yielded a large number of objects, sub-bagging should take place. It is common (in units as well as museums) to include so much quartz debitage within one bag/box that the individual artefacts are damaged mechanically over time by the pieces rubbing against each other, particularly in connection with handling. In exceptional cases, ‘weakened’ artefacts (weathered or fire-crazed pieces of debitage) may have to be bagged/boxed separately to avoid disintegration.

However, occasionally excavating teams or museum staff may have been slightly over-zealous in terms of attempting to give the lithic artefacts a protection they don’t generally need, as most lithic materials are hardy. This may hamper future access and research. In one case, the author had to examine a certain quartz assemblage, and each of the c. 3,000 quartz objects had been covered by kitchen foil (squeezed tightly around them) followed by wrapping them tightly in cling film. In connection with this project, an extra two weeks (out of a meagre budget) had to be invested in ‘liberating’ the lithic artefacts from their wrapping. In another case, a grant had been secured to examine and write up a flint assemblage of c. 20-30,000 pieces, and each individual artefact (including tiny chips) had been wrapped tightly in strips of toilet paper. In this case, the project had to be redefined, as removing the wrapping was so time-consuming that dealing with the debitage was impossible within the agreed budget, and only the ‘specials’ were dealt with.

It is a great help that some museums now allow their collections to be ‘rummaged’ electronically, through online catalogues. However, in many cases it is necessary to approach the relevant museum curator, visit the museum stores, and go through paper catalogues at the institution.
ACKNOWLEDGEMENTS AND CREDITS

The author would like to thank Emma O’Riordain (ScARF) and David Connolly (BAJR) for encouragement and support during the preparation of this guide.

He would also like to thank all the colleagues who have permitted him to reproduce their illustrations of lithic artefacts, including Terry Manby, Jørgen Holm, Alan Saville (thanks are owed to Annette Carruthers for allowing the author to use Alan’s material for this guide and the forthcoming classification system), Andrew David, as well as Hilary and Charlie Murray. Illustrations of some relatively rare lithic types were copied from Evans 1897 (according to copyright law, anything produced more than 75 years before the author’s death is Open Access), and the woodcuts in his volume were produced by J. Swain.

The artists include M. O’Neil, H. Martingell, J. Dunbar, M. Matsumoto, A. David, J. Holm, L. Whitelaw, and T. Manby, and the photographers include B. Ballin Smith, and L. Demay. Wessex Archaeology Ltd. and Headland Archaeology Ltd. are thanked for providing information relevant to the section on dealing with a project’s finds and archives.
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