Lithics from Bronze Age Domestic Sites

Volume 1

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Statement of Original Authorship

I hereby certify that the submitted work is my own work, was completed while registered as a candidate for the degree stated on the Title Page, and I have not obtained a degree elsewhere on the basis of the research presented in this submitted work.

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Abstract

This thesis considers lithic material coming from settlement sites dating to the Chalcolithic and Bronze Age, *c*. 2,500-700BC. Overlooked in favour of other artefacts and aspects of society at this time, lithics have attracted only sporadic attention from researchers. This has led to a situation where: a common artefact from sites of this period is poorly presented; understandings around it are unclear; and engagement is limited.

Scrapers and arrowheads are intrinsically associated with the periods. Beyond these, the material present on sites is challenging to grasp. This is partly due to the nature of assemblages. Unretouched flakes are routinely found, and give little away in terms of function. Material can be interpreted as residual or waste. This research set out to examine lithics from secure contexts on sites with structural evidence in order to assess the validity of such claims, and provide a basis for interpretations.

However, the major hindrance to the progression of this research was found to lie in the practice rather than the evidence. The application of terminologies and dating varied amongst analysts, and was largely inaccessible, with explanations or sources rarely given. Of particular difficulty, was the identification of bipolar reduction – which the Chalcolithic and Bronze Age are most strongly associated with. The schema presented by analysts within reports and other publications were, for the most part, either underdeveloped or not explained. As a result, some of the original aims were abandoned. A greater focus was placed on reviewing international research on bipolar reduction, and using these standards to identify this technology within Irish assemblages.

This research shows that bipolar reduction is more nuanced than is presented in Irish literature. Variations of the technology can be identified using replicable markers. The comments on the lithic traditions of the Chalcolithic and Bronze Age are limited. It confirms some aspects of what was known: scrapers are the dominant modified type on sites, followed by retouched pieces; bipolar reduction is the principal knapping method. It challenges others: the decreasing presence of lithics through time is less apparent. And establishes some new in-sights: the assemblages from settlement and burial contexts are broadly similar.

Volume 1 contains the main thesis, followed by appendices. Volume 2 contains the catalogue of analysed material.

Table of Contents

List of Tables

List of Figures

List of Plates

All photographs taken by C. Hogan.

List of Boxes

1. Introduction

1.1 Introduction

This research set out to examine the presence of lithic artefacts on excavated Chalcolithic and Bronze Age sites, which have a structural element interpreted as domestic. Initially it was to study archaeological evidence, however, the focus shifted to include a review of archaeological practice through the course of the research. This was an unintended review of the comprehension of lithics by general practitioners, and the presentation of lithics by specialists. Tied into the latter aspect is a more thorough review of new understandings of a long-standing knapping form – the bipolar reduction technique.

A lack of understanding of lithics in metal-using eras generally, and more specifically between metal and stone technology, has been acknowledged (Eriksen (ed) 2010; Gijn, Niekus 2001: 305). Within the Irish context, open and thorough deliberations of lithic traditions of the Chalcolithic and Bronze Age by lithic specialists, or archaeologists in general, are considerably less developed – if at all. Commentary is largely restricted to lithic analysis reports within excavation reports, with some of this grey literature informing a small selection of post-graduate theses. An assortment of digital versions of these can be variably found on the internet. But, there is a noticeable absence. Publications by lithic specialists that explain or contemplate – or even attempt to – the lithic traditions of the first eras of metal use are not seen in peer-reviewed journals nor monographs nor edited books.

The comprehension of lithic traditions of the Bronze Age in the Netherlands have been described as Cinderella-like – focusing on the attractive forms, and neglecting the more mundane pieces (Gijn 2010: 45). An apt description for Ireland. Barbed-and-tanged arrowheads, scrapers, bracers – these are what are presented, with some other forms occasionally, as the Chalcolithic and Bronze Age assemblage (see Roberts 2013; Waddell 2000). There is little contemplation of the considerable amount of commonplace material that is recovered from secure contexts on sites. This neglect of informal forms is much to the detriment of our understanding of later prehistoric society, economy, and everyday life. This research aims to redress this imbalance.

However, as we shall see, by delving into the topic of lithics of metal-using eras, Cinderella quickly turns into a Hydra. A myriad of interconnecting issues rear their heads, which range from standards of practice, attitudes, presentation, and specialist standardisation.

1.2 From Cinderella to Hydra

"The second Labour which he undertook was the slaying of the Lernaean hydra, springing from whose single body were fashioned a hundred necks, each bearing the head of a serpent. And when one head was cut off, the place where it was severed put forth two others; for this reason it was considered to be invincible, and with good reason, since the part of it which was subdued sent forth a two-fold assistance in its place."

– Diodorus Siculus, The Library of History IV.11.5 (trans. Oldfather)

The consideration of lithics in the Irish Chalcolithic and Bronze Age is much akin to Herakles' battle with the Hydra. In addressing one aspect, a plurality of intersecting problems comes forth. In challenging latent views, one needs to argue against the existing and for an alternative.

There are several concerns that loom large in the study of lithics of the first eras of metal use. During background reading for this research, and to establish the methodology, they became apparent. These encompass the archaeological conception of the lithics, metals and their interaction; the standardisation of technical terminology, and the presentation of technical terms.

The understanding of prehistoric lithic traditions is challenging. The juxtaposition of stone and metal within archaeological literature, in a way that other aspects of material culture have not been, has further complicated this. Viewpoints are poorly supported – if at all – which creates It was never a goal of this research to establish an alternative narrative – principally because it was assumed by the researcher that established views would be supported by either evidence or reasoning that confirm, or that allow for subsequent researchers to sufficiently comprehend and alter or refine. Such is beyond the remit of a single thesis. However, it will show that our considerations and interpretations of lithics during the first metal-using eras are largely inadequate. The goal here is to prompt greater reflection on lithics in the Chalcolithic, Bronze Age, and later.

1.3 The Irish Chalcolithic and Bronze Age

The Chalcolithic has been traditionally called the Beaker period, or referred to as the Final Neolithic/Early Bronze Age (**Table 1.1**; **Fig. 1.1**). The period is defined by the introduction of metallurgy – in the form of copper-working – alongside a particular artefactual assemblage and megalithic tradition (O'Brien 2012). The period is typified by ephemeral settlements, typically consisting of spreads and a small number of post- or stake-holes (Carlin 2018). Fully defined structures are rare. When they are uncovered, they appear more hut-like than those of the ensuing period (O'Brien 2004).

The Bronze Age is defined by the development of bronze alloying in metallurgy. It is separated into several separate sub-periods. The chronological separation of these has been based on recovered metalwork and pottery styles (**Table 1.1**; **Fig. 1.1**), and recently, settlement phases (**Table 1.2**) and trackway phases (**Table 1.3**). There is an expansion in metalworking from the end of the Early Bronze Age through to the end of the Late Bronze Age. In the Early Bronze Age, distinctive ceramic traditions – first Food Vessels, then Urns – replace that of the Beaker period, eventually giving way to a conventional form – Coarse Ware – in the Middle Bronze Age (Carlin 2018; Brindley 2007). Structures become more defined in their footprint, and show patterns of increase and decrease in settlement throughout the Bronze Age (Ginn, Plunkett 2020; Ó Néill 2009), though there is often a lack of associated habitation with other known activities, such as mining (O'Brien 2007: 29).

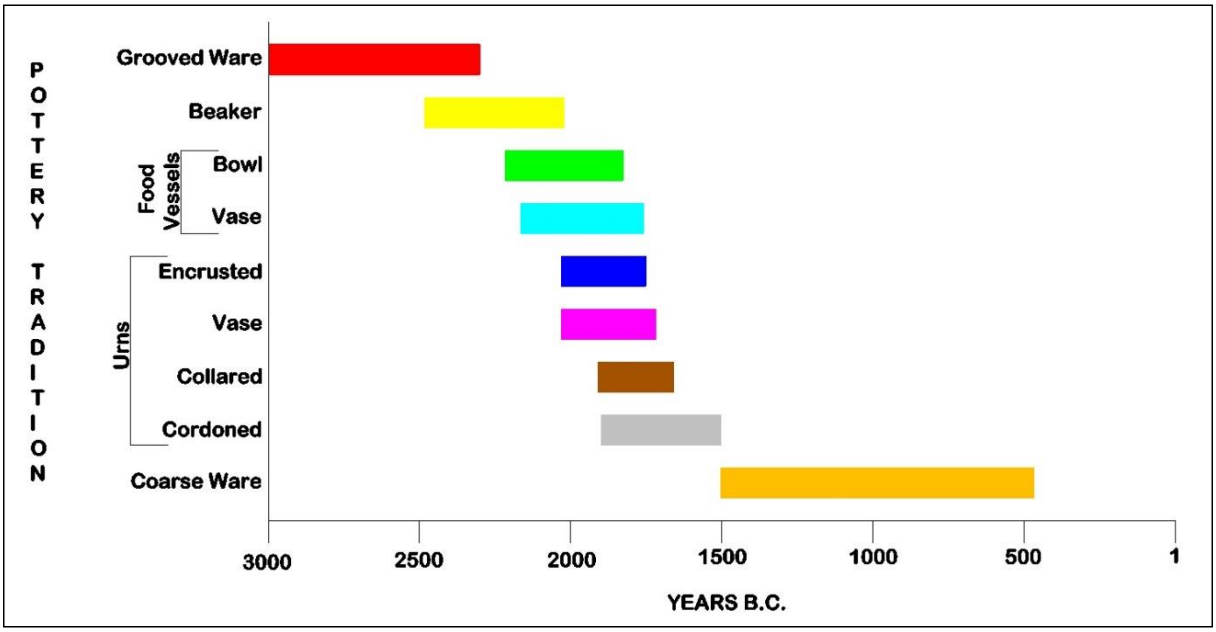

Fig. 1.1: Ceramic periods – approximate dates (sourced from Waddell 2010; Brindley 2007).

Period	Dates (BC)	Metalwork Phase	Dates (BC)
Chalcolithic	2500 – 2000	Knocknagur	2400 – 2200
		Killaha	2200 – 2000
Early Bronze Age	2000 – 1500	Ballyvally	2000 – 1600
		Derryniggin	1600 - 1500
Middle Bronze Age	1500 – 1000	Killymaddy	1500 - 1350
		Bishopsland	1350 - 1000
Late Bronze Age	1000 – 700	Roscommon	1000 – 900
		Dowris	900 – 700
Early Iron Age	700 – 400		
Developed Iron Age	400 – 1		

Table 1.1: Calendar dates for Chalcolithic, Bronze Age, Iron Age periods and sub-periods, with associated metalwork phases (sourced from O'Brien 2012; Waddell 2010; Becker *et al*. 2008).

Settlement phase	1	2	3	4	5
Date (BC)	2200 – 1700	1700 – 1300	1300 – 1100	1100 – 800/750	800/750 – →
	contraction	expansion	contraction	expansion	contraction

Table 1.2: Settlement phases in the Irish Bronze Age (Ginn, Plunkett 2020).

Trackway phase	1	Lull A	2	Lull B	3	Lull C	4
Date (BC)	2700 – 1900	1900 – 1700	1700 – 1375	1375 – 1225	1225 – 775	775 – 500	500 – 25 **(AD)**

Table 1.3: Trackway activity phases from the Late Neolithic to the Developed Iron Age (Gill *et al*. 2013). Note the AD date for TP4. Sequence continues until Middle Ages.

The study of the periods has traditionally been focused on the more visible aspects. Metalwork was the most discussed topic (O'Flaherty 1995; Kavanagh 1991; Eogan 1981; 1974; 1969; Coffey 1908). It is still a major focus for research (Lineen 2017; O'Flaherty 2002), often being placed within a social context, such as trade (Ó Maoldúin 2014; O'Brien 2010), or hoards (Becker 2006), or production (Ó Faoláin 2004). For a long time, burials, either cist or barrow or cemetery, were the primary indicator of inhabitation during the Bronze Age (Mount 1997; Waddell 1990). Similarly positioned are megalithic monuments (O'Brien 2005; 1999; Walsh 1993; Ó Nualláin 1978). Hillforts, being one of the more recognised aspects of settlement, have provided for several research projects, often with a landscape scope (O'Driscoll *et al*. 2020; O'Brien, O'Driscoll 2017; O'Driscoll 2016; Mallory *et al*. 1999). Crannogs and other wetland sites have provided a good degree of interest (O'Sullivan 2007; Cavers 2006; Gowan *et al*. 2004; Fredengren 2002), and allowed for consideration of woodworking (Ó Néill 2004). Pottery is one of the most frequent finds from sites. It has been returned to several times, with typologies and chronologies becoming more refined (Brindley 2007; Cleary 2000; Ó Ríordán, Waddell 1993; Kavanagh 1976; 1973; Harbison 1969).

Recent research has seen a greater focus on theoretical approaches to these various aspects. Ginn (2016) used settlement evidence to investigate social structure within later Bronze Age society. Leonard (2014) referred to several theoretical frameworks – cognitive archaeology, performance theory, structuralism, *etc*. – to inform her study of ritual in Late Bronze Age Ireland. Ó Maoldúin (2014), in discussing exchange during the Chalcolithic and Early Bronze Age, incorporated a variety of theories into his considerations of physical artefacts and sites. Brück (2019) challenged the traditional dichotomous approach within Bronze Age studies and presented an understanding of society during the period 2500-600BC by exploring the relationship between the people, the materials, and the places that inhabited that world. This built upon a series of articles that had re-assessed burials and settlements in Ireland and Britain through examination of the character and relations of person and object deposition (Brück, Davies 2018; Brück 2007; 2006; 2004; 1999).

Given the survivability of lithics, as well as their frequent occurrence on later prehistoric sites, the contribution to our understanding of the Irish Chalcolithic and Bronze Age. Three theses have considered the presence of chipped lithics over five decades (O'Hare 2005; Scannell 1992; Sproule 1968). The lack of understanding of Chalcolithic and Bronze Age lithic traditions is compounded by a lack of consensus amongst analysts (see **Chapter Three**). There is an application of unpublished terminologies and dating schema. There is a lack of development in discussions surrounding residuality. Also appearing is an inconsistency in the use of typologies.

1.4 A Changing Landscape

"But now, you look down there 'n' all you see is 'ouses, 'ouses, 'ouses"

The Imagined Village – 'Ouses, 'Ouses, 'Ouses

From an early stage in Chalcolithic and Bronze Age studies, there was little information regarding more commonplace settlement and activities (Harbison 1973: 127; ApSimon 1969: 33, 50; Eogan 1964: 315; Davies *et al*. 1940: 9). This paucity of settlement sites long remained a noted issue for lithic research of this period (Woodman *et al*. 2006: 126; Scannell 1992: 16). Burials and monuments provided the greater portion of material for earlier discussions and examinations (Scannell 1992; Sproule 1968). O'Hare's (2005) assessment incorporated the largest portion of settlement material, accounting for one-third against two-thirds burials. However, 'settlement' included sites such as Rathgall hillfort, Co. Wicklow, and Rathtinaun crannog, Co. Sligo, – which are seen as high-status, and not representative of lower-status habitation (O'Brien 2017; Ginn 2016; Fredengren 2002: 199, 200; Doody 2000). Despite this dearth of settlement evidence, a definitive narrative of the replacement of stone by metal across all aspects of society was still affirmed.

Over the last two or three decades, large-scale developments added significant numbers of sites to the Chalcolithic and Bronze Age corpus. Bronze Age sites account for over 50% of sites on many infrastructure projects (Grogan 2017: 57). While these developments display a bias for the south, east and midlands of the country, there are numerous publications for individual Bronze Age sites in the north (Barkley *et al*. 2014; Ginn, Rathbone 2012; Chapple 2010; Chapple *et al*. 2009; Gilmore 2009; Ballin Smith *et al*. 2003; Suddaby *et al*. 2003). The western portion of the island has not experienced the same level of development, so the sample of sites is much lesser, though both research (Rathbone 2010) and commercial excavations (O'Hara, McCormack 2017) have uncovered Bronze Age sites.

The level of settlement evidence increased dramatically in a short space of time. Doody (2000) noted 38 sites with 78 structures in his analysis of Bronze Age buildings. Little more than a decade later, these numbers had increased to 260 sites and 583 structures (Rathbone 2013). Three years later, the number of sites was raised to 306 (Ginn 2016). This represents an increase in representation of sites with structures by 705% and of individual structures by 647%, over approximately 15 years.

Despite an increasing number of sites and artefacts recovered (Grogan 2017), the role of stone within the first eras of metal use is still under-considered. Recent research looking at Bronze Age settlement has engaged with lithic material to a greater extent. Cleary's (2007a) review of material culture retrieved from sites highlights a greater occurrence of lithics than other materials. From an analysis of 106 sites (Cleary 2007b), metal was present on 15% [N=16] – 16 sites with bronze, 11 with 'metal', five with 'gold', two with 'copper alloy', one each with ‘tin’, ‘copper’, ‘bronze/lead’, ‘bronze/copper, and ‘bronze and gold’[1]. Conversely, ‘stone’ was present on 61% [N=65] and ‘lithic’ on 81% [N=86] of sites[2]. Sites with metal artefacts were predominantly high status, such as Rathgall, Co. Wicklow, or Haughey’s Fort, Co. Antrim (Cleary 2007a: 265). In her assessment of later Bronze Age settlement patterns, Ginn (2016: 120) posits small social units as self-sufficient. A utilitarian assemblage of chipped/ground/coarse lithics and pottery sherds is identified as the general package, with a lack of any artefactual evidence from some settlements noted (Ginn 2016: 115). Metal objects come in the very restricted presence of copper-alloy or bronze artefacts. Instead, moulds are the most ubiquitous association with metallurgy (*ibid*.) – though these are a ground lithic item themselves. The idea of a “thorough make-do-and-mend[3] economy” for the period (O’Hare 2005: 315) was refuted by the utilitarian assemblage and possible re-distribution routes through higher status sites (Ginn 2016: 120).

The evidence and arguments presented by Cleary and Ginn challenge long-standing preconceptions regarding the presence of lithics during the Bronze Age. The frequency of lithic items on habitation sites is greater than what has been depicted. This displays a functional usage that lasted a considerable time after the introduction and propagation of copper and bronze.

1.5 Aims

The aims for this research are laid out in detail in **Chapter Five**. Initially, they focused on the lithic material culture of settlements sites of the first metal-using eras, and developing an understanding of their occurrence. This included a focus on typology, technology, and contextual associations. Once research began, these started to shift. Information pertaining to them was still sought – but they were no longer the primary concern. Residuality became a

[1] There is overlap of occurrence on sites of the categories.

[2] ‘Stone’ refers to ground/coarse lithics and manuports; and includes one entry recorded as ‘Jet’. ‘Lithic’ is used in relation to pieces of flint and chert.

In Irish archaeology, ‘chert’ refers to forms of silicified limestone, of which higher quality material can be very similar to flint (Woodman *et al*. 2006: 83). In other countries, ‘flint’ and ‘chert’ are used interchangeably. In North America, chert can refer to what is known in Ireland as chert, flint, *etc*. This determination is further clouded by these being forms of quartz or chalcedony.

[3] The term ‘make-do-and-mend’ came about during the Second World War. People were encouraged to extend the lifespan of clothing by making repairs to items, take more care in their maintenance, and to improvise with what was available (Norman 2013). O’Hare (2013: 197) uses clothing as an analogy to describe the relationship of metal and stone – the former high fashion, the latter “the poor cousin”. Since the term is not explicitly defined, it is presumed that its usage is describing this kind of approach to materials.

factor of concern. The ill-defined attribution of this term to pieces skews the verifiable presence of diagnostic material. It was necessary to establish a rate of occurrence using only diagnostic pieces to allow for subsequent critique. Despite the widespread identification of bipolar-reduced lithics on sites, there is a noticeable deficit in the tool-kit. For bipolar reduction to occur, an anvilstone (or an anvil of some material) is necessary. Given the general absence of these in reports and research on coarse lithic material, as well as the intrinsic link to bipolar reduction, it was deemed necessary to investigate coarse lithic objects.

A key aim became the establishment of a reference resource for bipolar reduction. Additional foci included an assessment of the historical attitudes towards lithics, and the establishment of current opinions; and the formation of a conversant approach towards lithics of metal-using eras.

1.6 Structure of the Thesis

Chapter Two reviews the understanding of lithics in Chalcolithic and Bronze Age Ireland. The popular understanding of the assemblage and its production is presented, with a consideration of the supporting literature. The establishment of the current narrative is traced, and recent signs of change to this are highlighted. A brief review of the factors that lead to changes within lithic traditions is undertaken. Finally, a lithoculture – a defined assemblage – for Chalcolithic and Bronze Age Ireland, and the reasoning behind it, is presented.

In **Chapter Three** a critical review of lithic analysis reports is presented. This primarily incorporates commercial reports, though refers to theses or other publications as well. The review focuses on two aspects which are to the forefront of addressing issues with lithics in metal-using eras. Firstly, the understanding of bipolar reduction, in an Irish context, is critiqued. This is followed by an appraisal of the dating applied to lithic material.

International research on bipolar reduction is presented in **Chapter Four**. A summary of the history of bipolar reduction is presented. This is followed by an in-depth review of literature that presents a much more complete picture of the technique. This presents categories of artefacts with associated markers, and the bipolar tool-kit needed to produce this material. A presentation of the bias that can be seen against bipolar reduction is given. While this is starting to shift, the aspects mentioned can still be found in literature and awareness of the flaws when reading is beneficial. Finally, brief mention is given to an adapted method for sorting lithic artefacts from pseudo-artefacts.

Chapter Five lays out the methodology for the analysis. The aims of the research are set out in detail here. The parameters for the selection of the research assemblage are laid out. Analytical framework. The structure of database used to record material is presented.

The results of the analysis are presented in **Chapter Six**. This is divided into two sections. The first deals with lithics that appear on Chalcolithic and Bronze Age sites. This looks at the overall assemblage, through geology, primary reduction technology, and modified types. A review of residuality is presented. The analysed assemblage from Carrickmines Great 63M, Co. Dublin, is presented finally. This is done because the assemblage appears unique, in terms of lithic working in the Chalcolithic and Bronze Age, due to the volume and nature of material recovered at the site; and has implications for how we view the presence of lithics on sites. The second section focuses on the identification of bipolar reduction using internationally-set markers. Core material is dealt with first, followed by products. The bipolar tool-kit is briefly considered. The effect of geology and its relation to unclassified material is briefly presented.

In **Chapter Seven**, discussion covers the lithics of Chalcolithic and Bronze Age Ireland, and bipolar reduction. The assemblage of the periods is first presented. A comparison between material found on settlements and in burial contexts is then undertaken. This draws on four theses and a journal paper to summarise the mortuary assemblage, which is then compared and contrasted with the results of the analysis. The implications of the revised approach to bipolar reduction are then considered. The bipolar assemblage is presented. Some issues that arose during the analysis are also considered.

The conclusions are presented in **Chapter Eight**. The Chalcolithic and Bronze Age lithoculture is updated with the results from the analysis. Avenues for future research are presented. These were uncovered during background reading for this research, and will be informative of lithic traditions in metal-using eras going forward.

2. Lithic traditions of Chalcolithic and Bronze Age Ireland

2.1 Introduction

This chapter will present the current understanding of lithic in Chalcolithic and Bronze Age Ireland. It will set out what is presented as the standard assemblage. It will set out the historical narrative of lithics in discussions of Chalcolithic and Bronze Age Ireland. It will also present a new approach to this material. This is in response to the oversights and underwhelming comprehension currently espoused.

2.2 Chalcolithic and Bronze Age Lithics

There are clear ideas about the lithic assemblages of Chalcolithic and Bronze Age Ireland.

- The assemblage is flake-based.
- There are limited modified types.
    - Scrapers, convex particularly, are the dominant form.
- Bipolar reduction dominates.
    - This is an *ad hoc* and expedient reduction technique.
- The knapping is unskilled, especially compared with preceding periods.
- There is a diminishing presence.

These impressions are gained from reading general synopses of Irish archaeology and lithic analysis reports. In much the same way, we can understand the assemblages of Mesolithic and Neolithic Ireland. However, there is a stark contrast. The Mesolithic and Neolithic assemblages have a dedicated body of literature specifically dealing with aspects of lithic traditions behind those summations (see McCall 2019; Driscoll 2016; 2009; Driscoll *et al*. 2014; Sternke 2011a; 2009a; Warren *et al*. 2009; Costa, Sternke 2007; Woodman *et al*. 2006; Costa *et al*. 2005; Woodman 2005; Bamforth, Woodman 2004; Nelis 2004; Peterson 1990). Through these publications, ideas/theories/information are presented, reviewed, refined, corrected, challenged, and so on. For example, the early suggestion of soft-hammer, punch-controlled reduction being the primary form in the Early Mesolithic (Woodman 1978) was replaced by initial hard-hammer, then final stage soft-hammer working (Costa *et al*. 2005; 2001). This supersedence was re-enforced in the review presented in the Keiller-Knowles publication (Woodman *et al*. 2006: 110). Another example is when the components of Neolithic assemblages are reviewed in more detail. Nelis (2004) builds upon prior research to develop understandings of bifaces and hollow scrapers. The development is possible as it sits within a context where the period or sub-period has clear typological associations established through previous research (Woodman 1994).

For the lithic assemblages of Chalcolithic and Bronze Age Ireland, there is a distinct lack of literature. To date, there have been three post-graduate theses – one PhD (O'Hare 2005) and two MA's (Scannell 1992; Sproule 1968). Beyond these, one has to read through individual lithic analysis reports and attempt to compile a coherent general view from them. This approach is fraught with issues, some of which are dealt with specifically in **Chapter Three**. This absence creates problems when trying to: identify the origins of viewpoints; or support current understandings; or challenge (mis)conceptions.

Sproule's MA thesis (1968: 4, 5) aimed to analyse all Bronze Age (referring to Early and Middle sub-periods) material, with an acknowledged dearth of settlement sites. She arranged four chapters by forms – plano-convex knives; arrowheads; scrapers; and flakes and blades; and examined the lithics coming from various contexts, primarily monuments and burials, under each. This has been overlooked by other studies. And though limited by the available catalogue and a now dated understanding of the Bronze Age, it still raises some interesting points. She noted no evidence for a change horizon in lithic reduction associated with the Bronze Age, but rather saw a slow decline through the period (*ibid*.: 6, 7). This decline was attributed to the introduction of bronze (*ibid*.: 11). In her conclusions, she views the variety of flake forms as indicative of a thriving knapping community in Bronze Age Ireland (*ibid*.: 193) – where later analysts will see unskilled, expedient knapping.

Scannell's MA thesis (1992) looked at the chipped stone industry during the Neolithic and Bronze Age in Counties Cork, Kerry, and Limerick – although Co. Kerry was represented by only one or two sites throughout the research. The aim of the research was to identify the effects of limited resources – mainly referring to flint; what alternative materials were used; and determine trends, either change or continuity, relating to typologies, technologies, and use (*ibid*.: 1). The research was presented through chapters built around case studies, presenting the analysis and conclusions for each. Case study sites included material from burials, settlements, and ritual sites – though there is an overall lack of Bronze Age settlement in the thesis (*ibid*.: 1, 16). While the occurrence of bipolar was noted as commonly used on later sites, it was also recorded within Neolithic assemblages (*ibid*.: 156, 158, 160).

O'Hare's PhD thesis (2005) undertook an assessment of all Bronze Age lithic material recovered at that time. She aimed to examine the importance of the lithics industry during the Irish Bronze Age against a background of metalwork. The research followed the format used by Sproule (1968), where stone tools recovered from Bronze Age sites were analysed in comparison with Neolithic precursors.

At the time of completion, O'Hare's thesis was straddling two periods of Bronze Age research; with the earlier two (Scannell 1992; Sproule 1968) very much sitting in a landscape of extremely restricted, in terms of both material and viewpoints, Bronze Age research. These projects were formulated in the artefact-heavy interpretations and limited site types of Bronze Age society that had gone before (Ó Faoláin 1997; O'Brien 1995; Ó Ríordán, Waddell 1993; Woodman, Scannell 1993; Eogan 1964; 1962); and have been outdated by the wealth of recent theses and publications, resulting from boom-time excavations, that consider the Irish Bronze Age through many varied lenses – with much new information and material, and more developed theories of society being applied (O'Brien, O'Driscoll 2017; Ginn 2016; Leonard 2014; Ó Maoldúin 2014; Carlin 2011; Ó Néill 2009; Cleary 2007; O'Brien 2004). Being the most recent, this effect of an expanded dataset is particularly evident in O'Hare's thesis.

These theses remain mostly unpublished. There is one paper, within a collection of essays, providing a contextual setting for a specific site (Woodman, Scannell 1993), which incorporates some material from Scannell's MA. The article discusses six sites related to the Lough Gur complex. Three – Knockadoon A, Knockadoon B, and Garret Island – are periodised as Neolithic "on premise" (*ibid*.: 53). Grange stone circle is periodised as Beaker, due to a "significant Beaker component" (*ibid*.). Knockadoon C and D are periodised to the Bronze Age, as they contained a much more definite Bronze Age component" (*ibid*.). While this phasing implies clear-cut aspects, the article later states that "it is impossible to separate definitively the different chronological components" beyond slug-knife forms of plano-convex knives, small invasively-retouched scrapers, and later forms of arrowheads (*ibid*.: 55). The article sets out a change in technology from the Neolithic to the Bronze Age, moving from blade production to flake (*ibid*.: 54). The issue of residuality is highlighted for the sites due to attracting occupation repeatedly and throughout the archaeological record (*ibid*.: 60). There is a proof copy for an unpublished book (O'Hare 2013) from O'Hare's PhD. This focuses on material from domestic contexts identified in the original research, separating them into two periods: Earlier Metal Era – Beaker and Early Bronze Age, *c*. 2400-1800BC; and Developed Bronze Age – post-1800BC and the Late Bronze Age, *c*. 1800-600BC (*ibid*.: 20, 21). Reviews of lithic material in these periods is followed by a general synopsis and a discussion of the interaction of lithic and metal technologies.

The lithic tradition of the first eras of metal use is intimated as limited. This is understood by the focus on formal chipped typologies. The Chalcolithic is typified by barbed-and-tanged arrowheads and scrapers. Convex scrapers are the artefact most frequently recovered with Beaker pottery (see Carlin 2018). Sub-categories, such as thumbnail or disc, are often noted (Carlin 2018: 67; Scannell 1992: 167, 223). The Bronze Age is further restricted in its lithic tradition. Scrapers dominate the retouched assemblage (Scannell 1992: 116). Barbed-and-tanged arrowheads decline in the Early sub-period, with only a cursory presence from the Middle Bronze Age on (Green 1984: 35; 1980). The belief that lithic traditions cease beyond the Middle Bronze Age has been voiced by specialists (see Tierney *et al*. 2011: 44).

From the three post-graduate theses, we can arrive at some understanding of Chalcolithic and Bronze Age assemblages (**Table 2.1**). There is some coherency between them, but the variations are also apparent. Where early detailed sub-divisions are provided, it is unclear what a later absence signifies. The occurrence of 'retouched piece' in all three theses may conflate a specific designation with a generalised reference to all pieces with secondary modification, formal or non-formal. Woodman (1984: 4) presented an early summation of the Bronze Age assemblage in comparison with those of the Early and Later Mesolithic, and the Neolithic (**Fig. 2.1**). The Bronze Age is lacking any form of core and scraper. Very little relation can be seen to the theses that bordered it.

Sproule (1968)	**Scannell (1992)**	**O'Hare (2005)**
		Arrowhead
Arrowhead – barbed-+-tanged		
Arrowhead – hollow-based		
		Axehead
Blade	Blade	
		Chunk
	Core	Core
Flake	Flake	Flake
		Micro-debitage
Perforator		
Plano-convex knife		Plano-convex knife
Point		
Retouched piece*	Retouched piece^	Retouched piece
		Scraper
	Scraper – disc	
Scraper – end		
Scraper – hollow		
Scraper – round	Scraper – round	
Scraper – thumb		
	Split pebble	
		Utilised piece

Table 2.1: Chalcolithic and Bronze Age lithic assemblages as derived from previous research.

* = appears as "worked flakes" in thesis

^ = appears as "retouched flakes" in thesis

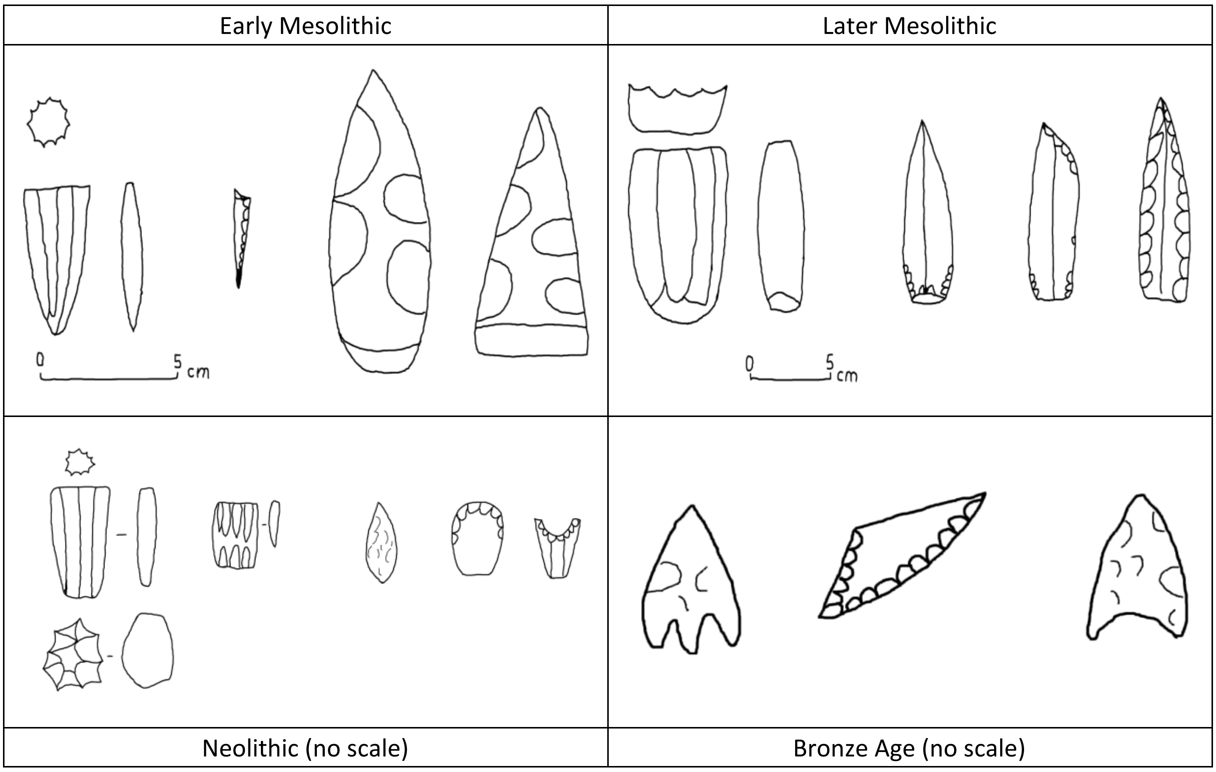

Fig. 2.1: Assemblages characterised by period (re-drawn and adapted from Woodman 1984: 4).

The omission of objects in discussion of lithic traditions occurs frequently. All three theses, incorporated the Chalcolithic period, yet objects are absent from their corpora. Lithic elements, such as bracers, beads or buttons, are associated with the period (Carlin 2018). Objects like these are rarely considered in the context of knapping (see Sternke 2010a; Roe, Woodward 2009). These objects can be created on siliceous rocks, such as jasper and porcellanite, or other rock types, like jet or siltstone. While their finished appearance and associations leads to their classification as a ground lithic item (Carlin 2018: 185), the initial stages of manufacture may have involved techniques similar to that of chipped items (see **Box 2.1**). Similarly, stone elements, for example moulds, are rarely, if ever, considered for their aspect of lithic working (see Larson 2009; Ó Faoláin, Northover 1998; Hodges 1954; Maryon 1938; Evans 1881: 427-438). To create a bivalve mould, wherein the recess of one half mirrors that of the other, sometimes with small channels for air to escape, and is coupled with the production of parallel faces to minimise seepage requires considerable ability.

Box 2.1: Lithic artefacts and production processes

The production processes of lithic objects have been well established for some, e.g.: axeheads, and less so for others. In the cases of bracers, V-perforated buttons, and beads, the *chaîne opératoire* is somewhat incomplete. Discussion and experimental work covering all production stages has mostly come from the Middle East (Gurova, Bonsall 2017: 163; Wright *et al*. 2008).

Focusing on bracers, several articles have discussed their manufacture – specifically the finishing stage (Nicolas 2020; Turek 2015; Roe, Woodward 2009; Woodward *et al*. 2006). In these, the visible marks left by processing were recorded and connected to steps. Perforations indicated boring, and striations indicated polishing and sawing. Some attempts were made to identify earlier stages of manufacture – though it is an area that still lacks insight (Nicolas 2019: 128). The highly finished nature of these objects is a noted issue in determining initial reduction strategies (Nicolas 2020: 21). The absence of flakes scars is seen as discounting percussion (*ibid*.: 26) – but this ignores the possibility of their removal through later grinding and polishing. Sawing is presented as an alternative to percussion, and as the cause of some striations (*ibid*.). Elsewhere an absence of saw marks, as a result of polishing, was not a reason to dismiss its use in initial stages (Turek 2015: 36).

The lack of recorded rough-outs for bracers in Ireland and Britain undermines our ability to understand these early stages. There are rough-outs known from Continental Europe (*ibid*.:

30). There is a difference in the raw materials used – jasper predominantly in Ireland (Roe, Woodward 2009) and metamorphic or silicified mudstones and fine-grained sedimentary stones, with some igneous rocks, in Britain and on the Continent (Nicolas 2020: 21; Turek 2015: 34; Roe, Woodward 2009), so direct comparisons between these stages should be cautious. But, by referring back to the geological material in its raw form, we can draw some insight.

Further focusing on jasper bracers (**Fig. 2.2**), the raw material is a form of silica with varying admixed minerals causing colour differences, meaning it is widely variable in its appearance, structure, and determination (Kostov 2010; Lovering 1972). It is similar to other silicates, such as flint, chert, chalcedony, *etc*. – though its formation is thought to be the result of replacement of a parent material, rather than diagenesis (Lovering 1962). It occurs in banded and nodular forms of varying size (**Plate 2.1**), and is recovered from a range of primary and secondary geological contexts (Lovering 1972).

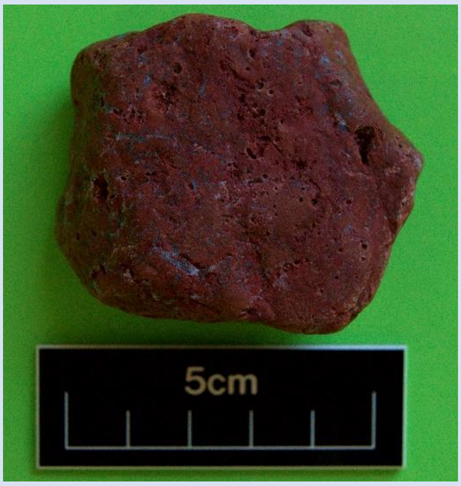

Plate 2.1: Jasper nodule recovered from Cross beach, Co. Mayo.

Fig. 2.2: Jasper bracer, fragmented, recovered from Rathmullan 10, Co. Meath (from Carlin 2018: 83).

To produce a bracer from a nodule would first require a suitable removal. It is not seen as likely that a finished form would be ground down from pebbles. The removal could be achieved through either freehand or bipolar reduction. Secondary flaking may have occurred to thin the material to a suitable outline. Then, as established elsewhere, the final processing steps would have been undertaken. For smaller objects like beads, this process may not have been necessary. Small pebbles may be close enough in size that they could be finished without significant initial reduction.

A bracer recovered from a secure context at Rathmullan, Co. Meath, was described in the Small Finds Report, mentioned in the Prehistoric Pottery and Charcoal Remains Reports, and completely absent from the Lithic Analysis Report (see Bolger 2012). While this might appear a minor distinction, the bracer recovered is of jasper – a form of quartz coloured by admixed iron oxides. This means it is little different to flint or quartz, and so is most appropriately analysed within the context of lithic traditions. How then, are these items like bracers, beads or buttons to be viewed?

Depending on how they are approached, there are implications for how archaeologists should view the level of knapping skill present in the contemporaneous community. Ó Maoldúin (2014: 167, 176) posits that jet objects – beads and V-perforated buttons – found in Ireland were imported in their finished form. These were likely made by craftspeople near to the source of the material, by Whitby on the north Yorkshire coast, England, for export (Sheridan, Davis 2002: 822). Likewise, ten V-perforated buttons – all unprovenanced finds in Ireland – made from albertite, which occurs at Strathpeffer, Sutherland, Scotland, are seen to represent imports (Carlin 2018: 179). The fact that beads are fewer in number during the Chalcolithic and Bronze Age compared to the Neolithic (Ó Maoldúin 2014: 185) raises the prospect of heirlooms. The small quantity of beads found in contexts from the earliest metal-using eras could indicate the ever-decreasing number of pieces handed down through generations. In these two instances, importation and inheritance, there does not need to be any skilled craftsperson within the contemporaneous local community. The pieces were already generated and the presence or absence of skills is no longer a concern. However, these objects were also made from materials available in Ireland. This could indicate a local trade which copied imported forms.

V-perforated buttons were made from a range of materials, including anthracite, steatite and mudstone – which are available in Ireland (Carlin 2018: 179). Similarly, jasper, porcellanite and various siltstones – all found in Ireland – were used as mediums for bracers (Roe, Woodward 2009). Regarding the various forms of beads, sandstone and shale are noted (Ó Maoldúin 2014: 174, 187); though in general, the geology of these pieces is not as well documented as other objects. Where artefacts are made from geological material found in Ireland, the likelihood that they are made by local craftspeople needs to be considered. To manufacture, even by copying, V-perforated buttons or bracers or beads, a significant level of skill is required

– beyond the bashing, smashing or splintering that is associated with lithic reduction of the period (e.g.: Sternke 2010b; Nelis 2009a; O'Hare 2005).

The dominant reduction technique of the Chalcolithic and Bronze Age is presented as bipolar (O'Hare 2005; Scannell 1992: 161) (see **Chapter 3**). Some freehand reduction is accepted in the Chalcolithic, and possibly lasting into the Bronze Age (O'Hare 2012: 158; Scannell 1992: 161). At a broad level, bipolar reduction is often portrayed as less skilled and knowledgeable than that of freehand (see Ballin 2021: 7; Odell 2000: 294; also see Woodman *et al*. 2006: 81 for further comment). As well, there is an intimation of decline in ability within bipolar reduction in prehistory through the descriptive language used – from 'controlled bipolar' in the Neolithic (e.g.: Sternke 2010c; 2009a) to the 'smash-it-and-see bipolar' which appears at the end of the Neolithic and continues into the Bronze Age (e.g.: Sternke 2010d). The apparent lack of skill in bipolar reduction is more bluntly expressed by Gibson (2016: 69), as it "produces nothing but shatter". 'Expedient', and to a lesser extent '*ad hoc*', are two terms associated with bipolar reduction and the lithic traditions of the period (Delaney 2009: 39; Walsh 2009: 55; Woodman *et al*. 2006: 81; Engl 2004; Milliken 2002). They are rarely explicitly defined, and can be applied in a variable fashion. Describing the assemblage from Squire's Hill, Co. Antrim, *ad hoc* is defined as the production of basic tools as required (Sloan 2016: 67). There is an intimation of lessened skill where they are mentioned. While normally reserved for unretouched flakes and blades, the secondary retouch creating hollow scrapers can also be "achieved expediently" (Nelis 2009b). A comprehensive review of bipolar reduction is undertaken later in this thesis.

However, the attribution of a greater ability in knapping should be sought with due care and consideration. Double-ventral flakes are associated with the Neolithic, and thought to be produced by indirect percussion, involving a fine platform (Nelis 2004: 158). That such reduction continued into the Bronze Age is noted as conceivable by one analyst (Sloan 2016: 66). Despite this going very much against the popular view of lithic reduction of the era, neither reason nor evidence is provided. The excavation uncovered a portion of a prehistoric structure, though no dates were returned, and artefacts indicating activity from the Neolithic and Medieval periods were recovered (Ó Baoill 2016: 64). No attempt was made to connect the double-ventral flakes to secure contexts indicating Bronze Age activity by either author. In this fashion, we cannot attribute a greater level of ability to Bronze Age knappers as there needs to be scientific evidence or reasoning provided to allow for critique.

The overbearing association of limited formal types and unskilled knapping with the Chalcolithic and Bronze Age appears largely misconstrued. Especially as these are not new developments in lithic traditions. Late Mesolithic material from Ferriter's Cove was described as "made and discarded in an expedient manner" and the site assemblage is "most characterised by a series of less diagnostic artefact types, many of which were manufactured on an *ad hoc* basis" (Woodman *et al*. 1999: 79, 83). Discussing Neolithic assemblages, Bamforth and Woodman (2004: 25) describe them as "marked by a relatively limited array of formal tools" (**Table 2.2**)[4]. It is entirely possible that the informal tools of the Bronze Age are a continuation of a long-standing use of simple flakes and blades, and not a degeneration of retouched forms. This association is coupled with the fact that many lithic forms within Chalcolithic and Bronze Age society have been completely overlooked in terms of their aspect of knapping skill.

Axehead
Arrowhead - leaf-shaped
Arrowhead - transverse
Plano-convex knife
Scraper – concave
Scraper - convex
Scraper – hollow

Table 2.2: List of formal retouched types in Neolithic assemblages (Bamforth, Woodman 2004: 25).

2.3 The narrative of lithics in metal-using eras, and flaws apparent

From an early stage, the possibility that lithics had a place in society beyond the Neolithic was dismissed. Artefacts now associated with the Chalcolithic and Bronze Age, were attributed to the Palaeolithic and Neolithic (Knowles 1903: 52). A view that, with the introduction of copper, there was a gradual displacement of lithics prevailed from early writings (Coffey 1908: 94). This view continued in the next few decades, when it was thought that the early adoption of metal in certain areas was a result of limited access to flint, which itself was indicated by the use of chert (MacAlister 1949: 104, 105).

When extensive publications were produced on sites attributed to the Bronze Age, lithic material was frequently among artefacts recovered. However, beyond noting them in finds

[4] When comparing to the assemblages in **Table 2.1**, one should note that there are non-formal typologies present in those, and look only for retouched types.

list, they were rarely mentioned in broader discussions alongside metal or pottery (Ó Ríordáin 1954; 1952). Discussing artefacts from 'The Corbie', Ballynagilly, Co. Tyrone, ApSimon (1969: 35) noted it as an "excellent flint industry of normal Bell Beaker character". The assemblage consisted primarily of small convex 'thumbnail' and 'button' scrapers, with a few barbed-and-tanged arrowheads and knives. Whether 'excellent' refers to the quality of working or quantity of pieces, or something else, is unclear. How 'normal' was established is unclear. The assemblage was attributed to the Chalcolithic occupation. No comment on the possible later occurrence was made, despite evidence for later settlement, into the Early and Middle Bronze Age, consisting of pottery remains (*ibid*.). At the same time, Sproule's (1968) thesis had established the presence of these artefact categories into Middle Bronze Age, and possibly beyond for scrapers. This is an early indication of the dissociation between general understandings of the Chalcolithic and Bronze Age and the specialised area of lithics.

An apparent division between chipped and ground lithic industries is evident in some writings. In contrast to the above attitudes, the Early Bronze Age flint industry was seen as flourishing (Harbison 1962: 118). The association of flint objects alongside side metal ones was evidence of this – perhaps an overstatement. The assertion was based solely on the recovery of a hoard containing two flint knives with two broken axes at Derryniggin, Co. Leitrim (*ibid*.). Other comments show a regard for fine or accomplished lithics (ApSimon 1969: 35, 46, 49, 53), namely scrapers, arrowheads and knives; with little to no consideration for functional, but unaesthetic, pieces.

Despite the antiquity of these publications, some have yet to fall out of favour. O'Flaherty (2002: 7) cites Coffey (1908) as being "relevant and valuable to researchers even today". This statement is in reference to Coffey's consideration of halberds – O'Flaherty (2002: 7) highlights it as "one of the earliest attempts at a regional synthesis" and as providing the base model for later typological frameworks. However, Coffey's comments on the relationship between metal and stone are caught up in this – which retain little relevance or value.

The unsupported assertion that "the introduction of the sickle and the securely hafted socketed axe enabled the farmer to cut his corn more effectively" (Eogan 1962: 60) highlights the general view of the greater efficiency of metal for all tasks over stone that took hold in Irish research. It is repeated later (O'Neill 2020: 37) – still with no supporting evidence. Sickles are one of the few examples where the assumption of use of metal is openly stated (Gowan *et al*. 2004: 359).

The lack of lithic sickles recovered is a noted issue (Woodman *et al*. 2006: 179). Lithic objects formally classified as 'sickles' occur in two forms: a single large blade usually curved, or small blades/flakes with serrated edges. No examples of either have been recovered in Ireland. Woodman *et al*. (2006: 179) suggest that certain invasively-retouched forms, like long plano-convex knives, could have been utilised as sickles. This claim has neither been proved nor refuted by use-wear analysis. The absence of lithic sickles, not just in the Bronze Age but also through the Neolithic (*ibid*.), implies that there were other forms or methods for reaping. It could be that unmodified or minimally-retouched blades or flakes were used individually or as inserts in composite tools (Mazzucco *et al*. 2017; Maeda *et al*. 2016; Groman-Yaroslavski *et al*. 2016; Arnoldussen, Steegstra 2015; Carvalho *et al*. 2013; Palomo *et al*. 2011; Andrefsky 2005: 168, 207); or that uprooting by hand took place (Anderson, Whittaker 2014). Their absence may result from a lack of recognition; though with an increasing number of Neolithic houses excavated this is seen as unlikely (Woodman *et al*. 2006: 179). In light of this, they suggest that arable farming may have less significance than previously believed, or that reaping occurred by other means.

This open uncertainty is in stark contrast to the unfounded confidence in metal ones (Waddell 2000: 260; Eogan 1962: 60). Thirty or so examples of bronze sickles lead to their establishment as an "important agricultural implement" (Waddell 2000: 260). The majority of these are apparently uncontextualized finds, with townland noted as provenance (Fox 1939: 238, 239, 242-247). Two are noted as coming from hoards: at Kilfeakle, Co. Tipperary, with a gouge, chisel, and punch (*ibid*.: 247); and at Ballygowan, Co. Kilkenny, with a spearhead and rings (Waddell 2000: 260, 262). The number is significantly less than other metal objects: halberds – 186 (O'Flaherty 2002: 1); spearheads – > 1,800 (Lineen 2017: 76); swords – 660 (*ibid*.); pins – 126 (Eogan 1974: 107-117). A total of 47 bronze razors highlights their rarity, and only "indicate a fashion for the cutting of the beard and hair by some men" (Mount 2013) – a glaringly opposing interpretation based on similar numbers of artefacts. And one which marries better with interpretations of sickles recovered from Bronze Age landscapes as being possessions of elites instead of farmers (O'Neill, Kearney 2014: Appendix 2: 6).

Razors are another case where a dichotomous relationship between metal and stone is established. Lithic knives have been recovered from contexts up to the Middle Bronze Age – found in association with Food Vessels and Urns (Mount 1997: 141; Mount, Buckley 1997: 10-13; Mount *et al*. 1993: 42). Flint knives are viewed as prototypes for bronze razors (Kavanagh

1991: 81) – though this ignores the development of copper and bronze daggers (Carlin 2018: 185, 186; Waddell 2000: 131, 132, 259-262), which could also have performed similar roles to lithic knives. At Knockast, Co. Westmeath, a flint knife and bronze razor were recovered. It was suggested that the dual presence may indicate differing functions; or that the two items played a role in the one act – the flint knife for the preliminary shaving, the bronze for the final finish (*ibid*.). This passively asserts the greater efficiency of the metal blade by stating its use for the closer shave.

The culmination of this treatment can be seen in recent – near the turn of the millennium – syntheses, where there is little attention given to the lithic assemblages of Bronze Age date. When they are mentioned, quite often it is with a level of disregard or disinterest (Grogan *et al*. 2007: 129; Waddell 2000: 210). It is disconcerting that Grogan *et al*. (2007: 129) find it "interesting that flint and chert continued to be used for the manufacture of tools and other small implements" – though their continued use had been well established by research at that point (O'Hare 2005; Scannell 1992; Sproule 1968). Lithics do not feature to any great degree in discussions on Bronze Age society. Cooney and Grogan (1999: 112) refer to lithics only once within the chapters discussing the Bronze Age. However, they do highlight the problem of assuming that all lithics found come from earlier prehistory (*ibid*.). Waddell (2000) refers to lithics in his Bronze Age chapters more frequently. The Chalcolithic receives the greatest discussion of lithics, from those that appear on domestic sites to burials, as well as covering possible new forms introduced (*ibid*.: 117-121). However, when discussing the Bronze Age itself, lithics are more frequently mentioned in relation to burials (*ibid*.: 143, 145, 154, 156, 160). When discussing settlement, lithics receive little consideration, despite recognising that Bronze Age Ireland was "a society which did not live by bronze and gold alone" (*ibid*.: 205). In the examples of settlement covered, lithics are only mentioned as found, consist of "simple flint scrapers and blade fragments", and receive no discussion on links to activities taking place (*ibid*.: 210). Contrast this with comments on Neolithic material – where "small thin sharp flint flakes" are seen as parts of composite tools, and convex scrapers – the same type as present in the Bronze Age – are attributed many uses, and positioned as parts of dedicated tool-kits (*ibid*.: 52). The difference in the adjectival and social descriptions is marked. There is also a subtle incorrectness seen in the 'blade fragments'. Prior to this publication, two theses (Scannell 1992; Sproule 1968) had established the dominance of flakes on Bronze Age sites –

not to the exclusion of blades, but certainly to the extent that Bronze Age lithic traditions were predominantly flake-based.

2.4 Signs of Change

However, it would be unfair to say that the above typify all publications. More recently, there are several published excavation reports which consider lithics in a better manner (MacDonald *et al*. 2005; Suddaby *et al*. 2003). The comprehensive synthesis of the Chalcolithic, *The Beaker Phenomenon* (Carlin 2018), presents a better view of lithics. The frequency of their occurrence within various contexts – burial and settlement – is well laid out (*ibid*.). In discussing the material culture on settlements and within pits, spreads, and middens, he highlights the fact that lithics are one of the most recurrent materials from structural features, and the most frequently occurring artefact type with Beaker pottery, noting that unretouched debitage is the predominant component (*ibid*.: 62, 67). Roberts (2013) in his general summary also presents a more nuanced view of lithics during the Chalcolithic and Bronze Age. He supports Harbison's (1962: 118) view that there was "a flourishing, rather than a decline" in lithic traditions during the Chalcolithic and into the Early Bronze Age (Roberts 2013: 536). He challenges the stone-metal dichotomy, acknowledging a quality of working until the Middle Bronze Age, and continued use into subsequent periods (*ibid*.: 544). Researchers have also looked at the use of lithics in metalworking. Bell (2016) compared the ability of drills with bits of bone, oak and flint to produce rivet holes in copper and bronze material. The flint bit was found to be the most effective (*ibid*.: 23, 27). Unfortunately, the experimental flint products were not related to archaeological finds, nor were the marks left on them described, making it difficult to identify such use archaeologically.

- Presenting the results of the excavation of the Corrstown site (Ginn, Rathbone (eds) 2012), the largest known Bronze Age settlement in Ireland, the presence of lithics is more considered. The excavation uncovered 76 structures, a road surface, and a large amount of other cut features (*ibid*.: 13, 14). The majority of the activity was attributed to the Middle Bronze Age, with some preceding in the Early Bronze Age. There was also Early Medieval activity present, and evidence of Neolithic activity in the form of pottery (*ibid*.: 5-10, 168). The excavation returned a lithic assemblage of over 16,000 artefacts (O'Hare 2012: 157), alongside more than 9,000 pottery sherds (Roche, Grogan 2012: 167), and 12 stone objects (Grogan 2012: 186-195). The section on material culture presents the complete lithic and stone analyses, alongside those of pottery and seeds (Ginn, Rathbone (eds) 2012: 156-196). The specialists' comments regarding the potential uses stand out as one of the very few instances where lithics are set within their creating society (O'Hare 2012: 166). The excavation directors also make use of the lithic material in a spatial analysis of the site. Combining the analyses of pottery and lithic finds in association with each structure, they attempted to identify differences in occupation or function (Ginn, Rathbone (eds) 2012: 234-240). The combined analysis helps the directors to establish a construction sequence for structures (*ibid*.: 240). Although, lithic material is not mentioned in Chapter 5, where "a more detailed assessment regarding the lives and activities of the Corrstown inhabitants is given" (*ibid*.: 241). The more ornate objects, such as maceheads and polished axeheads, are considered in relation to foundation deposits and heirlooms (*ibid*.: 247, 248). In the concluding chapter, the presence of low-quality lithic objects is seen as an indicator of a low-status site (*ibid*.: 260). This absence from more in-depth discussion may result from the fact that the majority of the lithic artefacts were viewed as "waste rather than tools" (*ibid*.: 240).

The final comment highlights what is probably the primary issue facing the integration of lithics into discussions of later prehistoric society presently. Chalcolithic and Bronze Age lithic tradition is understood as being *ad hoc* and expedient, and as utilising materials close to hand with little to no modification (Carlin 2018: 62, 67; O'Hare 2012: 157; 2005; Edmonds 1995: 176; Cleary *et al*. 1995: 71). Consequently, the understanding of tools, and categories, cannot be limited to formally-retouched pieces. If it is, it leads to an odd situation of having much waste but no product. While this is a concern inherent to lithic analyses of all periods, it is particularly pressing when combined with assemblages that present fewer modified types to unmodified pieces.

2.5 The shaping sands of society

Lithic use in later prehistory occurs in the context of numerous changes within society. Traditionally, lithic use in later prehistory has been portrayed in a dichotomous relationship with metal (O'Hare 2013: 19, 23; Roberts 2013: 536, 539; Edmonds 1995: 187). However, this is a gross oversimplification of the *longue durée* of the lithic life cycle, which was affected by numerous changes within society, and the lithic *chaîne opératoire*, which was impacted by more than just the use of copper and bronze. This issue has been noted before by researchers (Humphrey 2004: 21), though does not seem to have filtered into broader discussions. Moving from the Mesolithic to the Neolithic and then to the Chalcolithic and Bronze Age, numerous changes throughout society have affected lithic production and use – placing it in an expanding population with an increasingly hierarchical structure that was becoming more agricultural, changing subsistence patterns, developing new technologies and focusing more on warfare. Changes in society have been recognised as impacting stone tool technology elsewhere. Edmonds (1995: 81, 82) touched upon this, though did not fully develop it, when arguing that a more sedentary lifestyle associated with stock management led to changes in debitage and core forms. This was supported by Humphreys (2004: 9-24) discussion of changes in lithic traditions in Bronze Age Britain leading to conditions of lithic use during the Iron Age (**Fig. 2.3**), though again, how exactly these impacts manifested themselves was not fully considered.

Fig. 2.3: View of influencing factors on lithic use in later prehistory (Humphrey 2004; Edmonds 1995).

However, this societal influence on lithics does not appear to be greatly considered in Irish literature. Nor do other influences. It is argued here that lithic technology was subjected to social shaping, "a process in which there is no single dominant shaping force" (MacKenzie, Wajcman 1999: 28). Over millennia, various factors have impacted the production of lithics to varying degrees at different times. These influences included – but are not limited to – alternative raw materials, availability and access to resources, or changes in the applications of lithic tools (**Fig. 2.4**). The following sections highlight different aspects of society that impacted lithic traditions. This is a glimpse into the milieu of social forces at play. The relationships between stone and objects of the broader material culture are under-developed here. Social organisation, e.g.: what is the interaction of a hierarchical sedentary society with lithic material as compared to an egalitarian mobile group, is not discussed here. The list is not exhaustive. For one, the geological background, affecting the dispersal of raw materials, needs to be considered as well (Briggs 2009; 2001; 1988).

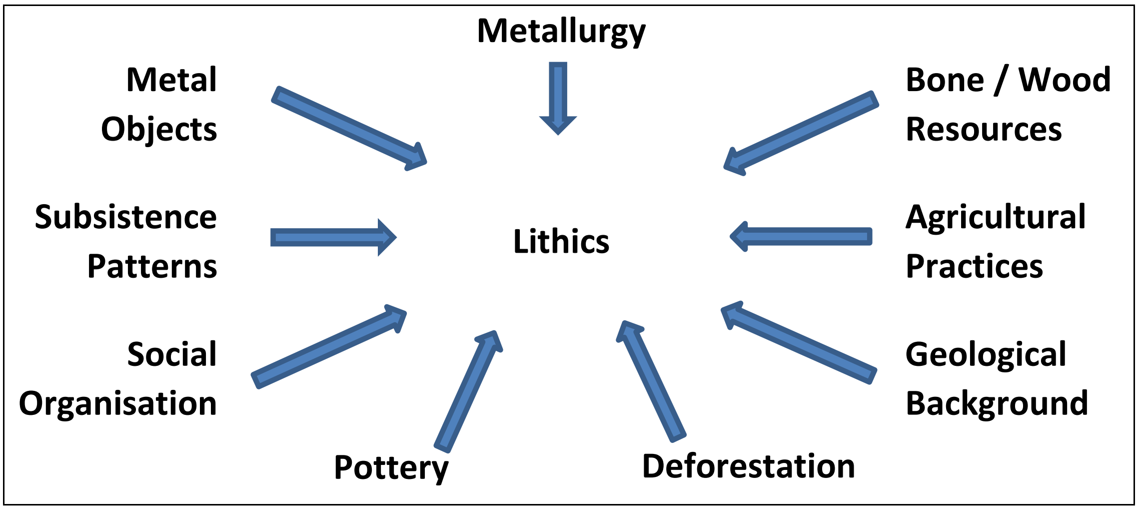

Fig. 2.4: Revised view of influencing factors (non-exhaustive) on lithic use in later prehistory.

2.5.1 Subsistence Patterns and Agricultural Practices

The introduction of agricultural practices, both pastoral and arable, with the ensuing societal changes, during the Neolithic affected lithic technology. The contrasts with preceding Mesolithic material are clear. But the changes effected in the Neolithic contrast with the succeeding Bronze Age material. Neolithic settlement evidence displays a completely different society to that of the Bronze Age. A brief floruit of house-building at the start of the period is followed by centuries of scant or enigmatic evidences of occupation, i.e.: pit complexes, with an extended period of varied monumental construction (McLaughlin *et al*. 2016; Whitehouse *et al*. 2014; Smyth 2013; 2012; 2011), which feeds discussions, but no conclusions, as to the sedentary/transitory nature of Neolithic society (Mulligan 2012). In the Chalcolithic and Bronze Age, where scant and ephemeral evidence at the end of the Neolithic builds to clearer evidence with increasing occurrence through centuries (McLaughlin *et al*. 2016; Carlin, Brück 2012; Ginn 2011). The agricultural – referring to horticulture, pastoralism, arablism – practices were also variable between the periods (McClatchie *et al*. 2016). Often brought together under the term 'late prehistory', this mis-represents the vastly different practices and patterns evident in Ireland during the Neolithic and Bronze Age. These differences would have created differing interactions and needs for lithic traditions.

2.5.2 Pottery

One area of lithic use that has received no attention is that of pottery. The recorded occurrence of siliceous materials as pottery temper is low; though their use, either fresh or burnt, has been noted (Brück 2019: 101; Percival 2016: 4, 10; Gibson 2002: 38). A comment by Waddell (2000: 210) notes the inclusion of chert in vessels from Lough Gur, Co. Limerick. A polypod bowl from Newtownbalregan 2, Co. Louth, had a single piece of flint visible on its outer surface (Grogan, Roche 2009). It is not clear whether this means it is contained within or adhering. From Rathmullan 10, Co, Meath, cordoned necksherds from a large domestic vessel were recorded as having "some flint", measuring up to 4.45 x 2.62mm, in the fabric (Grogan, Roche 2011: lxxxi). This report notes the rarity of flint within pottery fabrics, citing material from Ballygally, Co. Antrim, as the only other example. While they could easily be viewed as natural/un-intentional inclusions, deliberate inclusion warrants consideration. There has been no discussion on how this use would display itself in lithic assemblages. There appears to be no cross-over between specialists; or no consideration of the dual appearance in excavation reports. While the occurrence is infrequent, it still raises questions. The ceramics noted above relate to either the Neolithic, Chalcolithic or Early Bronze Age. If manufacturers are deliberately crushing siliceous materials for pottery temper, how does this appear, if at all, in the lithic record? How does this affect the interpretation of lithic assemblages and use – could the lack of small debitage on sites be the result of inclusion in pottery, or that the presence of a 'smash-it-and-see' bipolar technology is not a deficiency in skill, but simply crushing material for pottery?

Ground/coarse lithic objects are suggested as being used in the sourcing and preparation of raw materials for pottery manufacture (Crandell *et al*. 2016: 244-248). Chipped lithics could also have played a role in the decoration and finishing of vessels. The creation of marks is attributed to plant-fibre cord, seed impressions, combs, bone points, fingertips/nails, amongst others. Edges of flakes or blades are speculated to have been used to incise/impress decorations seen on vessels (*ibid*.: 248). Flint sickle blades with coarsely-denticulated edges have been suggested as the production tool for the typical decoration on Neolithic Wadi Rabah pottery (Khalaily, Kaminsky 2002). If only the flake edge is of concern to the user, then the overall form of a flake may be given less importance and, therefore, less regularity or refinement. Ceramic vessels from the Chalcolithic and Early Bronze Age display varying levels of decoration (Carlin 2018: 200; Brindley 2007). Stones were also used to burnish surfaces prior to firing (Crandell *et al*. 2016: 248). A possible burnisher – "a small, polished ball of flint" – was identified in the artefacts recovered from Pit burial 6 at the cemetery at Edmondstown, Co. Dublin (Mount *et al*. 1993: 46, 60).

2.5.3 Leatherworking

The presence of leather (Waddell 2000: 129, 240, 259, 266, 320) may also have had an impact on lithic technology. Scrapers, long associated with working hide and leathers, are a ubiquitous type artefact in later prehistoric assemblages. The persistent presence of scrapers well into the Bronze Age (Woodman *et al*. 2006: 156), with no obvious metallic replacement, shows that later prehistoric societies retained an understanding of the benefits of stone use in certain contexts, even when metal was available.

Ethnographic studies also provide insight into the perception of comparative efficiency regarding metal and lithic tools. Arthur (2010) observed and interviewed Konso women of southeastern Ethiopia, relating various aspects of their knapping tradition. Konso hide-workers "shun" both glass and iron tools due to the fact that these implements have a tendency to tear delicate hides and are ineffective in softening them (*ibid*.: 229). While this is an anecdotal observation of efficiency, it provides some sense of how working edges interact with other materials. Whether this could be related back to arguments of thinner and more consistent working edges would require experimental studies.

2.5.4 Bone

In addition to other agricultural factors, the maintenance of stock would have increased the availability of bone as a raw material resource. From continental Europe, the use of bone in prehistory is more considered (Baron, Kufel-Diakowska (eds) 2011). Discussing the bone-working traditions on Saaremaa island, Estonia, Luik *et al*. (2011: 255) note the change from the use of wild animal bones in the Neolithic to those of domestic animals in the Bronze Age. Objects made from bone and antler include: harpoons, arrowheads, decorative pins, spearheads, ard points, awls, chisels, to name a few. Given that some of the categories listed also appear in the lithic corpus, the possibility of interplay should be considered.

There is evidence for bone artefacts from Irish archaeological sites. A bone spearhead or blade came from a Bronze Age urn burial at Maganey Lower, Co. Kildare, though details are scant (Mount 1997: 142; Prendergast 1962: 169-173). However, the effects of bone resources upon lithic traditions have not been contemplated; nor has the interface of metal and bone traditions. This aspect was recognised early enough in Bronze Age studies (Harbison 1962: 113, 144). Nonetheless, this topic has merited little consideration in discussions since. To do so, is complicated. Comparing the occurrence of bone material through periods would be difficult where preservation is low.

2.5.5 Deforestation

The opening up of the landscape for settlement and agricultural purposes would have brought different resources into circulation. During the Mesolithic, the landscape was heavily forested, with coastal, riverine and lacustrine areas providing material for knapping. Tree-throw, caused either by purposed felling or natural event, may have exposed lithic resources (Edmonds 1997: 102); though the frequency and extent of this cannot be established. Starting in the Neolithic and continuing throughout prehistory, tree clearance occurred in order to create suitable areas for agriculture. Analyses of cores from lakes and bogs show periods of intense deforestation around the country during various periods (Plunkett 2009). Rare archaeological evidence for this activity comes from the site of Ask, Co. Wexford. Over 100 tree-bowls, identified by amorphous spreads of scorched soils, were seen as evidence of a clearance phase or phases (Stevens 2011a: 20).

It has been suggested that, through this practice, *remanié*[5] lithic resources were brought into circulation (Woodman *et al*. 2006: 127). The turning of soil, either through removal of tree stumps, churning by cattle, or ploughing, brought pebbles to the surface, allowing them to be collected and utilised. These resources would previously have been out of reach due to trees and undergrowth covering them – with certain exceptions, such as tree-throw, or uprooting by animals, or erosion out of river-banks. *Remanié* resources differ in terms of size and quality to material gathered from beaches or quarries. The quality is usually seen as poorer and the size as smaller – aspects which have an impact on what lithic tools can be produced. Edmonds (1995: 175) identified Early Bronze Age knappers as using materials that were close to hand. This practice would have been established in the Neolithic with the introduction of agriculture; and was reinforced as populations became more dependent on agriculture, requiring a continual expansion of deforestation.

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[5] '*Remanié*' refers to material sourced from a secondary geological context. It is defined as (Miriam-Webster online dictionary):
"a part or fragment (as a pebble or fossil) of an older formation incorporated in a younger deposit".
The secondary geological context or younger deposit is typically a soil deposit, either in the form of fluvio-glacial deposits, or soil created through processes such as weathering, erosion, and dissolution of geological strata.
The term 'erratic' is also used with the same meaning, though less frequently.

2.6 Chalcolithic and Bronze Age Lithoculture

So where to go from here? Historically, the lithic traditions of the Chalcolithic and Bronze Age have been demonstrably undefined. More recent work, though more aware of their presence, is similarly unclear in what constitutes their lithic traditions. Without a clear view of the traditions we are unclear as to how lithics present themselves in the archaeological record. And without a clear view of the archaeological record, our understandings are unfocused, vague, and derisory.

At the turn of the millennium, there was a call for a more systematic approach in researching Bronze Age metalworking lithic tools (Brandherm 2000a in Brandherm 2009). It is a specific call for specific area – though easily scalable to all lithic material of the Bronze Age. This appears to have been overlooked by Irish researchers. Theses produced subsequent to this call which have looked specifically at lithic tools of the period (Walker 2010; O'Hare 2005) did not attempt to provide an overview for Chalcolithic and Bronze Age lithic/stone material. There was no demonstrable effort to set out the greater lithic context in which their specified and specific research sat, i.e.: how their targeted assemblage was connected to other material present. Nor has there been any attempt to establish such following numerous other theses and publications which touch upon lithic material during the earliest metal-using eras (Lineen 2017; Ó Maoldúin 2014; Boutoille 2012; Carlin 2011; Cleary 2007; O'Flaherty 2002).

Neither did the publication of the Keiller-Knowles collection attempt to separate the assemblages of later prehistory (Woodman *et al*. 2006). Given the standard approach of discussing the Neolithic and Bronze Age as later prehistory, this seems appropriate. However, that the discussion purposefully sets out a division of early prehistory, by discussing Late Mesolithic material specifically (*ibid*.: 118-126), shows that the authors were aware of the nuances of tradition within these broader time periods. The publication lists a total of 19 archaeological lithic forms, and a forgeries category, under 'Neolithic/Bronze Age artefacts' (*ibid*.: 50). A further 20 coarse forms are listed separately, without any chronological indication (*ibid*.: 51). Only in the descriptions of later prehistoric artefact classes is mention made of period classification (*ibid*.: 126-198). Where mentioned, dates are buried in text, and explicit dating is infrequent. At the time of publication, there were clear ideas of what constituted a Neolithic assemblage and a Bronze Age assemblage present in Irish archaeology, or at least being touted. Both O'Hare's (2005) and Sproule's (1968) theses examined Bronze Age lithic assemblages in comparison to those of the Neolithic – allowing for shared and distinct components to be defined. An assemblage of formal Neolithic tools had been designated two years before the Keiller-Knowles publication, which involved one of the authors (Woodman, Bamforth 2004). In regards to coarse forms, several papers had taken steps to establish dates for particular forms (Connell 1994; Simpson 1990a; 1990b; 1989; 1988).

This criticism of the Keiller-Knowles publication may seem heavy-handed. Especially given the fact that it is the report of a particular study of an antiquarian-collected, non-contextualised set of artefacts. However, the publication fills a void that exists in Irish lithic studies – that of a centralised, or at least a largely agreed-upon, documentation of terminology and typology. It is viewed as an "overview of Irish stonecraft" – the first in over 150 years (Driscoll 2010: 29, 35, 44). It is used as a reference source by lithic analysts in reports and research (Driscoll 2010; McDevitt 2010; Sternke 2010c; 2009b); and by archaeologists in non-lithic publications (Carlin 2018). Though other analysts do not use it – or at least it does not appear in bibliographies (Nelis 2009a; O'Hare 2009). And the publication itself strays beyond its remit, commenting on the broader Irish assemblage. It discusses artefacts not found in the specified collection – daggers, sickles, ground stone points – and draws implications for the archaeological record from this (Woodman *et al*. 2006: 178-179, 198). It questions the validity of existing typologies, not only within the Keiller-Knowles collection, but also within Irish studies (*ibid*.: 138-139). As such, the Keiller-Knowles publication appears something of a Schrödinger's guide to Irish lithics – in the same moment, it both is and is not.

Another misgiving of note is the lack of clear differentiation between 'stone' and 'lithic'. Artefacts are often divided into these two broad categories – most obvious in artefact registers, and the production of separate specialist reports. However, the terms are not always clearly defined, and are used interchangeably, or inconsistently; and sometimes with a conflation of the two categories in discussions (see Carlin 2018: 18; O'Brien 2010). This cuts to the heart of issues of terminology (see **Chapter 3**) – issues that have been highlighted by commentators in relation to scientific practices over a considerable length of time (Slisko, Dykstra 1997; Kosolapoff 1945), including one instance specifically relating to anthropology (Pershits 1979). In such articles, clearly defined terminology applied in a consistent manner is seen as a cornerstone of scientific communication.

An example comes to us from the Keiller-Knowles collection. Polished flint axes are separated from polished stone axes. The former is categorised under 'NEOLITHIC AND BRONZE AGE ARTEFACTS', and the latter under 'COARSE-STONE PRIMARY TECHNOLOGY AND RETOUCHED

TOOLS' (Woodman *et al*. 2006: 50, 51). Given that the finished form is demonstrably the same, these are only separated by material. Similarly, and perhaps more strangely, rough outs are separated. Stone is simply 'stone axe rough outs', while flint is 'polished flint axe rough outs'. Why the 'polished' adjective is retained for the flint examples is not explained. This is a major assumption on the part of analysts as to how far the knapper intended to work the object – which is unknowable. Axes is the only occurrence of this division. Why this is the case is unclear. Is it that the raw material is seen as 'chipped' and not 'coarse' stone? Should the Knowth macehead, then, be categorised by itself due to the fact that it is of flint, as opposed to the variety of rock types used for other examples? This raw material division continues. Porcellanite scrapers, cores and flakes are discussed under 'COARSE- AND POLISHED STONE ARTEFACTS' (*ibid*.: 180-184). This is excused by virtue that the "purpose of the chapter is to provide a guide to the range of flaked flint tools" (*ibid*.: 179), though no such clause is laid down in the introduction (*ibid*.: 105-107). The false separation is underpinned by the geological nature of materials. Flint, chert, chalcedony, jasper, quartz, *etc*., are forms of siliceous rock, present as a bedded or nodular occurrence within a parent body. They are formed by the deposition/transformation of silica (see Bradley 2017: 102-107 for discussion). And, porcellanite is similarly a siliceous rock (Pisciotto 1980: 1133; Keene 1975: 430). One of its principal components is opal-ct (Adachi *et al*. 1986: 127), which is an intermediate step in the diagenesis of silica to chalcedony (Fröhlich 2020); though can also contain quartz as the dominant silica polymorph (Keene 1975: 434). It is not as pure as other forms of chert, though still displays a dominant component of silicon dioxide [SiO_2] (Adachi *et al*. 1986: 136; Pisciotto 1980: 1133). Perhaps categorisation should be left at form – core or scraper or polished axe, which can then be sub-categorised by raw material, size, *etc*., if the topic of discussion so warrants.

Focusing in this way on singular examples of word-use comes across as semantic nit-picking. However, there are studies (see Brookes, Etkina 2015) which have demonstrated the language used in discussing topics can directly affect the understanding and thinking of researchers when they engage with subjects. Brookes and Etkina (2015) examined how language affected the reasoning of students in relation to heat in thermodynamic processes. They note that the different ways in which heat is talked about has been blamed for students' problems in understanding heat in thermodynamic processes (*ibid*.: 2). While it is an impossible task to neatly arrange and define every term in every context, there should be consistent application of terms. This should occur especially with classification terms, and intra-text classifications.

A clear approach to Chalcolithic and Bronze Age lithoculture is laid out in **Table 2.3**. Lithoculture[6] is defined here as –

the presence/use of rock as a raw material within society during an archaeological period.

The approach provides distinct usages of 'lithic' and 'stone'. Broadly speaking, lithic refers to useable items, and stone to structural aspects. The categorisations are based on recovered form. For lithic forms, it roughly follows the perceived degree of working applied to pieces, though this is quite arbitrary in instances. The framework is based on this author's interpretation of the presentation of these items within other publications, and by inference from an object when not categorised elsewhere. The difference between 'ground' and 'coarse' is related to the finished appearance of the pieces. Raw material/colour/size/*etc*. have no influence. There is a problem with the continued use of stone here – confusion may arise when use is not clear between stone (archaeological use) and stone (material/geology). Another suitable term could not be found, so it is retained. Also, 'stone' is tied into the name of many coarse lithic pieces, which changing at this point is too cumbersome.

The incorporation of stone used for/within construction may seem excessive. However, it addresses an issue raised in relation to our understanding of stone in constructions. O'Connor (2009: 148), focusing on burial monuments, states the traditional divisions between worked and unworked stone overlook the deliberate inclusion of natural pieces in monuments. Greater contemplation on the geographic and metaphoric aspects of this material is called for (*ibid*.). This echoes a more encompassing call from the Eighties. Runnels (1985) argued that the working definition of 'lithic' should be extended. This meant that lithic studies would cover all forms of stone and stone working – chipped tools, architecture, sculpture, gemstones, semi-precious stones, sand, and more. This leads to categorisation within the lithoculture. Whether meaningful sub-categories can be established remains to be seen.

[6] The term 'lithoculture' has been used in archaeological discourse previously. It refers to the 'culture of the Stone Age' – meaning Palaeolithic/Mesolithic/Neolithic, sometime specifically to sub-periods of the Palaeolithic. It occasionally appears in this sense in current literature (Bandeh-Ahmadi 2018: 99; Straus 2007: 11; McGee 1902).

Lithoculture				
Lithic			**Stone**	
Chipped	**Ground**	**Coarse**		
Arrowhead - barbed-+-tanged	Axe-hammer	Anvilstone	Boulder burial	Rock art
Arrowhead - hollow-based	Axehead	Bedstone	Cairn	Standing stone
Blade	Battle-axe	Burnisher	Cist	Stone circle
Core	Bead	Cushion stone	House foundation	Stone pair
Flake	Bracer	Hammerstone	Field boundary	Stone row
Plano-convex form	Button - V-perforated	Hoe	Fulacht fia	Wall
Scraper - convex	Gaming piece	Manuport	Mettled surface	Wedge tomb
Split pebble	Macehead	Maul		
	Mould – bivalve	Rubber stone		
	Mould – cut	Touchstone		
	Portable rock art	Whetstone		
	Spindle whorl			
Other	Pottery inclusion			

Table 2.3: Proposed lithoculture (non-exhaustive; non-definitive) for Chalcolithic and Bronze Age Ireland, with descending divisions for lithic material, and components.

The purpose of this is to provide clarity as to what is part of or referred to under lithic traditions. It is not dogmatic. Components can be removed, added, changed, or re-ordered. The whole thing can be restructured, or challenged. But, it gives a clear picture – something up until now which has been lacking – of what lithic material is present within Chalcolithic and Bronze Age society. This is solid base from which to develop understandings of knapping, changes in traditions, and place in society – to name a few.

2.7 Conclusion

The understanding of lithics in Chalcolithic and Bronze Age Ireland to-date has been presented in a largely negative, dismissive, and narrow light. This appears to be based on historic attitudes which have not been adequately reviewed as new evidence has come forth. This is coupled with a lack of dedicated literature on the lithic traditions of the periods. The majority of presentations available are embedded in larger articles discussing particular sites – which bear much resemblance to excavation reports. A review of the influencing factors on lithic traditions was undertaken. Through the lens of Social Shaping of Technology theory, it is possible to see various stimuli that helped to form the lithic tradition of the periods. A lithoculture for the periods has been proposed. This aims to provide a substantive base for future discussions and research of lithics. It provides a clear statement as to what is present, which allows for aspects to be selected and deliberated upon with intent.

3. An Irreproducibility Crisis in Irish Lithic Analyses

"If you're not confused, you're not paying attention!"

– Tom Peters

3.1 Introductory Remarks

In 2018, the National Association of Scholars (NAS) released a report concerning the use and abuse of statistics in science (Randall, Welser 2018). While the document focuses on statistics specifically, many comments in, or perhaps the entirety of, the preface and executive summary can be paralleled in archaeological circles. The discussion centres on the replicability and reproducibility of research (*ibid*.: 18). Replicability is defined as "whether an experiment's results can be obtained in an independent study, by a different investigator with different data", and reproducibility as "whether different investigators can use the same data, methods, and/or computer code to come up with the same conclusion" (*ibid*.). The concern is that much research is neither replicable nor reproducible. A concern which can be echoed in reference to lithic analyses.

The following discussion arises from impressions gained by general background reading, and, more importantly, reading of reports for case study selection. It does not claim to be a review of lithic analysis reports. The aspects under discussion relate to bipolar reduction and to assemblages associated with sites from the Chalcolithic, Bronze Age or Iron Age. It does not refer to freehand material, or sites with only Mesolithic and/or Neolithic activity. Some of the discussion about lithic reduction may be relevant to these earlier periods, which should be borne in mind. Also, academic texts are referenced occasionally throughout. The focus on commercial lithic reports does not imply that other analytical writings, e.g.: theses, are above such issues.

On first reading through excavation reports and accompanying lithic analyses, there is an impression of consistency. However, this can be attributed to a higher frequency of reports by one analyst, with a lesser amount by a number of others. When the views of each analyst are documented, this paints a much different picture. While there will be some variation in understandings and systems of analysts, there are some glaring issues that go beyond simple differences in stance. At times, one is left wondering how, in a small arena like Ireland, specialists can arrive to such disparate conclusions.

3.2 Terminology

This review of terminology relates only to bipolar material, as this plays a significant role in this research. The issues raised here will be addressed throughout **Chapter 4**. Little consistency can be seen (**Table 3.1**). Some analysts present a very developed system for understanding the reduction form. Others much less so. Unfortunately, due to a complete absence of glossaries and references for terminologies, and very few in-text explanations, there is great difficulty in understanding the jargon – leading to assumption or confusion on part of reader, or for them to simply ignore it.

In very few places are definitions or understandings offered. Ballin gives a clear definition in the reports for Rathdown Upper (2014) and Carrickmines Great (2006). The variations used differ in terminology, though they can still be related to terms defined in **Chapter 4**, allowing for transferable understandings. Scannell (1992: 37) described it as "striking a core from directly above while holding it [core] against an anvil". This is describing axial bipolar reduction. In one definition, additional wedging stones, which hold the core in place on the anvil, are added to the tool-kit (Brady 2007). This is not a recognised variation of bipolar reduction. 'Controlled bipolar' reduction involves the "careful planning of removals in a highly controlled manner, while the flakes rested on an anvil" (Sternke 2010c: xiii). While this gives insight into the interpretation of material, it does not aid in its identification.

Classification	Reference	Analysts [N=]
Bipolar	Sternke 2015\2012a\2011b\2011c\2011d\2010d\2007; Ballin 2014\2006; Nelis 2010a\2010b\2010c\2010d\2010e\2010e\2010f\2010g\2009a\2009b\2006a\2006b; O'Hare 2009; Brady 2007; Little 2005; Engl 2004; Milliken 2002; Scannell 1992	9
Plain bipolar	Ballin 2014	1
Scalar	McDevitt 2010; O'Hare 2009; Brady 2007; Woodman *et al*. 2006; Clarke 2003; Scannell 1992	6
Classic scalar	Sternke 2012b	1
Bipolar-on(-an)-anvil	Sternke 2011b\2010a\2010b\2010d\2010e\2009b\2009c; O'Hare 2012	2
Smash-it-and-see	Sternke 2010a\2010b\2010d	1
Controlled bipolar	Sternke 2012b\2011b\2011e\2010a\2010b\2010c\2010e	1
Classic controlled bipolar	Sternke 2010a\2010b	1
Classic controlled bipolar rest	Sternke 2010b	1
Rest core	Sternke 2010c	1
Split pebble	Ballin 2014\2006; Sternke 2012b\2010a\2010d\2009c\2007; Nelis 2007; Scannell 1992	4
Split pebble flake	Sternke 2011b\2010a\2010b\2010c; Moore 2009a	2
Classic bipolar-on-an-anvil and controlled bipolar combination core	Sternke 2010b	1
Platform core which was reduced while resting on an anvil	Sternke 2011e	1

Table 3.1: Various bipolar classifications cited in commercial lithic analysis reports and other texts.

There are issues with the lexicon. Firstly, the redundant 'bipolar-on(-an)-anvil'. In all forms of bipolar reduction, an anvil is necessary. There is no definition given, so it is unclear why it is being applied or how it differs from the generic 'bipolar'. A possible reason is the existence of a bipolar method on platform cores which involves striking flakes from opposing platforms (Inizan *et al*. 1999: 68). This 'bipolar' method involves the sequential removal of flakes from opposing platforms, using a hammerstone or punch (**Fig. 3.1** – A). The use of 'bipolar' in this fashion has been dismissed – though will still be present in older texts. This method, and resultant cores, should now be referred to as opposed-platform or cylindrical (Ballin 2021: 9). Bipolar reduction involves the use of a hammer and anvil to effect a removal using opposing forces operating in tandem (**Fig. 3.1** – B). The term 'bipolar' will be retained. None of the denominational terms will be used.

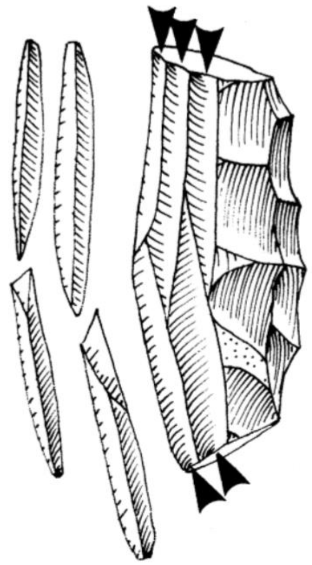
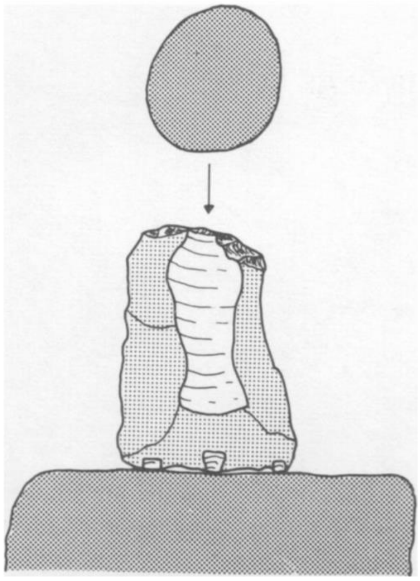
A – Bipolar Method	B – Bipolar Reduction
	

Fig. 3.1: Difference between bipolar (opposed-platform) method (after Inizan *et al*. 1999: 41) and bipolar reduction (from Leaf 1979: 40).

The ‘rest’ forms suffer a similar complaint. It is not clear how these differ from the normal placement of a core on an anvil. It could be interpreted as referring to non-axial bipolar reduction, although this is a guess. A possible origin is Knutsson’s (1988: 39) description of nodule-quartering. Here, cores were described as being rested on an anvil, with removals occurring via bending and Hertzian fractures. However, Hertzian fractures cannot occur under bipolar reduction. Whether this form of reduction could be compared to non-axial bipolar remains to be seen. The term will not be used.

In a number of cases, the term ‘classic’ appears before a root term. It is unclear whether this refers to: A) a sub-division of the reduction technology; B) adjectival use, implying that all features expected to be seen are present; C) adjectival use, implying that it is not affected by changes in tradition. The most probable would be B, but there is nothing confirming this. Ballin also uses ‘classic’ (2006). This is during a comparison of unifacial and bifacial bipolar cores, of which the latter are the ‘classic’ form. A similar critique can be applied to the usage of ‘plain’. These terms will not be used.

The term ‘scalar’ appears infrequently in literature, often used as a synonym for bipolar (O’Hare 2012; McDevitt 2010; Brady 2007; Woodman *et al*. 2006: 81; Scannell 1992). In reading reports, its usage is variable. One analyst appears to use ‘bipolar’ when referring to the reduction technology, and ‘scalar’ for the products, i.e.: cores, flakes, blades (Clarke 2003). Another analyst identifies cores as ‘bipolar’ and flakes as ‘scalar’ (O’Hare 2012; 2009). There are no explanations given for this dual usage by each author – when cores and removals are both prefixed by 'platform', the differentiation between 'bipolar' and 'scalar' is unclear. The term scalar itself may be a derivation of 'scalariform', which refers to the stepped morphology of some retouch (Inizan *et al*. 1999). Scars of similar morphology appear on the hammer and anvil ends of bipolar cores due to impacts. While they appear like stepped retouch, they differ in origin and are called *écaillé* retouch elsewhere. The term 'scalar' is no longer relevant as it does not appear in international publications, and will not be used.

Split pebbles are strongly associated with bipolar reduction. Ballin (2006) notes them as evidence of testing pebbles for suitability. While this is true, other studies have shown that split pebbles were produced as blanks in their own right (Knarrström 2001; Low 1997). The 'split pebble flakes' have only been noted in Irish lithic reports. However, there appears to be a difference in understanding at times. One report discusses it in the core sub-section (Sternke 2010a: cxiv). Two other reports identify it as flake debitage (Sternke 2010c: xiv; Moore 2009a). 'Split pebble flakes' may have some relation to 'segmented pieces'. The term 'split pebble flake' will not be used.

While the issues of terminology discussed above relate specifically to bipolar, there are also problems with artefact names. One example will be mentioned here, as this was not a primary focus of the literature review. The Keiller-Knowles publication (Woodman *et al*. 2006) presents the most up-to-date and comprehensive list of Irish lithic typologies. Woodman *et al*. (2006: 156) disavow the use of terms like 'round scraper' and 'thumbnail scraper'. This is due to the fact that they "are frequently a subjective selection from a broad range of scrapers", and therefore they lack any "real validity" (*ibid*.). However, this term is still used by researchers and analysts (McDevitt 2010; Nelis 2010g). This then feeds into general synopses (Carlin 2018: 67). The end result of this inconsistency amongst lithic analysts is a confused typological list, and a confused understanding of lithic traditions.

These terminological issues are compounded by the mis-identification of pieces. Woodman *et al*. (2006: 81) associate the production of segments with the pillowed profile of bipolar cores. Beyond a superficial similarity in curvature, these pieces are not related. The different processes in their production are explained in **Chapter 4**.

3.3 Dating

The dating of lithic material from excavations presents a bewildering array of viewpoints: some justifiable, some contradictory, and some incoherent. Some analysts specify particular periods based on technology and/or form. Others state that material cannot be ascribed to any period and give a broad date range. In some instances, there is an attribution of material identified as non-diagnostic to the archaeological periods of the Neolithic and Bronze Age (Moore 2011; 2009b). For some reason, the Mesolithic is entirely discounted, as well as ignoring the possibility of historic use. In one instance, the poor quality of a suggested Mesolithic assemblage is noted as "reminiscent of Bronze Age techniques" (Chapple 2007: 1) – a cautionary testament to how analysts can perceive and date lithic material.

A number of analysts are restrained in their dating. Debitage, in the form of flakes and blades lacking clear technological markers, are recorded as being undiagnostic, and are seen as being "chronologically indistinct" (Nelis 2010f), or having "no temporal significance" (Little 2005), or generally attributed to later prehistory (Milliken 2002). In two reports, utilised and edge-retouched material is noted as being present throughout Irish prehistoric and historic periods (Nelis 2010a; 2010b).

In two cases, the range of later prehistory is narrowed to the middle of that broad era – Late Neolithic, Chalcolithic, Early Bronze Age, Middle Bronze Age (O'Hare 2009; Clarke 2003) – excluding other sub-periods. No explanation is given. Perhaps the analyst saw a preliminary report, or their technological classification permits such restricting, which explains the scenario. However, there is no comment stating so. Elsewhere, similar material is often given more specific dates. Bipolar debitage is, at various times, placed in: later prehistory (Ballin 2006); Middle Neolithic (Sternke 2011d); Neolithic or Bronze Age (Moore 2011); Neolithic – the second half – and Bronze Age (Sternke 2011f); Late Neolithic or Early Bronze Age (Sternke 2011g; 2009b; Engl 2004); Late Neolithic and Bronze Age (Sternke 2010d); Bronze Age (Sternke 2012b; 2007); Bronze Age – possibly the first half (Sternke 2015); and the Middle Bronze Age (Sternke 2011c).

Some of the varying dates are the result of apparent technological divisions or derivation of form. 'Controlled bipolar' reduction is viewed as characteristic of the Middle Neolithic, with sporadic occurrences in the Late Neolithic (Sternke 2011e: 433; 2010c: xiii). 'Smash-it-and-see' bipolar reduction is noted as diagnostic of the Chalcolithic (Sternke 2011b: lxxiii), though elsewhere it is seen as dominant of the Bronze Age in general (O'Hare 2005). Scannell (1992: 278) established the presence of bipolar material on Neolithic and Bronze Age sites, and dismissed a diagnostic connection to periods (*ibid*.: 161), much earlier. This was later supported by Woodman *et al*. (1999: 73), who identified bipolar and scalar cores as an "element of post-Mesolithic assemblages", implying Neolithic and Bronze Age.

Size is used to discriminate between lithics of the Early Bronze Age and the Middle/Late Bronze Age, with the former being larger and the latter smaller (Sternke 2011c: 93; O'Hare 2005). However, these are questionable dating methods. Other analysts attribute variance in size to the raw material being worked. Clarke (2003) notes that, in addition to reduction strategies that included bipolar working and flat platforms, a small core size was indicative of working pebble resources. It was not a chronological marker.

A remark of interest to the dating discussion comes from Carlin's (2018) consideration of Beaker material. In setting out the parameters, he excludes (*ibid*.: 18)

> "stone tools lacking contextual associations with Beaker pottery and those that have not been demonstrated by radiocarbon dating to have been contemporary with this ceramic. This is because of difficulties in accurately ascribing date ranges to lithics based solely on typological or technological characteristics."

This statement – by a non-lithic specialist – contradicts many of the above assertions of period or sub-period dating or dominant associations – by lithic specialists. No explanation is provided as to why the more specific dating schema presented above were not accepted, or whether it is in support of the more generalised dating – despite all of them being established much earlier than the publication.

In an extreme example, the lithic analysts' dating of material, and interpretation of residuality, was openly questioned in the excavation report due to the complete lack of coherence with the site narrative up to that point.

> "The lithics report from Dr. Sternke was received at the end of the post-excavation process and breaks with the smooth narrative that had formed up until then that showed we were dealing with a Bronze Age settlement. The same assemblage was described by O Dowd as non-diagnostic in terms of dates which allowed for them to be slotted into our narrative in the manner described at the start of this paragraph. Dr. Sternke is very clear that the lithics date from the Late Neolithic-Early Bronze Age and that lithic production ceased by the Middle Bronze Age. They could have been made 700-1000 years before this site was occupied. They are explained as 'residual inclusions' in her report, which means that they were lying around when the site was being built or used and simply fell into the features that they were found in.

> Alternatively, they were deliberately brought back into circulation by being taken from known earlier sites and then deposited into features as charms or ritual deposits. The latter points is [*sic*] highly speculative. Another explanation is that some production of lithics and their use did continue into later [*sic*] Bronze Age period." (Tierney *et al*. 2011: 44).

This comment by the excavators shows how out of sync lithic dates can be with the corresponding archaeological interpretations, and the need for greater clarity in chronologies, primarily in discussions of residuality.

3.4 Concluding Remarks

The review presented – focusing on bipolar reduction and dating – displays an inconsistency that is startling. By failing to provide definitions and references, many reports read as each analysts' lithic ideology. By failing to review and correct, errors are repeated. This undermines scientific approaches in archaeology and feeds an epistemic crisis of reproducibility and replicability in lithic research, where terminologies and chronologies cannot be verified independently.

4. Bipolar Lithic Reduction

4.1 Introduction

There has been a greater recognition of lithic knapping taking place during the Irish Chalcolithic and Bronze Age – or certainly the earlier part at the least – since O'Hare's research (2005). This has been focused largely on typologies. Specific, detailed discussion of the technique employed – bipolar reduction – is absent. Due to the strong association of this technique and the latter millennia of Irish prehistory (O'Hare 2005), coupled with a profusion of international research on bipolar reduction published in the decade since O'Hare completed her project (e.g.: Pargeter, Duke (eds) 2015; Peña 2015a; Gilabert *et al*. 2015; Jeske, Sterner-Miller 2015; Maffezzoli *et al*. 2015; Torre *et al*. 2013; Drift 2012a; Diez-Martín *et al*. 2011; Vergès, Ollé 2011; Matilla 2010), the following chapter will focus on the bipolar knapping technique. It aims to provide a brief overview of the history of research on the subject, with specific focus on the numerous studies that have emerged in recent decades which delve into the topic. A synopsis of the physical aspects of bipolar percussion will be presented. This will provide information on the characteristics of the reduced material, and the materials used to reduce; as well as laying out the variations on the technique. Coarse lithic tools will also be considered. Given their integral role in bipolar reduction, it is necessary to review research on them.

The vast majority of bipolar research is dedicated to the chipped lithic assemblages of the earlier eras of human prehistory (Goren-Inbar *et al*. 2015; Hiscock 2015a; Drift 2012a; Diez-Martín *et al*. 2011; Soriano *et al*. 2010). Many of the insights provided come from technical papers relating to material from the various stages of the Palaeolithic. However, within this spread of Palaeolithic papers, there are a handful of papers that crop up which consider the evidence from following prehistoric periods. Regarding Mesolithic and Neolithic contexts, there are increasing numbers of papers that bring bipolar reduction into the fold. In regions where freehand percussion, in one of its guises, was thought to dominate, researchers have been putting forward evidence for bipolar percussion also being carried out (Osipowicz *et al*. 2016; Gilabert *et al*. 2015; Driscoll 2010; Sternke 2009a; Devriendt 2008). And, more pertinent to this study, there is an acknowledgement of bipolar reduction taking place in Chalcolithic and Bronze Age periods in Britain (Ballin 2002), France (Furestier 2010), Ireland (O'Hare 2005), and Lithuania (Piličiauskas, Osipowicz 2010).

The bipolar technique of knapping has been around for millennia, spanning a period of around 1.8 million years. The earliest examples of artefacts created by this technique date from the Palaeolithic era and its implementation continued, interspersed with other flaking styles, until the recent historical age (Hiscock 2015b; Knight 1991). In sharp contrast to its extended and widespread history of use, research into this knapping method has been erratic, with the area being disdained and overlooked (Yang *et al*. 2016: 5; Peña 2013: 33, 34; Prous *et al*. 2010: 202). Discussion around the topic appears quite ambiguous, with uncertainty existing at times as to what constitutes 'bipolar' (Knight 1991: 58). Recently, however, there have been concerted attempts to better understand this technique (e.g.: Duke, Pargeter 2015; Maffezzoli *et al*. 2015; Eren *et al*. 2013; Low 1997). These studies have looked at various aspects of bipolar knapping and provide much more nuanced points of view on the subject, and challenge the popularised view that it is "a crude core- or nodule-smashing technique that would not be worthy of mention" (Odell 2000: 294).

One reason given for this oversight is the preference of modern-day experimental knappers for freehand techniques (Drift 2012a: 8), and a strong emphasis on conchoidal fracture (Cotterell, Kamminga 1987: 683). With the majority of aesthetically attractive lithic artefacts the result of these methods of reduction, there has been a neglect of bipolar-reduced forms, which are thought of as unconventional and crude in both production and appearance. This preference is then seen to have filtered through to archaeological theories, influencing the view of researchers that freehand techniques were those preferred in the cultures being studied (Drift 2012a: 8; Cotterell, Kamminga 1987: 681, 683). This view is corroborated by a reading of texts concerning the analysis of lithic assemblages. Kooyman's (2000) discussion of lithic features , seen as a reference standard, is notable by its lack of consideration of bipolar reduction. In the section covering the characteristics noted by experimental knappers regarding different techniques, e.g.: hard hammer vs. soft hammer, there is no mention of the effects caused by the use of anvils or characteristics created by such (*ibid*.: 79). Similarly, with Inizan *et al*. (1999), bipolar percussion is not discussed to any extent. However, this is beginning to change with an increasing number of experimental research projects focusing on bipolar reduction taking place (Bril *et al*. 2015; Duke, Pargeter 2015; Maffezzoli *et al*. 2015; Peña 2015a; 2015b; Torre *et al*. 2013; Diez-Martín *et al*. 2011; Driscoll 2010; Low 1997).

4.2 Bipolar Reduction

Bipolar reduction constitutes the creation of lithic debitage through the compression of a core between two surfaces, namely a hammerstone and an anvilstone. Traditionally, this is seen as the placement of an anvilstone on the ground, on which sits a core, which is then struck from above with a downward force (**Fig. 4.1**). It is implemented when a round core or pebble lacks a suitable striking plane, reduction face or rib that allows for freehand flaking (Drift 2009: 4). In these cases, a strike from a hammerstone on a core held in the hand would have insufficient force to break open the resource, as most of the force will be received by the holding hand with the core too small to counteract the blow (*ibid*.: 1-4). Using an anvil increases the forces working on the core and also directs them to it, permitting the resource to be opened; or possibly crushed (*ibid*.: 5).

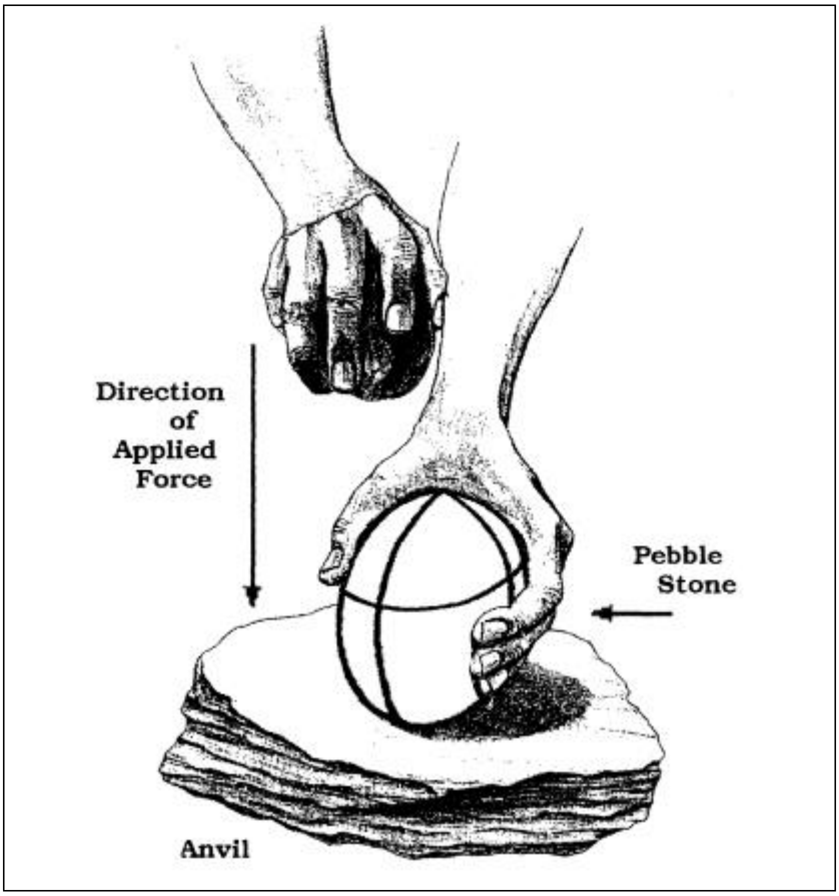


Fig. 4.1: Bipolar reduction - simplified (from Low 1997: 14).

The lack of focused research going back over decades has led to a wide range of terminologies being developed for the same aspects. There has been no synthesis of the relevant characteristics and terminologies as there has been for freehand knapping (Kooyman 2000;

Inizan *et al*. 1999). The following section presents a summary of the many aspects that constitute research into bipolar material.

4.2.1 Terminology

Bipolar artefacts are roughly separated into two categories, related to how the split occurs on a core when it is struck. Despite there being only two divisions, a long list of terms has been generated.

1) Axial: [pseudonyms – split-pebble, straight, true, nut-cracking technique] (**Fig. 4.2**: 1, 2)

   Axial bipolar material has been reduced under the strictest definition of the technique. In this classification, the anvil and hammerstone have both connected with the core in axial continuity and are both responsible for the detachment of a removal (Hiscock 2015b). This results in compression forces acting in both directions along the detachment. This method tends to result in sheared flake surfaces, i.e.: ventral surfaces without marks (Zaidner 2013: 18 – see **Chapter 7.5.2** for discussion), a greater extent of scars caused by distal rebound force and the distal truncation of flakes (Duke, Pargeter 2015: 349). Axial techniques have also been split into categories of vertical and horizontal (Diez-Martín *et al*. 2011: 692). The difference here is which way the long axis lies: vertical the long axis is perpendicular to the anvil surface; horizontal the long axis is parallel.

   Note the curving fracture line in the horizontal axial strike (**Fig. 4.2**: 2). This is due to the strike occurring near the outer edge closest to the impact points, which makes it easier for horizontal stretching to propagate towards it (Drift 2009: 6). This approach is called ‘pebble decapitation’ or ‘cobble sectioning’ and can be used to open or to ‘slice’ pebbles (**Fig. 4.3**); the products of it exhibit fractures that curve in two directions (*ibid*.). If the strike were to be positioned at the centre of the horizontal pebble, then the fracture line would run straight, due to the horizontal stretching having an equal distance to run to either vertical edge (*ibid*.). This horizontal method of fracture is appropriate for large resources as it reduces the distance between percussor points and thus the level of force needed to effect a removal (*ibid*.).

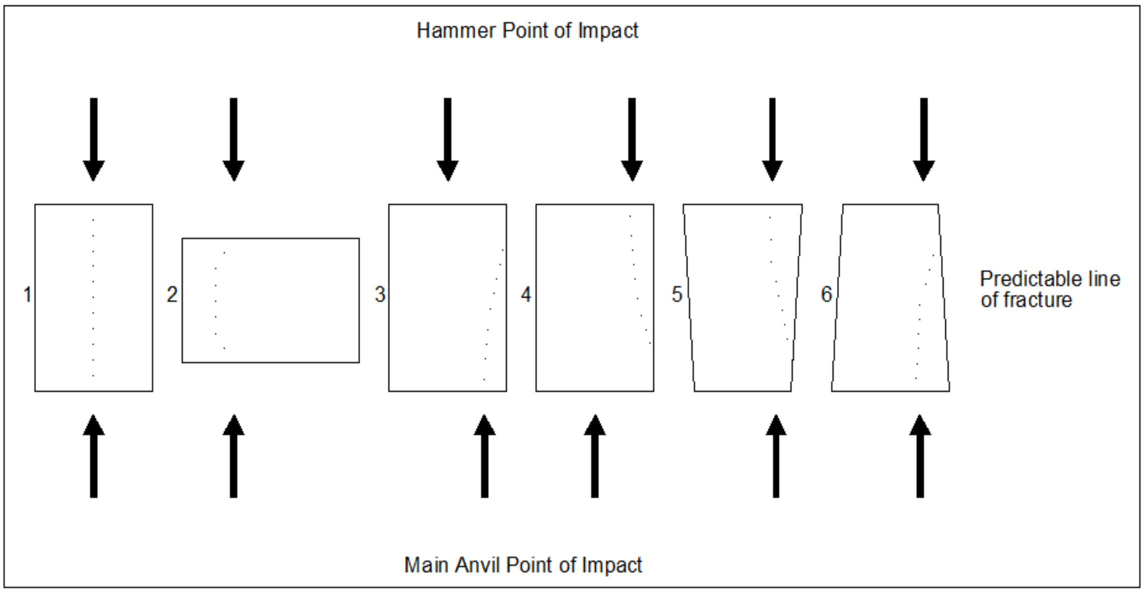


Fig. 4.2: Diagram of variations within bipolar flaking. 1) Axial flaking – vertical. 2) Axial flaking – horizontal. 3) Non-axial flaking – displaced; eccentric resting point. 4) Non-axial flaking – displaced; eccentric impact point. 5 & 6) Non-axial flaking – low displacement. 3), 4), 5) & 6) can be positioned horizontally also (adapted from Vergès, Ollé 2011; Diez-Martín *et al.* 2011).

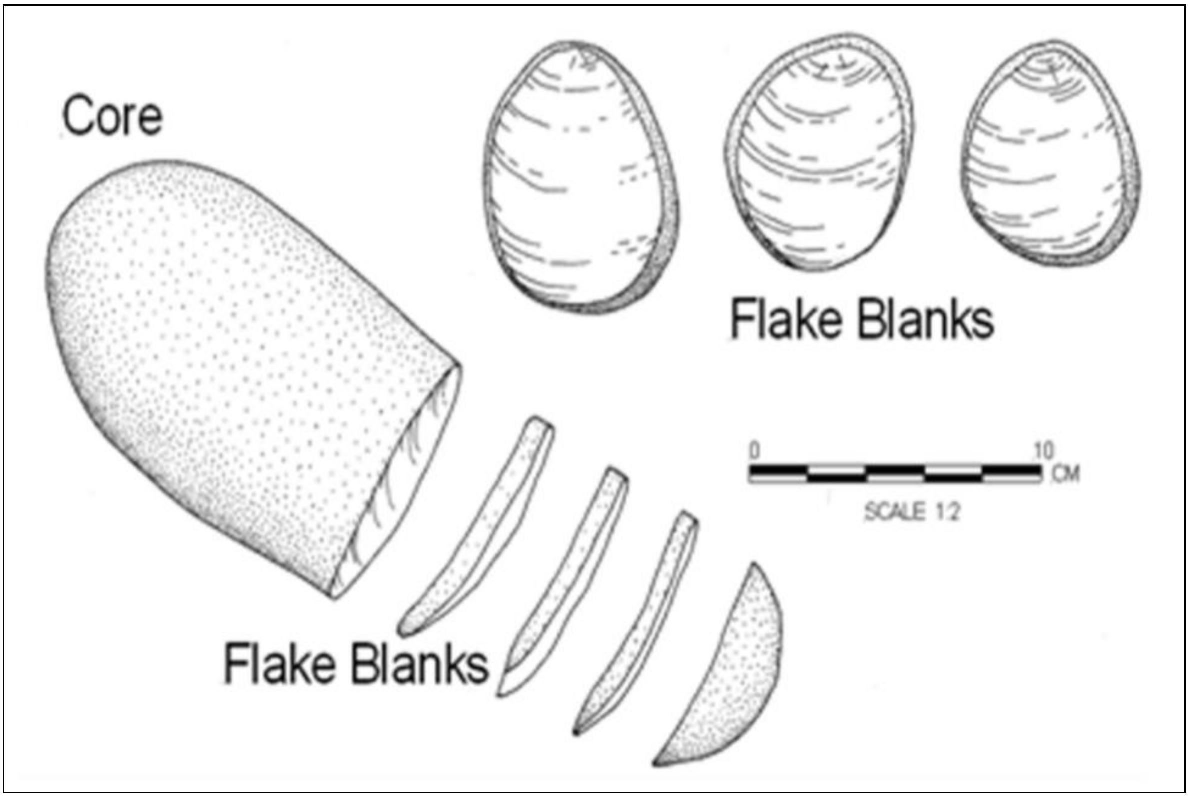


Fig. 4.3: Illustration of 'pebble decapitation' or 'cobble sectioning', with 'slices' (flake blanks) – somewhat idealised as curvature can be more pronounced and can produce thicker slices (from Hintzman, Garfinkel 2011: 5).

2) Non-axial: [pseudonyms – oblique, anvil-rested, tangential, anvil platform] (**Fig. 4.2**: 3, 4, 5, 6)

Under this definition the core is placed on the anvil and then struck with a hammerstone, though the two are not aligned. This means that there is only one point of impact on the removal, despite the presence of both active and passive percussors. The removal is initiated by either the hammerstone or the anvil, but not both (Duke, Pargeter 2015; Drift 2012b; Diez-Martín *et al*. 2011: 692). The removals here differ from freehand percussion in their lack of necessity for a compression cone. The absence of this cone creates characteristic markings, e.g.: compression ripples across the whole ventral surface, enlarged eraillure scars and an extra, dead-end cone (Drift 2012b: 160). However, it is harder to identify as the resultant removals will not have the distinctive crushing of axial bipolar removals; and the characteristics exhibited may compare with debitage produced by freehand percussion (Duke, Pargeter 2015: 349). Within non-axial flaking there have been sub-divisions created based the level of offset of percussors: displaced – where removals are detached at the compression point furthest from the centre of the core; and low displacement – where removals are detached from the surface with the lower external platform angle (Vergès, Ollé 2011).

Non-axial bipolar reduction has also been suggested as a method of retouching lithics (Drift 2009: 7, 8), where anvils are noted as being very helpful in producing steep retouch (**Fig. 4.4**). This is possibly the enclume retouch described in Woodman *et al*. (2006: 94); and the anvil retouch mentioned in Inizan *et al*. (1999: 130, 138).

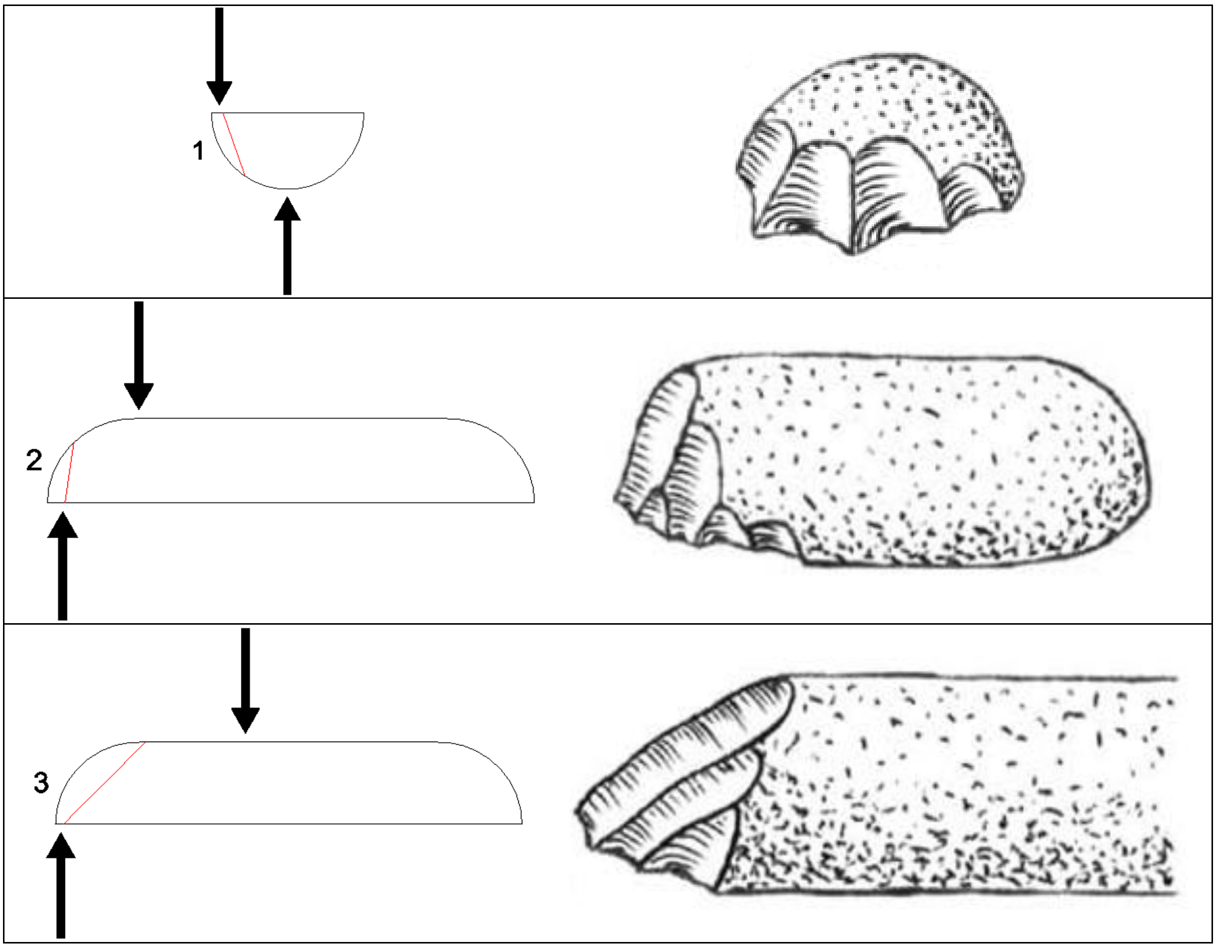


Fig. 4.4: Diagram of variations of bipolar retouch on lithics showing contact points of hammerstones and anvils, with accompanying illustrations. 1) Oblique retouch initiated at hammer contact point; 2) Oblique retouch initiated at anvil contact point; 3) Acute retouch initiated at anvil contact point – note the wide displacement of the hammerstone and anvil (adapted from Drift 2009: 5 – Fig. 5, 7-9).

4.2.2 Non-conchoidal Fracture Characteristics

As a result of being positioned between a hammerstone and anvilstone, bipolar lithics are distinguished from their freehand counterparts by their non-conchoidal fracture pattern (Drift 2012a: 8). This produces a number of different markers during knapping as a result of how fracture forces act upon the material (**Table 4.1**). However, difficulty can be had in identifying non-axial bipolar material from freehand material, especially that struck by a soft hammer (Drift 2009: 7). One way of telling the difference is the ripple patterning that occurs on the ventral surface. On conchoidal flakes they are limited in their distribution by the function of the neutral cone in freehand knapping, which creates two smooth bands on the left and right proximal edges (**Figs. 4.5**: A, **4.6**). In bipolar reduction, this cone is essentially nullified so non-conchoidal flakes maintain ripples across their entire ventral surface (**Fig. 4.5**: C). Axial bipolar knapping may produce opposing sets of ripples (**Fig. 4.5**: B) (*ibid.*: 12, 13).

Conchoidal Fracture	Non-conchoidal Fracture
Prominent bulb	Flat/diffuse bulb
Neutral cone	Dead-end cone
Compression ripples inside cone	Compression ripples across complete surface
Eraillure scar at proximal end	Variable: very large scar; central scar; no scar
Tension fracture outside cone	

Table 4.1: Component features of conchoidal and non-conchoidal fractures.

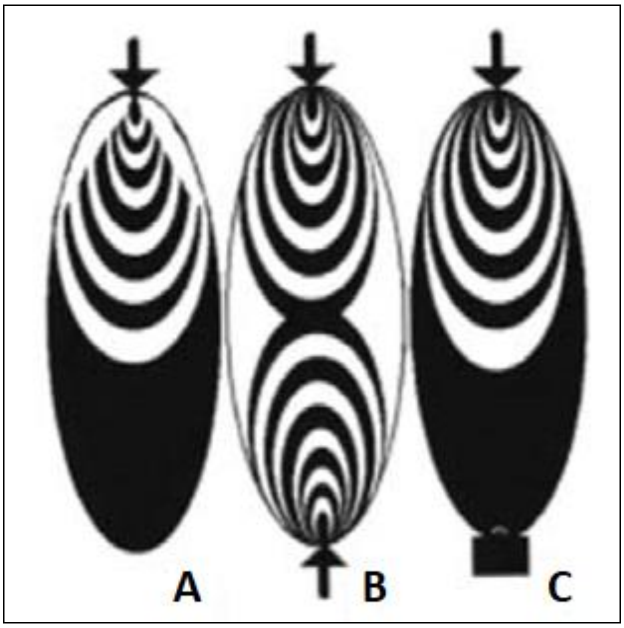


Fig. 4.5: Idealised ripple patterns developing from A) freehand reduction – note the blank areas to the left and right of the point of impact resulting from their location outside the neutral cone;
B) axial bipolar reduction;
C) non-axial bipolar reduction
(from Drift 2009: 12).

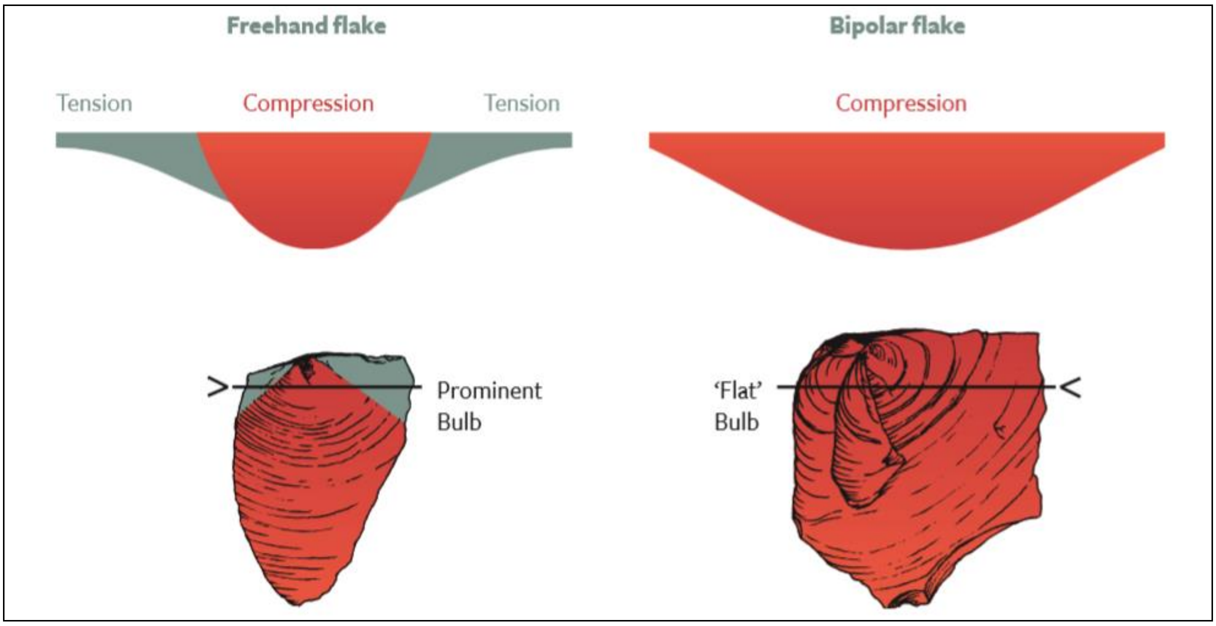


Fig. 4.6: Simplified comparison of bulb cross-sections – note the restricted compression and resulting bulb on the freehand flake, whereas the bipolar flake has a compression across the full width of its proximal end (from Drift 2012a: 11).

Eraillure scars are an incredibly variable marker. These typically appear at the proximal end of removals, just below the striking point, in freehand knapping as this is where the greatest strain is (Drift 2009: 14). The experimental work carried out by Pargeter and Eren (2017) compared axial bipolar material to freehand. The researchers found that eraillure scars were much more commonplace on the freehand flakes than on the bipolar ones, appearing on 22% of the products as opposed to 1% (*ibid*.: 11). However, this apparently clear-cut ratio is complicated by the fact that Drift (2012a: 13, 14) claims that non-axial bipolar material is partly characterised by large eraillure scars, with small to absent ones on freehand. In addition to this, it is possible that the eraillure scar can appear in a more central position on axial bipolar material as this is where the strain is greatest as the two impact forces meet (Drift 2009: 13, 14), though this was not noted by Pargeter and Eren.

Bulbs of percussion can provide some assistance in the identification of bipolar reduction. This is clearest between hard hammer freehand methods, which result in a prominent bulb, and bipolar, both axial and non-axial, which produce flat or very diffuse bulbs. Issues arise in assemblages that have been reduced using soft hammer direct percussion, due to the fact that soft hammer fractures are initiated over a wider oval area (Drift 2012a: 11). This can also result in diffuse bulbs, leading to difficulty in separating out its removals and those of non-axial bipolar percussion, as other diagnostic markers will be absent.

An important caveat should be borne in mind when applying these markers. The experimental pieces that informed this list only consisted of flint and quartz (Peña 2015b). The applicability of these characteristics to other knapped material, i.e.: chert, should be treated cautiously due to differences in the structure of the rocks. For instance, bedding planes present in knapped chert nodules will likely influence the propagation of waves of percussion and so could interfere with the development of the identifiable characteristics noted. Even with the use of quartz within experimental bipolar studies, research has shown that the identification of intentionally reduced pieces is extremely challenging (Driscoll 2010; Driscoll, Warren 2007). For the same reasons as chert, bipolar quartz pieces should be treated with caution.

4.2.2.1 Fracture Initiation and Propagation

Beyond the differing terms, axial and non-axial bipolar reduction are also distinguished by how fractures are initiated and develop. For axial bipolar, fractures are the result of a wedging initiation (**Fig. 4.7**: B) and a compression-controlled propagation (Cotterell, Kamminga 1987: 684, 685). Here, fractures are initiated by wedging particles into a pre-existing flaw; or as a result of plastic deformation – where a point, impacted repeatedly with increasing force, permits the initiation of a crack (*ibid*.: 687). It should be noted that while this is predominant mode of fracture initiation in axial bipolar reduction, it is not the only one (*ibid*.). This initial fracture then moves through the lithic piece by compression, due to the aligning of the points of contact of the hammerstone and anvilstone. This axial alignment provides a stabilising effect on the fracture development, resulting in the flat ventral surfaces of axial bipolar products (*ibid*.: 698). This fracture pattern is typically associated with centrally struck material. When it occurs closer to the edge of a piece, the compression line can be altered due to difference in tension pulling on the broader side compared to the narrower. This is the reason for the curvature in pebble decapitation pieces (see **Chapter 4.2.1**; **Figs. 4.2**: 2, **4.3**).

Non-axial bipolar is more difficult to establish the method of fracturing for; and to identify during analysis. Removals are the result of bending-initiated fractures (**Fig. 4.7**: A), which continue through stiffness-controlled propagation. Bending fractures initiate where the removal bends away from the percussor, resulting in a concave or flat proximal ventral area (Cotterell, Kamminga 1987: 690). This works best on edges with small angles, though with soft percussors the angle can be increased (*ibid*.: 689, 690) – a factor of the vertical placement of a core on an anvil and then striking from above. This initiation then continues through the removal under a combination of stiffness-controlled and compression propagation. Due to the offset of the points of contact of the hammerstone and anvilstone, the removal runs along one side of a core – resulting in stiffness-controlled propagation (*ibid*.: 694). In non-axial bipolar, compression propagation is also enacting upon the removal, though to a lesser degree than in axial bipolar. Bending initiation has been overlooked in the archaeological record due to a very similar appearance to conchoidal pieces (*ibid*.: 683). It is noted as being associated with soft hammer removals, breaks and retouching pieces (*ibid*.: 690), which has implications for the classification of bipolar pieces based on the extent of waves of percussion.

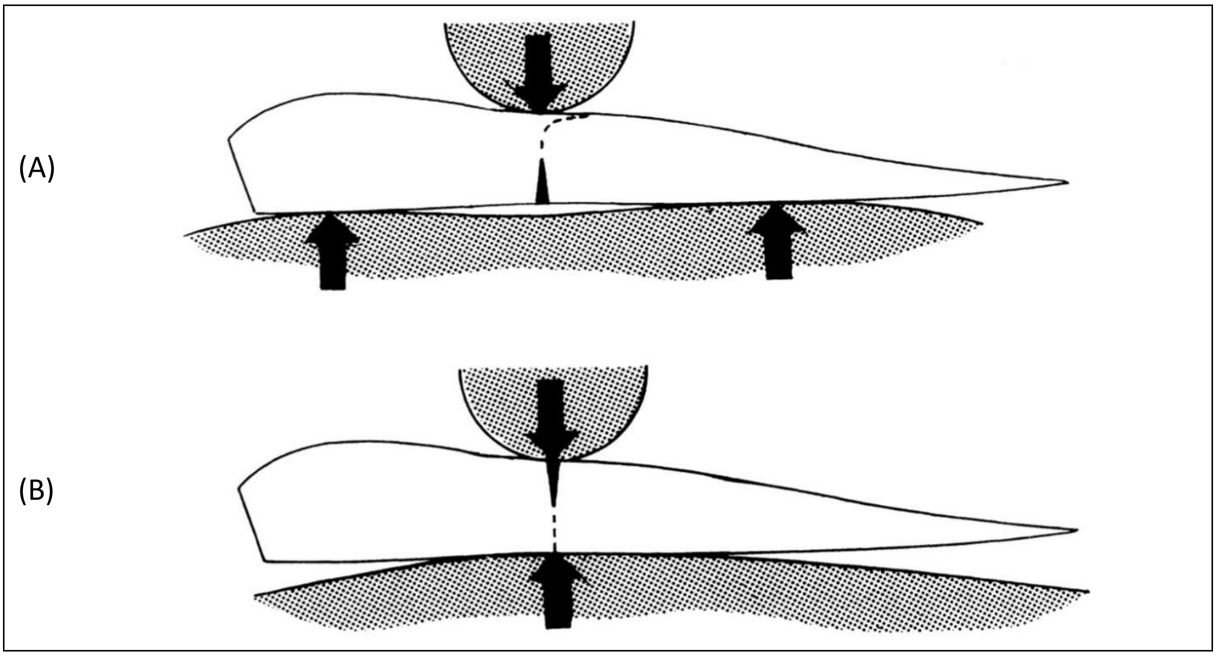


Fig. 4.7: (A) Fracture initiated by bending; (B) Fracture initiated by wedging (from Cotterell, Kamminga 1987: 695).

4.2.3 Variations

In addition to the variety of impact compositions, variations on the application of the bipolar method have been posited. It has been suggested that soft anvils, such as the ground, may have been used (**Fig. 4.8**) (Drift 2012). Archaeological invisible, as traces of impacts would be easily destroyed (if they are produced at all), this variation may produce differences in flake morphology that would allow for identification; though there has been no experimental work on bipolar flakes produced on the ground. Also, given that resistance is needed for the anvil to perform its function, ground conditions would be a highly variable factor. It could be suggested that ground-struck material may be closer to freehand material: the ground may offer support to the core in the way that a leg does; and it may allow for the core to be rolled slightly, allowing for a conchoidal fracture – though this is just conjecture.

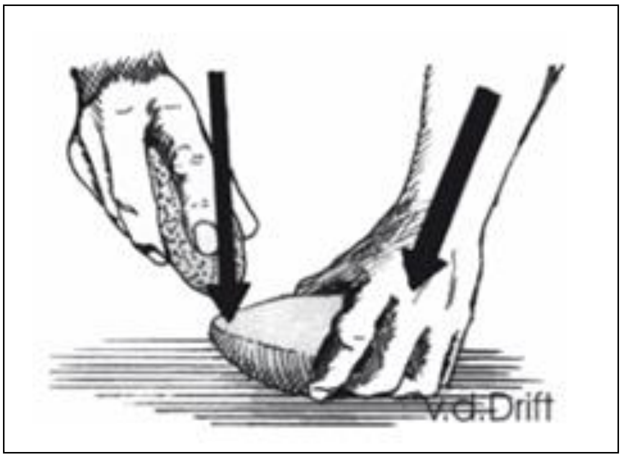


Fig. 4.8: Bipolar technique showing use of the ground (from Drift 2012: 163).

Other variations exist in relation to the grasping of the hammerstone or the number of participants. **Figure 4.9** shows the different iterations of the bipolar technique that have been theorised. Again, no experimental work has been done on the difference, if any, in the resulting debitage from these methods. It remains to be seen whether they are archaeologically visible to any degree. The two methods involving one person would appear to be the most logical (**Fig. 4.9**: 1, 2). These are the standard methods seen in experimental work, focusing mainly on the 'one person – one hand' (Bril *et al*. 2015; Maffezzoli *et al*. 2015; Cormack 2014; Faivre *et al*. 2010). The 'one person – two hands' seems to be applicable to particularly tough, large cores. From the drawing it appears as if the core is supported by a pile of sand or earth rather than an anvil, though it may be covered. Whether this would provide a secure enough stance for the core to allow the force to travel through and rebound is questionable. In addition to the configuration of participants, the position of the knapper is suggested to have an effect. According to Kobayashi (1975: 116), if small flakes are sought after, then it is best for the knapper to sit with the anvil placed between their knees. If large flakes are desired, squatting is proposed as the best stance.

Some of the methods seem questionable in their deployment. The 'vice-anvil-maul' approach would appear to be excessive (**Fig. 4.9**: 4). The amount of force exerted on the core would be massive, most likely causing extreme levels of shatter. The accuracy of the impacting blow could not be guaranteed either. And in a lithic technology that is strongly associated with the fracturing of small pebbles and cores (Pargeter, Eren 2017; Hiscock 2015a; 2015b) – especially in the later prehistoric periods – this is an important consideration. Low (1997: 13) notes that it would only be used in conjunction with the hardest of materials. Given the use of primarily small flint and chert nodules or pebbles in Ireland (Woodman, Scannell 1993: 61; Green, Zvelebil 1990: 62; Peterson 1990: 92; Woodman 1984: 3, 6), with little evidence for the use of other rock types for the chipped industry, it seems unlikely that it was employed. Also noted as dubious is the ‘two-handed two-person’ approach (**Fig. 4.9**: 3). Low (1997: 13) is of the opinion that it would require an extremely trusting individual to hold the core and is most likely correct in this assumption.

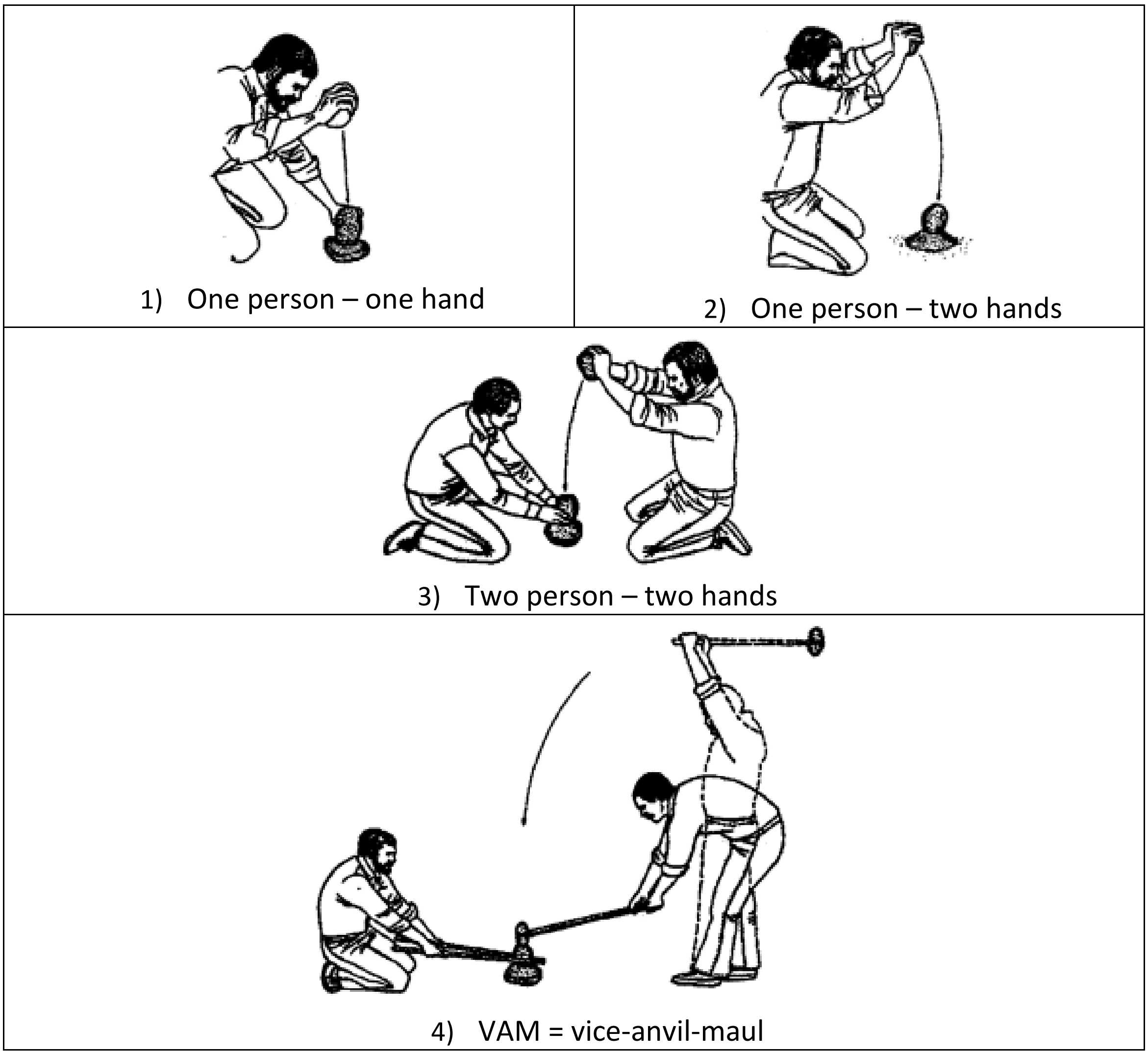


Fig. 4.9: Methods of bipolar reduction (from Low 1997: 15).

4.3 Bipolar Debitage

The resulting debitage of bipolar reduction are somewhat different in their form to those of freehand production. The traditional dichotomy of core and removal is undermined by the fact that bipolar reduction can create functional removals without a core being generated. Waste, i.e.: unintentional removals, can be produced, though if the strike is neat this can be minimal to non-existent. This leads to some difficulty in the categorisation and discussion of bipolar material. A small number of studies have established identifiers for cores and products.

Where the form of the core is referenced as an influencing factor, there has been little elaboration on contributing aspects. Peña's (2015a ; 2015b; 2011) work mentions symmetrical and asymmetrical cores, but does not go into detail if these were struck in an axial or non-axial fashion when outlining the experiment (Peña 2015b) – though this may be difficult to properly record. The type of bipolar reduction may also influence the development of impact scars and so there could be greater variation than is currently displayed.

4.3.1 Cores

Identifying cores has proved one of the most challenging aspects of bipolar research, down to the fact that they are frequently confused with or misclassified as wedges or intermediate pieces (Peña 2015a).

The symmetry of cores can affect the markings present. Peña (2011) has identified differences in the removals present on symmetrical cores to those on asymmetrical ones (**Fig. 4.10**).

A number of characteristics for identifying bipolar cores have been set out by Peña (2015b). These include:

- Hammered edge and passive edge are smooth and rectilinear. If the core is rotated, this results in a quadrangular or rectangular form.
- Both hammered and passive edges develop numerous impact scars (known elsewhere as *écaillé* retouch); though the majority will be found on the hammered edge.
- If the core is symmetrical, impact scars will be present on both faces. If the core is asymmetrical, impact scars will develop on the convex surface (if the form is straight-sided/convex-sided).
- Bipolar reduction rapidly reduces the cores size. As a result, cores can attain an extremely small size – with examples of 2 or 3cm width known.
- A striking platform can be evident on many examples. This is not a sign of core preparation; rather an unintentional product of the bipolar reduction process.
- Step or hinge terminations are the dominant termination types of *écaillé* retouch or removals.
- Deep ripples normally develop.

- Impact scars develop following a pattern: > initial scars are large and usually overlap, they are likely to be hinged; > subsequent scars are smaller, but also hinged; > a row of parallel scars is produced; > area next to edge fissures and becomes blunt.

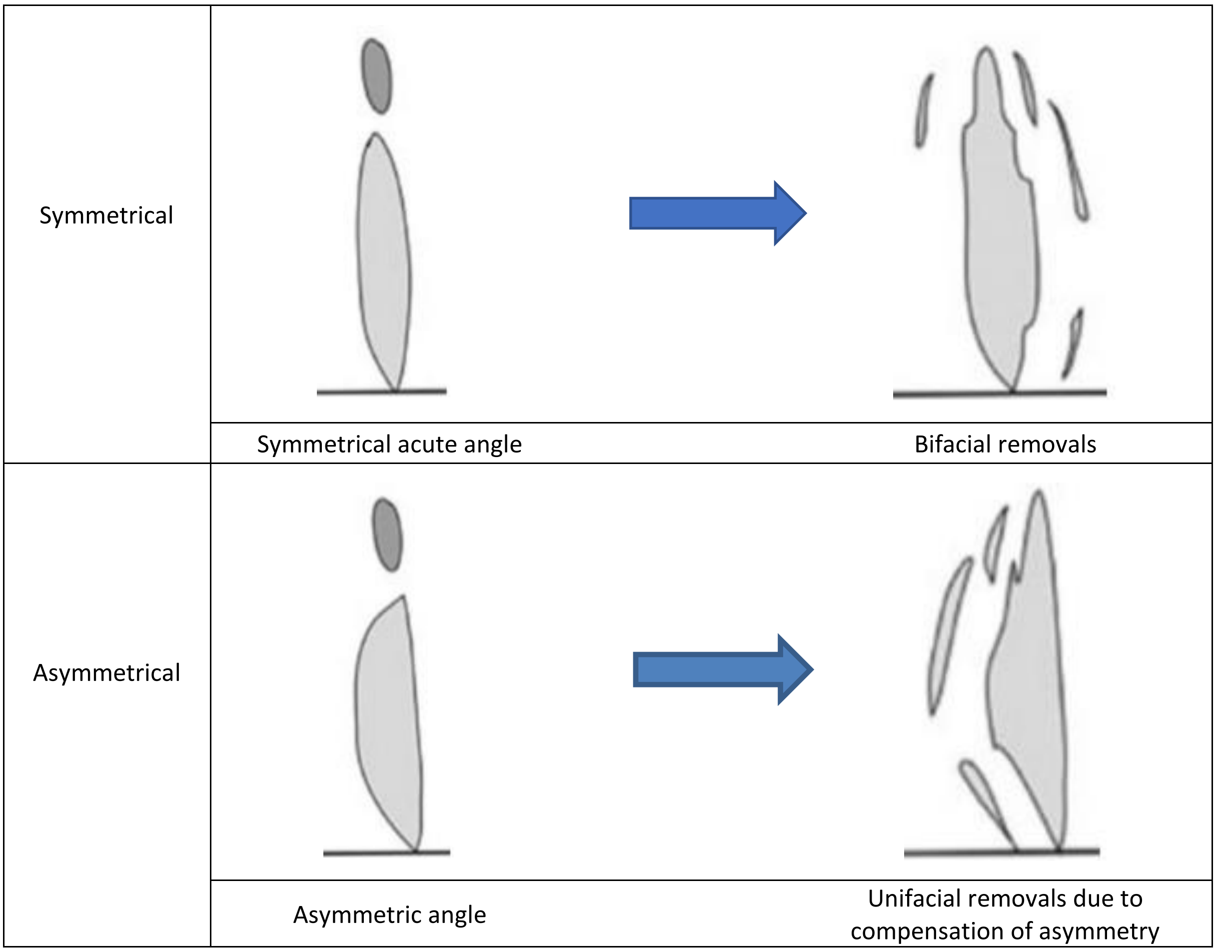


Fig. 4.10: Schematic drawings of removals on symmetric and asymmetric cores (after Peña 2011: 88). [Translated by author].

Peña (2011) has expanded on three phases of bipolar cores (**Fig. 4.11**) that can be present in the archaeological record, which had been identified by previous research (*ibid*.: 80).

Ballins' (2014; 2006) understanding of unifacial and bifacial bipolar cores appears similar to the core symmetry suggested by Peña above, and may be seen in the phase 1 and 2. Similarly, the categories of the one-sided and two-side bipolar cores by Zvelebil *et al*. (1987: 32) could be comparable. Bifacial may be the equivalent of symmetrical; and unifacial of asymmetrical – though this may be a semantic conflation. The pillowed profile of bipolar cores noted by Woodman *et al*. (2006: 81) is present on phase 1 and 2 cores.

Phase-three bipolar cores are possibly described by others as well. Zvelebil *et al*. (1987:32) refer to ridged splinters – defined as “a piece with primary cortex on one side opposite one or more ridges. Triangular or quadrangular cross-section. Dorsal crushing on many items” . The dorsal crushing and cross-section are certainly seen on third-phase cores, but the cortex is not a definite occurrence.

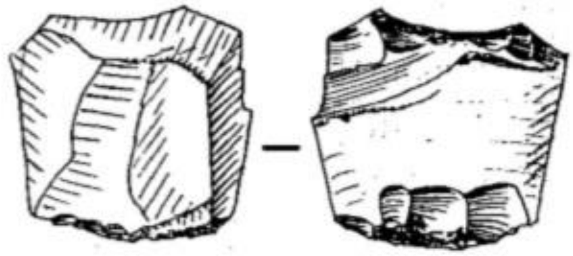
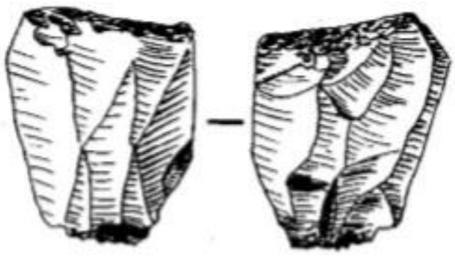
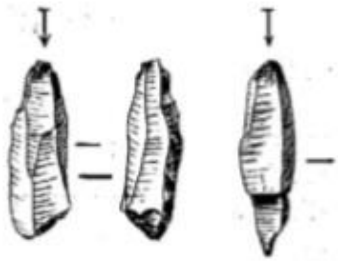
Phase	Image	Description
1		Splintering at the edges, without invasive removals. Back and front intact for the most part.
2		Indistinguishable front and back
3		Core is fragmented into numerous pieces, with a triangular or quadrangular cross-section, always without a butt

Fig. 4.11: Three phases of bipolar cores (after Peña 2011: 80). [Translated by author].

4.3.2 Products

A number of characteristics for identifying bipolar removals have been set out by Peña (2015b). These include:

- A wide variety of removal forms are obtained – flakes, bladelets, and chunks[7]. Chips are also produced during reduction.

  Bladelet = lithic artefacts with one ventral face, dimensions where length ≤ width x 2. The derivation ‘bladelet’ is subjective, and is

[7] These were not defined by Peña in the article. Standard definitions are provided.

established in relation to the encompassing lithic tradition (Inizan *et al*. 1999: 130, 131). It is possible that the association of bipolar reduction with small resources has led to an inference that bladelet, rather than blade, is appropriate.

Chip = lithic artefacts with greatest dimension ≤ 10mm (Ballin 2017: 17).

Chunk = indeterminate pieces, not identifiable as a core or a blade/flake, due to irregular breaks, frost-shattering, or fire-crazing. Chunks tend to be identified as larger indeterminate pieces (Ballin 2017: 17).

Flake = lithic artefacts with one ventral face, dimensions where length > width x 2, and greatest dimension > 10mm (Ballin 2017: 17).

- They display broken or linear butts. The dorsal surface displays fissures.
- There is no distinguishable impact point.
- The compression waves on the ventral surface are very distinct and close to one another. Drift (2012a: 11) expands on this aspect, stating that the waves cover the full extent of the ventral surface.
- The removals tend to have a rectilinear profile. This depends on the morphology of the core, so can vary.
- A pronounced hinge bulb is a distinctive feature – though not always present.

Flakes that result from 'cobble-slicing' or 'pebble decapitation' will display a distinctive curved ventral face. The curve can occur on the horizontal or vertical axis, depending on the form of the resource and how it is placed on the anvil.

The identification of a 'platform' on bipolar debitage products is somewhat spurious (Ballin 2021: 7). Bipolar reduction does not involve the creation of a platform to effect removals from. An alternative to 'platform' for bipolar pieces is suggested as 'striking zone'[8].

There is an association of crushed terminations with bipolar reduction. However, the various non-axial arrangements laid out above, allow for other termination types to be present.

[8] The reference (Ballin 2021: 7) that caused this view came out after the analysis was completed. As such, in the analysis and database, 'platform' is used.

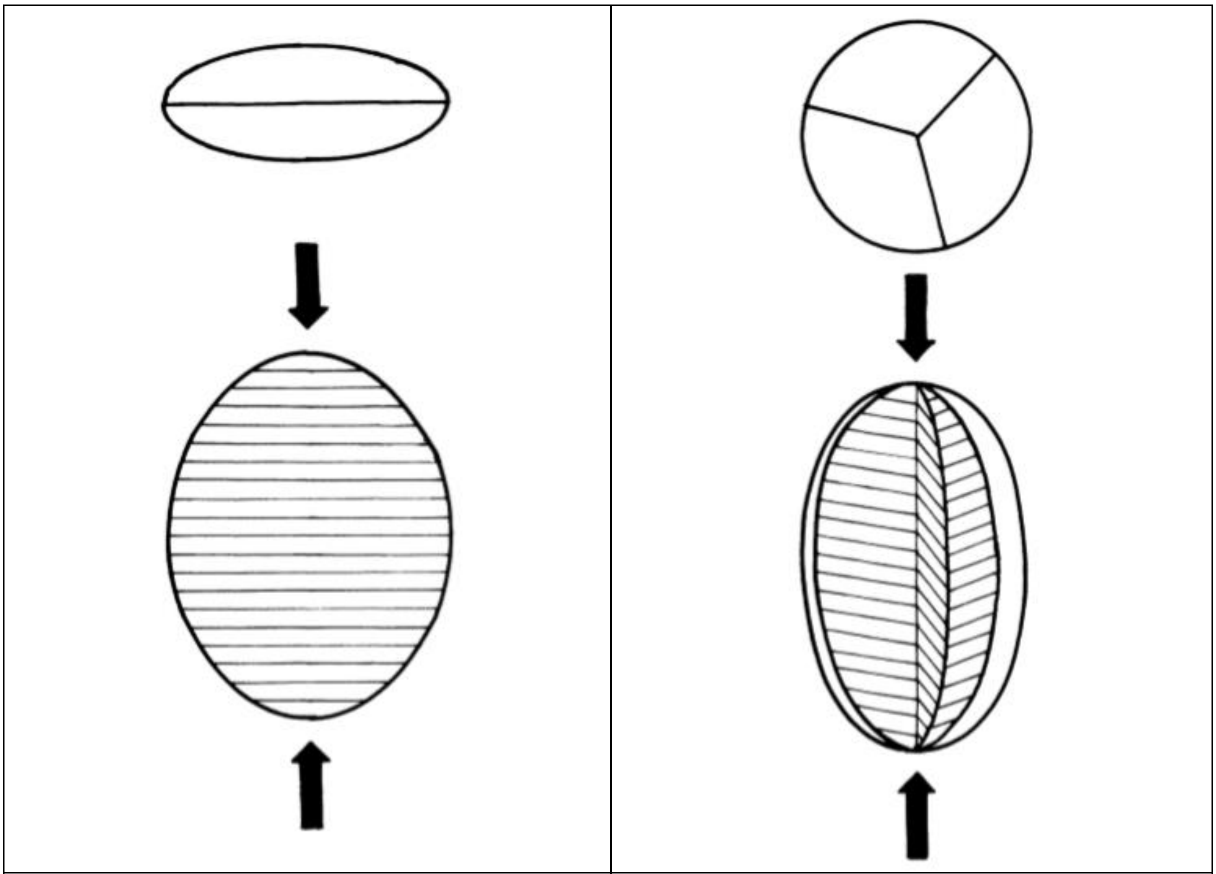
4.3.3 Split Pebbles

The term 'split pebble', falling under the scope of axial bipolar, is seen as a sub-division of bipolar cores. It implies the creation of two lithics from a single pebble (**Fig. 4.12**: A), though it can be the case that more pieces are created (**Fig. 4.12**: B). If the split is generated without fault or difficulty, there is little to no waste produced and no core generated. Given this, the classification 'bipolar debitage' may be a hindrance. Conceptually, it may be better to classify split pebbles and segmented pieces (see below) as 'bipolar façonnage'. This has been noted previously (Peña 2011: 80) – though more in relation to wedges (*pièces esquillées*) and bruised blades (*pièces machurées*). This negates the need for the core/removal dichotomy, as façonnage refers to the shaping of raw materials to a form (Woodman *et al*. 2006: 79, 80). There are concerns regarding the methodological ability to separate debitage and façonnage due to their interconnectedness and superimposition, especially where retouching takes place (Grimaldi *et al*. 2020).

These have been posited as early-stage bipolar cores (Ballin 2021: 15) – as described above. This may be possible. An alternative understanding to their position as a core is laid out below (see **Chapter 4.3.3.1**).

In practice, it is difficult to say if a piece is truly a split pebble. The possibility that it represents an 'opening flake' or the first in a series of 'pebble slices' will always remain – though the presence/absence of a mirror-symmetric curve may help in deciding. Only if refitting halves or quarters were recovered, could this be established with confidence. Axial bipolar working is mostly associated with the production of split pebbles. However, another piece – popularly called a segment– is also the result of this form of working (**Fig. 4.12**: B). In this case, the lithic being struck is more egg-shaped, than flat (Cotterell, Kamminga 1987,: 699, 700).

Other views on split pebbles have been espoused. Ballin (2021: 15) equates this classification to that of 'tested pebble', wherein they have less than three flakes removed. This understanding is not adopted here. If a resource is thought to be tested, its classification is left at that. Given the identifiable and independent classification of split pebble, the conflation is inappropriate. The suggestion that they can be created by freehand reduction is also made, though not evidenced nor supported (*ibid*.: 4, 15). No other references to their production using freehand methods have been found, so it remains to be validated.



A) Flattish Pebble | B) Egg-shaped Pebble

Fig. 4.12: Idealised axial compression fracturing of pebbles (from Cotterell, Kamminga 1987: 699).

4.3.3.1 Segmented Pieces

This debitage type has been identified throughout the literature (Peña, Wadley 2014; Knarrström 2001). They are discussed here as a sub-classification of split pebbles, though they may not strictly be so. The form can vary somewhat, but typically has two faces which meet on one side with a sharp edge (**Fig. 4.13**). The opposing side is thicker, giving the segment-like appearance. This thick edge can be corticated if reduced from a split pebble.

These are identified in the literature as: radially split pieces (Driscoll 2010); segment knives (Knarrström 2001: 108); nodule-quartering (Knutsson 1988: 39); orange segment (Woodman *et al*. 2006: 81; Knutsson 1988: 39); ridged splinter[9] (Zvelebil *et al*. 1987: 32). The description of a central arris between two faces also draws comparison with convergent flakes (McCall 2019) – though these are attributed to freehand reduction.

[9] This is possible – the description offered appears very similar: "a piece with primary cortex on one side opposite one or more ridges. Triangular or quadrangular cross-section. Dorsal crushing on many items" (Zvelebil *et al*. 1987: 32). It may also describe third-phase bipolar cores (see **Chapter 4.3.1**).

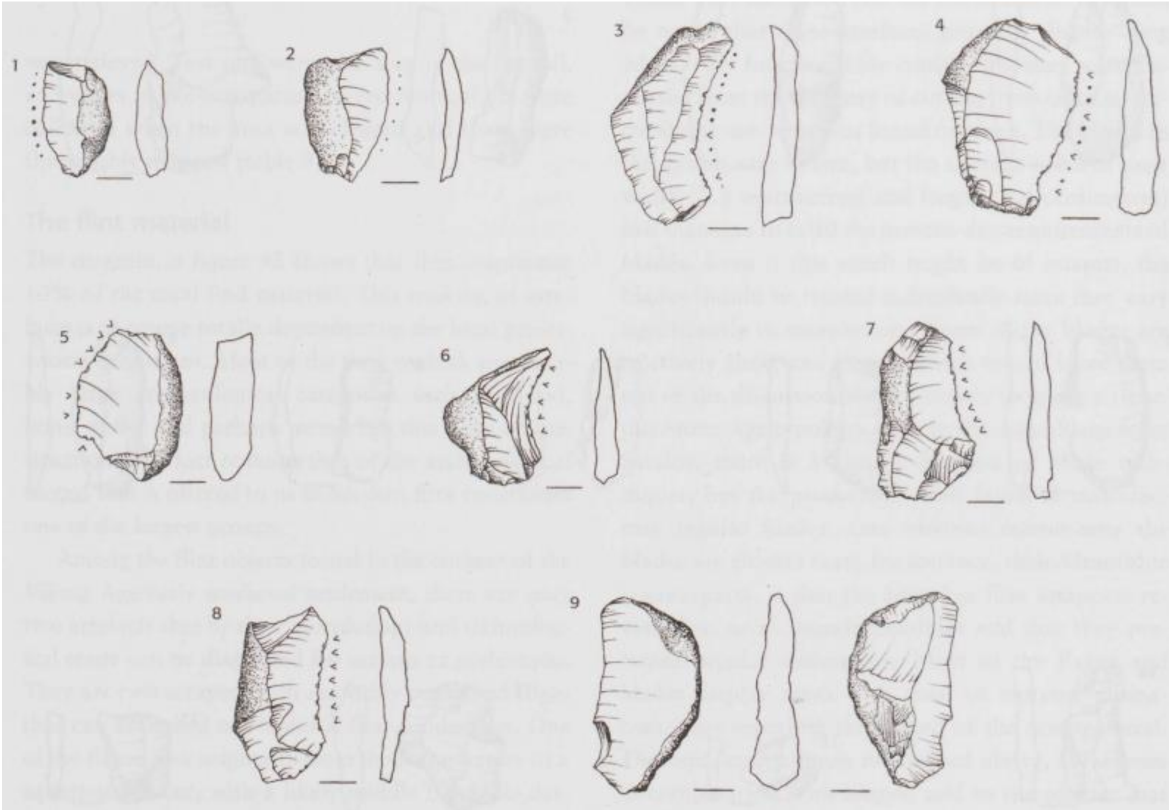


Fig. 4.13: Selection of segment knives from an excavated late Viking Age / early Middle Ages farmstead at Särslöv, Dagstorp, Sweden. Scale 1:2 (from Knarrström 2001: 108).

Knarrström (2001: 108) has suggested a strategy for their production. The first step involves the production of a split pebble half, which is then further reduced into segments (**Fig. 4.14**). In this fashion, the split pebble half becomes a core, and the segments are products – framing them in the traditional debitage dichotomy.

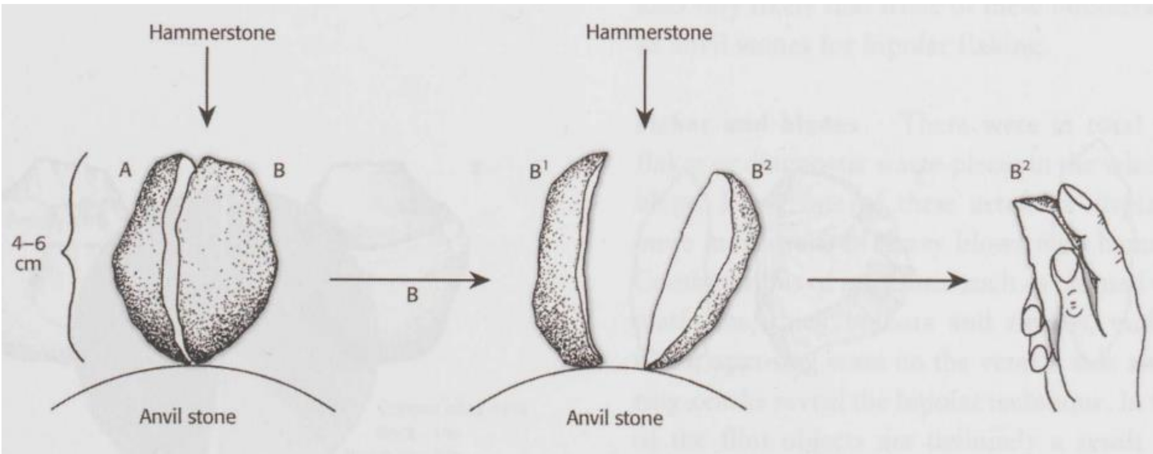


Fig. 4.14: Production strategy for segments – a flint pebble is split in two pieces, A and B; half B is then split into segments B1, B2, …..; which are then used (from Knarrström 2001: 108).

4.3.4 Wedges

No discussion on bipolar cores is complete without some consideration of wedges. This is an area that has caused a good deal of consternation amongst analysts. Known by several terms – intermediate pieces, splintered pieces, *pièces esquillées* – there has been much discussion as to the actual nature of these artefacts and their identification (Peña 2015b; 2011; Hayden 1980). In much of the literature, these items and cores are viewed as synonymous; an erroneous viewpoint which has led to a high degree of misunderstanding (Hayden 1980: 2).

Upon initial examination, wedges and cores are very similar, morphologically speaking. However, recent research, taking a closer look at these items, has identified a number of characterising differences (Peña 2015b; 2011). These variations in form are a result of the interaction on differing materials and surfaces. Wedges are viewed as being used to work materials such as bone, wood, or horn (**Fig. 4.15**). The interaction between the base of a core, a passive edge, on a stone anvil is different to that of the wedge base, an active edge, on the worked material.

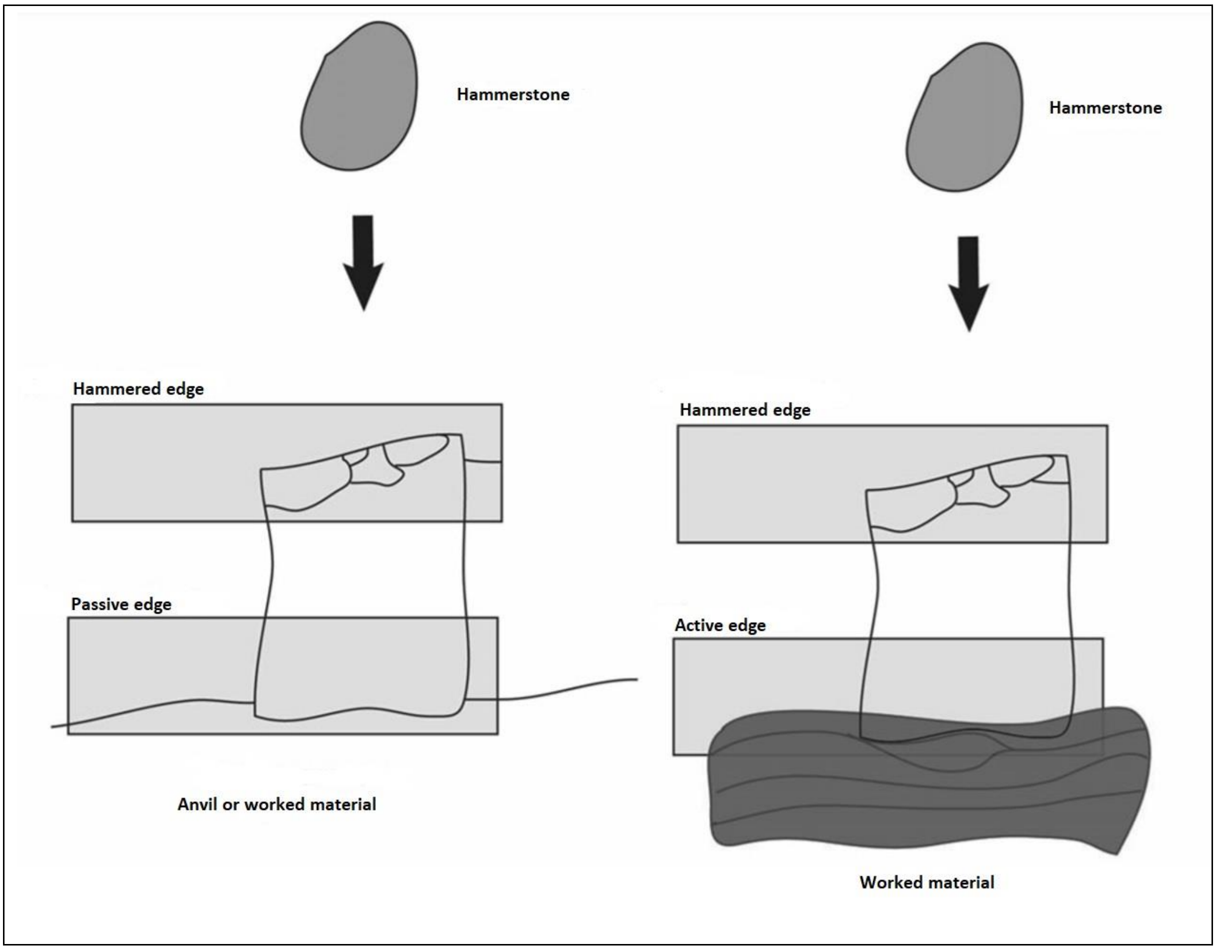


Fig. 4.15: Comparative operational schema of bipolar cores versus wedges (after Peña 2011: 82). [Translated by author].

Characteristics for identifying wedges have been set out by Peña (2015b). The material being worked influences the development of these, so there is a great degree of variability. Characteristic markers include:

- The hammered edge produces impact scars identical to those on the hammered edge of bipolar cores.
- The active edge does not display the same degree of impact scarring as the passive edge on bipolar cores. The variability in scar size and distribution was much lesser; impact scars tended to be smaller and more dispersed. In some instances, they could be absent altogether.

4.4 Bipolar Tool-kit

The tool-kit for bipolar reduction includes a hammerstone and anvilstone. These items have been subject to a degree of research, looking variably at form and signs of working. Some discussion has taken place on how differences in the tool-kit would affect the products of bipolar reduction, though this is not as well established as for freehand reduction (see Andrefsky 2005: 118-120). Additionally, there is a brief discussion on the use of wrapping in bipolar reduction. Archaeologically invisible and unsupported by experimental work, this is a topic of some potential relevance.

4.4.1 Anvilstone

Recent researches have examined the anvilstones involved in bipolar knapping to a greater degree. These have discussed classification of anvils and markings left subsequent to working. The study of anvilstones within the bipolar world is complicated by the fact that, in many cases, these items may not have been used solely for knapping, but also for various other percussion activities which have not been recognised (Torre *et al*. 2013). Anvilstones permitted a number of changes to freehand knapping strategies, primarily the use of smaller hammerstones and slower striking speeds, due to the effect of dual forces acting on the raw material (Drift 2009: 5).

Early on, Kobayashi (1975) did make notes regarding the morphology and use of anvilstones, but did not describe the markings left behind. Kobayashi found that flat surfaces were better to use rather than convex, and that the thicker the block the better. This was due to the fact that more convex surfaces seemed to produce more shattering at the distal end of a core (*ibid*.: 116). However, this view is contradicted by the study carried out by Maffezzoli *et al*. (2015). Through their experimental work, they concluded that convex anvils were more efficient. This is a result of the core being compressed between two smaller areas and that the rebounding shockwaves through the anvilstone are more concentrated.

Torre *et al*. (2013) conducted a comprehensive review of markings created by several activities carried out using anvilstones. While they were able to establish a number of characteristics, they warned that any interpretation could be impaired due to multiplicity of activities and by the original condition of the stone (*ibid*.: 331). The percussion activities carried out by the experimenters included bipolar knapping, meat tenderising, bone breaking, nut cracking and plant processing. These activities were found to leave characteristic markings in many cases (**Figs. 4.16**; **4.17**), with a variance in their location and intensity relating to the activity (*ibid*.: 323). Curiously, bipolar knapping seemed to produce less of an effect on the anvilstone than some of the other activities. While significant damage was done, it was confined to a central area and resulted in heavy pitting and crushing; where greater damage is identified it is in the complete fracturing of the anvilstone in two (*ibid*.). Activities such as bone breaking, meat pounding and plant processing, were shown to fragment anvils to varying degrees (*ibid*.: 318, 323). This has implications for the identification and interpretation of ground lithic tools and associated activities on sites.

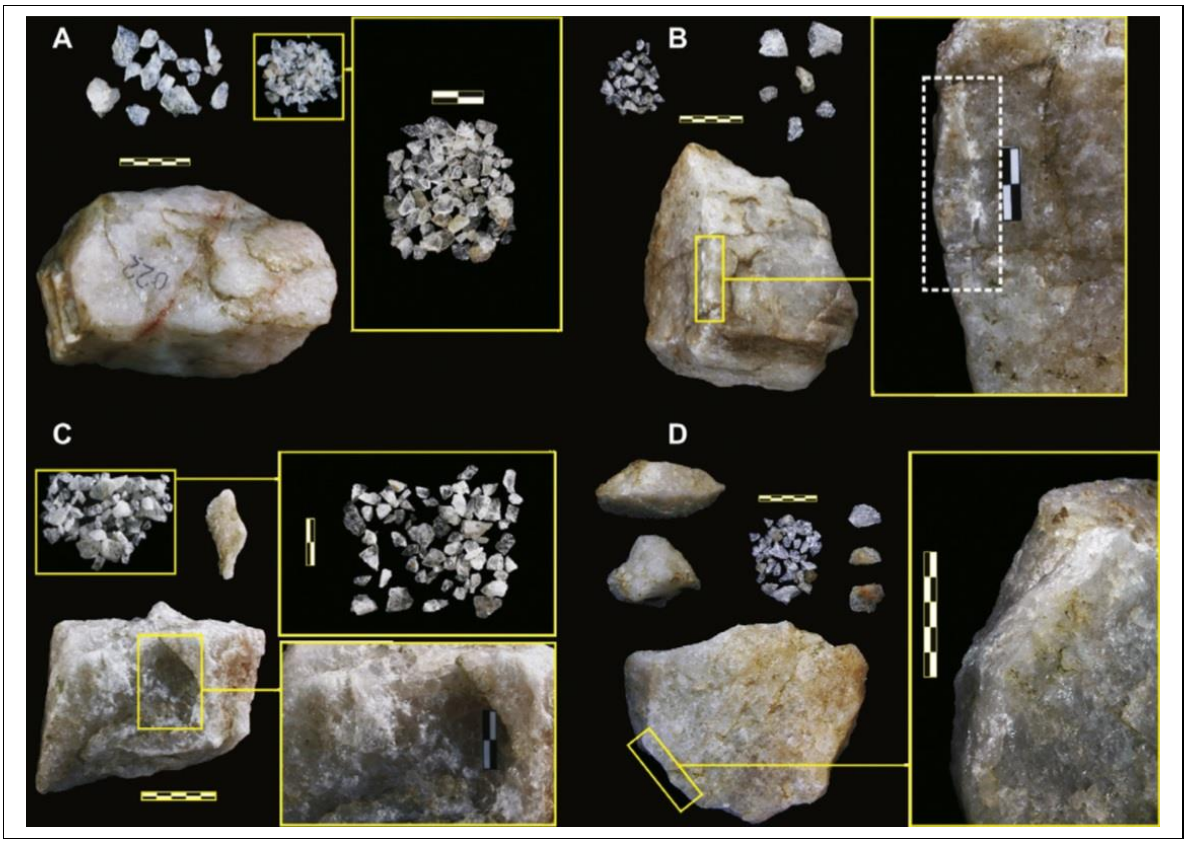


Fig. 4.16: A) Anvil and fragments produced during bone breaking and dismembering; B) Anvil and fragments produced during meat-pounding activities; C) Anvil and fragments produced during plant processing; D) Anvil and fragments produced during bone-breaking (from Torre *et al.* 2013: 318).

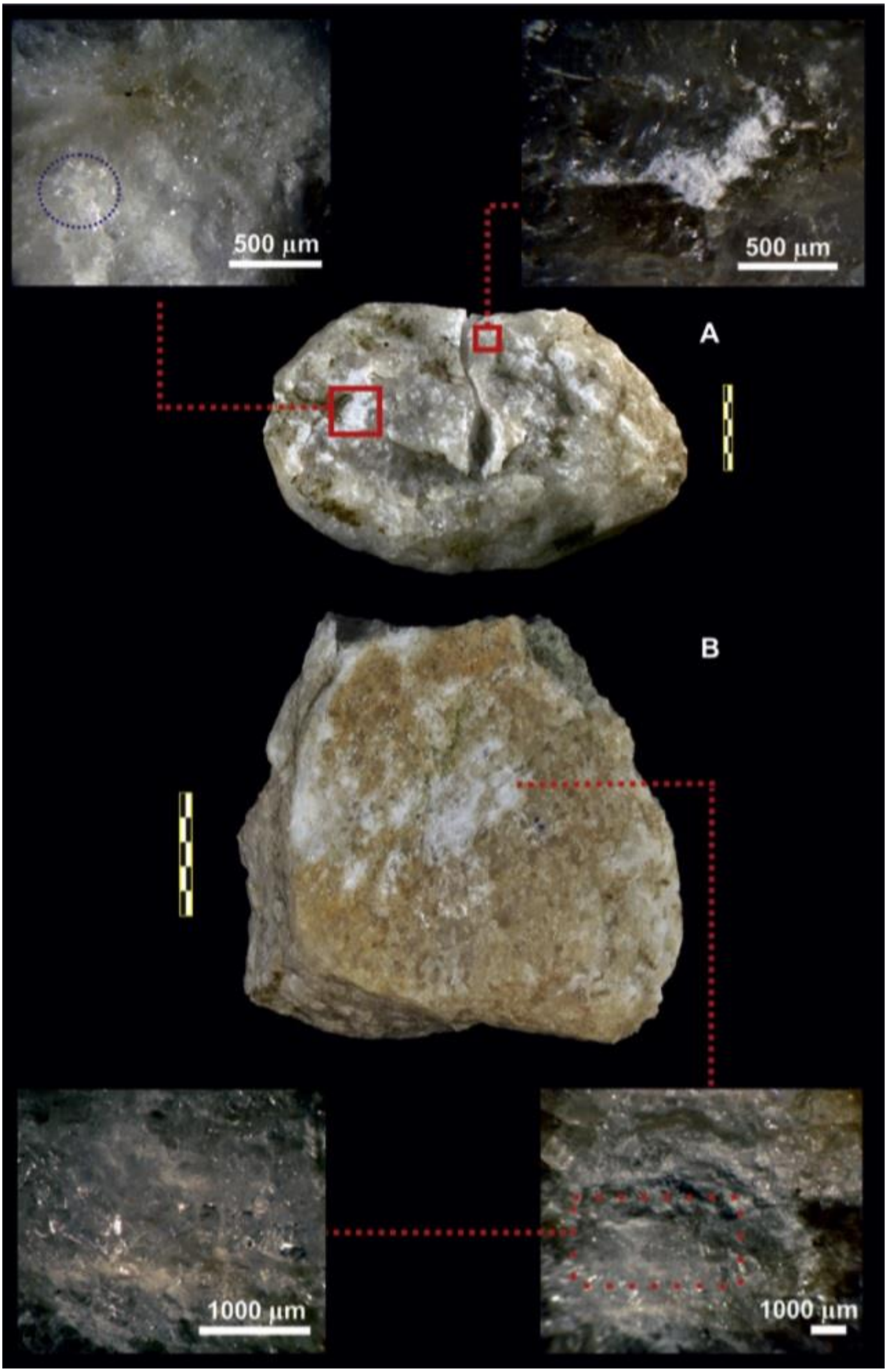


Fig. 4.17: A, B) Use-wear marks produced during bipolar knapping (from Torre *et al.* 2013: 322).

Size and shape do not appear to be relevant factors in the determining of anvilstones. From their review of anvilstones, Mora and Torre (2005) roughly classify anvilstones into two categories: 1) static; and 2) mobile. The static anvils were much larger pieces, weighing over 10kg, and in one instance over 20kg. Due to the difficulty of moving such heavy items, they are viewed as being essentially static. Mobile anvilstones are naturally much smaller in form. Those examined by Mora and Torre weighed between 555g and 733g, allowing them to be easily transported (*ibid*.: 185). While size may not aid in the identification of anvilstones, it could prove a useful factor in interpreting the knapping practices of a site, or of a region. Goren-Inbar *et al*. (2015) categorise two types of anvilstones: 1) large blocks with a flat base, often pyramidal in form; and 2) small blocks of varying form – which supports Mora and Torre (2005). The authors note the localised nature of anvilstones and caution against wide-cast standards (Goren-Inbar *et al*. 2015: 2). This has implications for any analysis carried out on purported anvilstones – as national, regional, and geological parameters will have to be established. However, Low passes some interesting comments about the impact of anvilstone size in bipolar reduction. From his experiments, he established that the anvilstone stores a certain amount of energy before rebounding it back to the core, much the same as Maffezzoli *et al*. (2015) concluded. This rebounded energy is proportional to the size of the anvilstone. As a result, the larger an anvilstone is, the less downward force is needed to effect a removal (Low 1997: 259, 260). This leads Low to conclude that larger anvilstones allow a greater amount of control during bipolar reduction, in the same vein as Kobayashi (1975).

A number of other possible anvil types have been suggested. As previously mentioned, Drift (2012) considers the ground to be a potential anvil. The use of soft ground as an anvil is identified in a bipolar-reduced, basalt core from Dmanisi, Georgia (*ibid*.: 162) – though gives no indication as to the research defining as much. The removals were noted as leaving deep scars on the core. The use of the ground as an anvil would seem to negate the effect of rebounding energy (Maffezzoli *et al*. 2015; Low 1997), as a result of a far greater object absorbing all impact. The deep scars that are seen may be due to the use of the ground, as opposed to an individual stone, being used. This could provide an interesting experimental comparative project. Low (1997: 12) similarly asserts the use of the ground as an anvil, amongst others. Also listed as potential anvils are large bones, hardwood blocks, a padded thigh, and the palm. The first two options could be viable, if thicker cores or split pebbles are considered. Although, the fact that wedges are viewed as a tool to split such materials (Peña

2011) raises some doubt. Bipolar cores that have a thinner profile could end up splitting or wedging into such anvils. Regarding the latter two, this author finds it highly unlikely that anyone would strike down on a part of their own body with the necessary force to remove a desirable piece of debitage. If sufficient padding is used to completely eliminate any impact shock, it would likely end up cushioning the core and possibly not result in a bipolar removal.

4.4.2 Hammerstone

Studies that have examined the effects of differing hammerstones in bipolar reduction are few and far between. While the virtues of soft and hard hammers, punches and billets and the resulting variation in their impacts has been well understood for direct and indirect freehand percussion (Kooyman 2000: 79; Inizan *et al*. 1999: 30-32), the effects of differing hammerstones in the hammer-and-anvil world are less identified. Kobayashi (1975: 116) states the size and weight of a hammerstone affects the dimensions of the removals – with a light-weight hammer resulting in smaller, thinner flakes. Also, it is declared that a hammerstone with a straight-edge and a U-shaped cross-section is the most appropriate. In a belated follow-up to Kobayashi, Faivre *et al*. (2010) examined the effects of hammerstones in more detail. They note that there is little difference in the characteristics created on removals by a straight or convex striking edge (**Table 4.2**) (*ibid*.: 139).

<table>
<tr><th>Type of percussion</th><th>Type of striking edge</th><th>Characteristics on the face of the removal</th></tr>
<tr><td rowspan="2">Percussion direct,
vertical
hard striker,
on a nodule on an anvil</td><td>Convex</td><td>Signs of distal support, axial or non-axial, by a double or single bulb at the point of impact or support, or by the mixed presence of a bulb and a contra-bulb, which can be at the point of impact or support

Crushing at the points of impact or support
Detachment of parasitic removals</td></tr>
<tr><td>Straight</td><td>Absence of bulb at the point of impact
Signs of distal support , axial or non-axial, by the presence of a bulb or contra-bulb at the point of support

Crushing on impact line
Detachment of parasitic removals</td></tr>
</table>

Table 4.2: Resulting differences in bipolar flaked pieces using a convex and a straight hammerstone edge (from Faivre *et al.* 2010: 138). [Translated by author].

Some researchers have gone so far as to consider how a hammerstone is gripped and the effects it has. In their comparison of freehand lithic-flaking and nut-cracking using a hammerstone and anvilstone, Bril *et al*. (2015) recorded the grips used by the experimenters. They identified six grip types, which could be sorted into two categories: power grip (spherical power grip; cylinder grip); and precision grip (three-jaw-chuck grip; baseball grip; buttressed-pad grip; and delicate-precision grip) (**Fig. 4.18**). From the nut-cracking, it was observed that the spherical power grip was used predominantly, with the baseball grip being second-most popular (*ibid*., 6). This offers an interesting comparison to bipolar flaking with the fact that a core – small or large – may have needed to be steadied with the other hand. Of the three participants who held the nut while striking, two used a baseball grip and the third a three-jaw-chuck (*ibid*.). This demonstrates a preference for precision over power, which runs counter to the uncontrolled – 'smash-it-and-see' (Sternke 2010b: clvii; cf. Sternke 2009a: 5; O'Hare 2005) or "bashing or splintering, on a hard surface/anvil" (Nelis 2009a) – thinking surrounding the bipolar industry in Ireland. This argument is buttressed by Low's experimental work. Forceful blows were found only to be effective when reducing large cobbles. A much more controlled approach was required when working with small pebbles (Low 1997: 259); which is seen as the primary raw material in Ireland (Woodman, Scannell 1993: 61; Green, Zvelebil 1990: 62; Peterson 1990: 92; Woodman 1984: 3, 6).

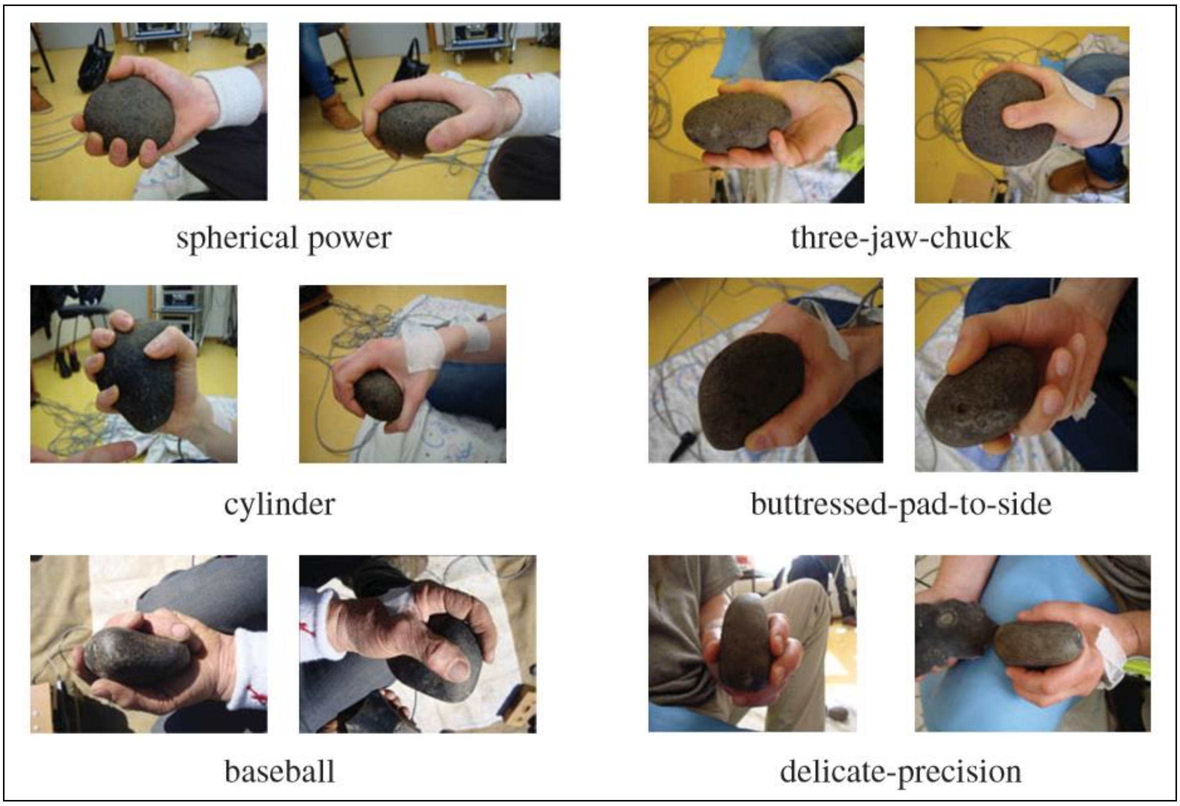


Fig. 4.18: Series of grip types used during experimental knapping (from Bril *et al.* 2015).

However, Mora and Torre (2005) threw something of a curveball as regards hammerstones in their paper surmising percussion tools from Tanzania. They doubt the use of completely spheroid hammerstones, where they are the result of anthropological shaping, as lithic knapping tools. The intense battering needed to produce such objects would not be characteristic of knapping (*ibid*.: 184). As a result, any object that has a spheroid shape that is due to human influence cannot simply be assumed to have had a role in knapping, and other possible functions must be examined.

4.4.3 Wrapping

One aspect of the bipolar knapping method that is mentioned on an infrequent basis is the role of wrapping. In their paper detailing their experimental study of bipolar knapping, Duke and Pargeter (2015) discuss some of the ethnographic evidence. They refer to the Duna of the Papua New-Guinea highlands, who have a tendency to wrap the cores being worked in bark. Here, the bark wrapping is used to restrict debris scatter and to aid in the production of more standardised flakes (*ibid*.: 351). This may be the same ethnographic evidence referred to by Deacon (1984: 103). She states that knappers in New Guinea bind a bipolar core in fibre and then strike it. The view that this produces bladelets and flakes of a longer and thinner morphology than those produced from hand-held bladelet cores is put forward. While the use of bark is attested to, hide or leather may also have been used to the same end. Archaeologically invisible, these elements may have formed part of the bipolar knappers' tool-kit, though it is impossible to say with any certainty. Knight (1991: 58) mentions the lack of evidence for this aspect from other contemporary cultures. He goes on to say that wrapping in conjunction with finger pressure may result in longer pieces being removed, providing no evidence or reference to support this assertion. However, in a reply to an early article on bipolar reduction, Sollberger and Patterson (1977) question the role of wrapping. They contend that wrapping shows a frugality towards knapping, as it is a means of containing the flake scatters; although it has no effect on the knapping process as it cannot direct impact forces due to its soft nature (*ibid*.: 26).

4.5 Bias

In several papers it is possible to see a bias against bipolar reduction being held up, and this is not restricted to older publications. This comes across in manipulation of data, parameters set for studies and the language used.

A study conducted by Morgan *et al*. (2015) to establish the flaking efficiency of bipolar versus freehand concluded that the latter was more efficient at reducing small pebbles (*ibid*.: 137). But, their methodology contained an extreme flaw that creates this false impression of bipolar reduction. One of the questions posed by the researchers was: "Is bipolar percussion more efficient than freehand percussion on small cores?". In order to answer this, the researchers recorded the attempts of four knappers – two novice; two expert – to split ten small pebbles by bipolar reduction and ten through freehand. When the data was gathered all knappers had successfully reduced all ten pebbles using a hammerstone and anvilstone. Conversely, with the freehand experiment, only one expert knapper successfully reduced all ten pebbles. One novice produced nothing; and the other two flaked only two or three pebbles of the ten. Inexplicably, the researchers chose to dismiss the data of the three who had produced little or no freehand debitage. Instead, they used only the datasets from the one expert knapper who successfully reduced all twenty pebbles. There is no reason given for not using the data for all four knappers. This individual managed to exact more usable material from the pebble through the freehand than the bipolar technique, which led the authors to assert that bipolar reduction should not be carried out under circumstances of raw material constraints, in either quantity or quality (*ibid*.). The researchers appear to have failed to recognise that on the scale of efficiency, not being able to produce any results is 100% inefficient. If the dataset was rightly adjusted to include figures from all four knappers the conclusion would be very much the opposite. Indeed, the actions carried out in this study raise similar concerns as identified in Irish lithic analyses (see **Chapter 3**). The alteration of the datasets as done by Morgan *et al*. is a concern highlighted in the NAS report (Randall, Welser 2018: 17, 18) on the reproducibility crisis in modern science.

One experimental study carried out by Diez-Martín *et al*. (2011) compared bipolar and freehand knapping of Naibor Soit quartz from Olduvai Gorge, Tanzania. One of the findings of the research was that bipolar reduction was wasteful of raw material. However, as one looks at the data presented to back up this assertion, doubts begin to arise. The researchers define shatter as any piece of debitage ≤ 25mm (*ibid*.: 693). This figure is questionable because other researchers have highlighted the possibility of producing minute cores through bipolar reduction. Hiscock (2015a: 3) refers to dimensions of complete bipolar cores as reaching sizes less than 10mm in length and 5mm in width, though tempers these figures by giving averages of 10-30mm length and 6-25mm width. While these are a general summary of sizes, the numbers given place a significant amount of material within the waste category as defined by the study. This is compounded by the fact that authors present no dimensions for archaeological material coming from the Olduvai Gorge. Reading the paper, it is unknown as to whether bipolar cores, and thus removals, from archaeological contexts are smaller than 25mm. There are no reasons given for this size definition, and the arbitrariness of this figure is admitted in another publication (Eren *et al*. 2013: 250). While this may seem like a small issue, it does have serious implications when placing interpretations on societies that implement bipolar reduction strategies. It displays their choice of technique as wasteful and uninformed, when it may have been functional and efficient, and entirely appropriate.

The language used in relation to bipolar reduction can be negative and dismissive. Discussion of material is often couched in terms of decline and degeneration, mainly through a comparison of either contemporaneous or preceding freehand material. This could be seen as the result of qualifying quality in terms of aesthetic values. In his discussion of lithic technology and efficiency, Jeske (1992) dismisses bladelets – and a couple of other artefact types – produced through bipolar reduction as being 'pseudo' in nature. His qualification of 'real' bladelets goes beyond the standard morphological description of them being twice as long as they are wide (Ballin 2017: 17; Inizan *et al*. 1999: 34, 71, 130, 131). He further restricts bladelets to being flaked from a pre-shaped pyramidal or prismatic core (Jeske 1992: 472). In this vein, it could be proposed that flakes produced by bipolar reduction are 'pseudoflakes' because they were not struck from a platform core. While Jeskes' restriction may be valid when discussing the technological aspects of assemblages at a broader level, to apply it to artefact-level interpretations and discussions seems inappropriate as it would be impossible to provide consistent, uniform and usable definitions across all types of artefacts and methods of production.

O'Hare (2012) also uses the term 'pseudo' – in relation to flakes from Irish assemblages. Throughout her analysis of lithics from the Corrstown assemblage, O'Hare (2012: 159, 161, 162, 165, 166) refers to 'pseudo-struck' material. Her definition of 'pseudo-struck' flakes is "flakes which have platform-struck attributes but which are technically unintentional product of bipolar reduction" (*ibid*.: 159). On reading this sentence, two things stand out. Firstly, it could be that O'Hare is referring to non-axial bipolar material (see above) in this instance. Secondly, the use of the word 'unintentional'. In this case, if the analyst believes that the material is not being produced with intention, then surely it should fall into the 'debitage'/'debris'/'waste' category, on account of it being an incidental by-product. Furthermore, the sentiments displayed are dismissive of bipolar technology to be able to produce material beyond irregular, random 'smash-it-and-see' removals.

The inappropriate use of the prefix is underpinned by Drift. In his discussion of the identification of conchoidal and non-conchoidal knapped material, Drift uses the term 'pseudo-artefact' to describe non-conchoidal material that is natural, i.e.: objects that form a typologically incorrect group with high natural fracture incidence (Drift 2012a: 9; 2010). This is a long-recognised complication in identifying bipolar reduction (Ballin 1999: 18, 19). The use of pseudo in relation to accidentally produced items has been applied by other researchers. Driscoll *et al*. (2015) use it to describe quartz flakes that were produced by trampling underfoot rather than by knapping. They highlight the fact that "pseudo-complete flakes" were produced by sequential breaks caused by crushing and that the pseudo-artefacts exhibited platforms and low edge-angles, which could allow for them to be mistaken for a true artefact (*ibid*.: 142). As a consequence, the association of 'pseudo' with intentionally produced bipolar material simply muddies the waters and does not aid in the understanding of the technique.

4.6 Sorting bipolar-reduced material

Given the occurrence of non-conchoidal reduction markers on pieces that have been created by design and on pieces created by accident, the identification of archaeologically-relevant material becomes a concern. Drift (2012a) addresses this issue. He reflects on the standard approach (**Fig. 4.19**: A) used by archaeologists and lithic analysts to identify lithic assemblages and refines it (**Fig. 4.19**: B). This allows for better identification of bipolar debitage, primarily during field collection.

By following Algorithm A, non-conchoidal material can be overlooked in favour of the more recognisable conchoidal pieces. This results in a loss of material from the site assemblage and the overall archaeological record. With Algorithm B, the incorporation of bipolar material becomes more standard.

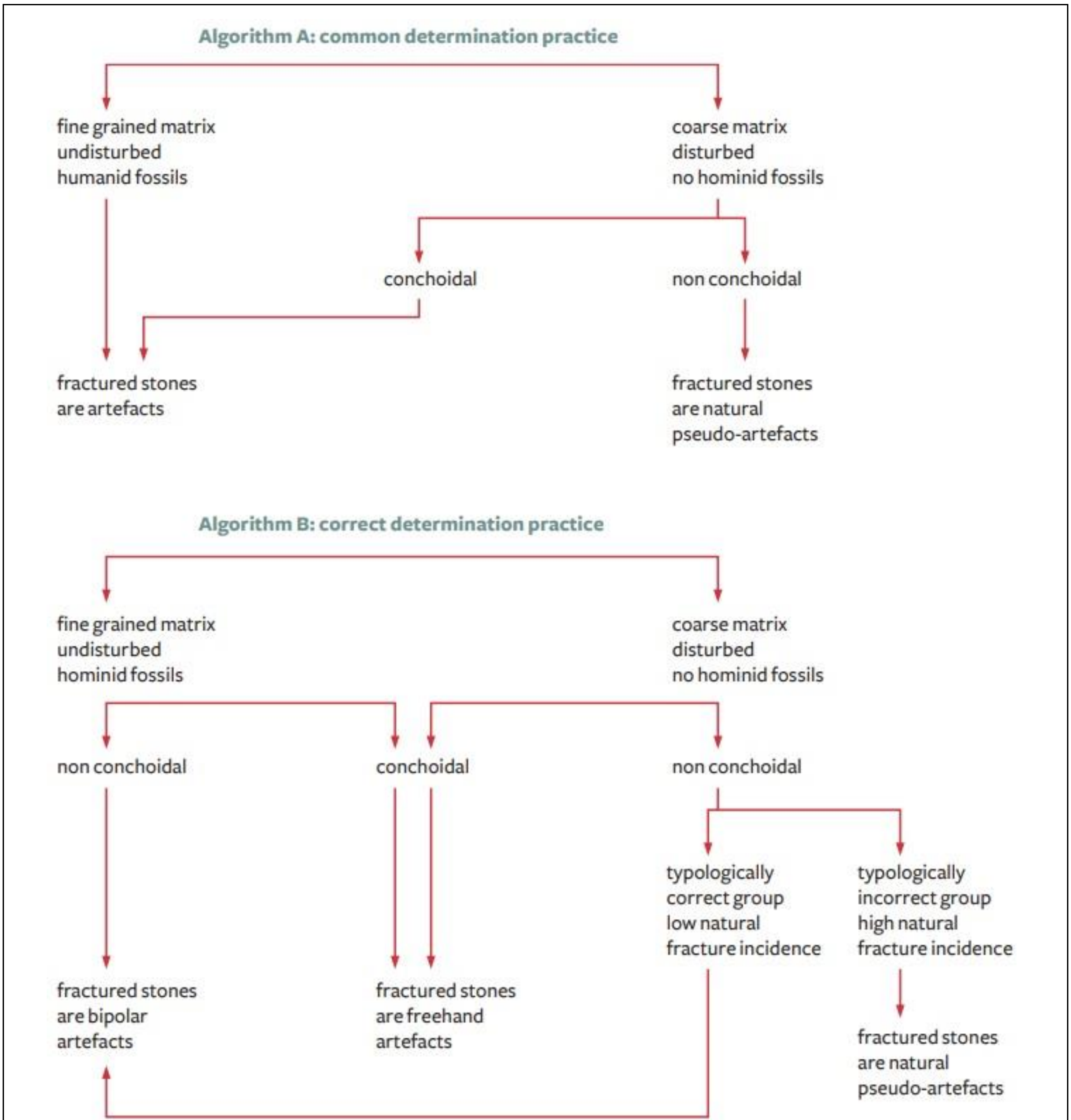


Fig. 4.19: algorithms for determining intentional bipolar reduction (from Drift 2012a: 9).

4.7 Conclusion

This chapter presented a review of literature on bipolar reduction, working towards a guide to identification for analysts. The review followed a particular view of bipolar reduction – based on axial and non-axial, which has been set out by a number of analysts. There are other schema regarding bipolar material. The insular Irish one is reflected on in **Chapter 3**, and played no role here. Other bipolar schemes present in Ireland and Britain, and further afield, did not play a part in the synthesis (Driscoll 2010; Ballin 1999). For those reading up on bipolar reduction, they offer interesting comparatives – exclusion here is not a comment on their validity. Nor even is the critique in **Chapter Three** a disallowance of validity – it is simply the case that they are not understandable nor reproducible. The more extensive library of works by Peña (2015a; 2015b; 2011), Drift (2012a; 2010; 2009), Hiscock (2015a; 2015b), and others **–** incorporating experimental work, visual representations, archaeological evidence, tool-kit aspects – which could be inter-linked and reproduced, was preferred.

Bipolar reduction is present throughout the archaeological record, both in time and space. The historic lack of recognition has undermined understandings of lithic traditions. Newer research has done much to challenge this over-sight. The technique itself is much more refined than previously considered. Its implementation indicates less a lack of skill, and more a responsive process to raw materials and social requirements.

A major challenge to this appreciation was the dispersal of specified literature. This is mainly of concern to lithic analysts. But this feeds into general archaeologists who commission reports or read theses. When combined, it presents a robust and universal understanding of the technique, that is readily applicable to all relevant assemblages and analyses.

5. Methodology

5.1 Introduction

The methodology was established early in the programme of research. It reflects the initial aim – an analysis of a designated lithic assemblage, with the purpose of informing a discussion on the nature of lithic traditions on Chalcolithic and Bronze Age domestic sites. It provided a base for some of the reading presented above. Due to issues flagged in **Chapters 2**, **3**, and **4**, the focus of research shifted and the methodology was accordingly adapted.

In consequence, the methodology became more fluid than would normally occur. Topics not identified previously became central. Bipolar reduction became a key item. The dating of artefacts took on greater significance. These shifts in focus resulted in changes to the research questions and database. For example, an initial aim was to discuss artefacts in relation to their find context, but this aspect was dropped as greater importance was given to other areas of study.

5.2 Research Objectives

The objectives laid out here are the product of the fluid methodology. They were not all conceived of at the start of the research. Nor were all the starting objectives still retained.

1) Traditionally, the view that when metal became available to societies, lithic use disappeared. While this view has changed somewhat in recent decades, there is still a lack of clarity as to the occurrence and role of lithic objects in the first periods of metal use in Irish society. So what is the nature of lithics on Chalcolithic and Bronze Age sites? Typologies and reduction technologies will be identified. Settlements of the period are described as self-sufficient – evidence for this will be sought. The accepted narrative of decreasing presence through time has not been categorically established – evidence for this will be sought.

2) Moving into later prehistory, an amount of lithic material from prior societies will have accrued. This material is likely to present itself in contexts not associated with their

manufacture and use. This issue has been noted by analysts looking at later prehistoric assemblages. However, without a clear understanding of the nature of chipped and ground/coarse lithic assemblages in later prehistory it is difficult to say with confidence what material belongs to which period. The degree to which diagnostic Mesolithic and Neolithic chipped and ground lithic artefacts appear will be assessed to establish a rate of confirmed residuality. The possibilities considered here feed into discussions of 'heirlooms' and related curation aspects. Coarse lithic artefacts, e.g.: hammerstones, will not be included. Their form is not refined nor researched enough to allow for categorisation by period.

3) While there is a general consensus about the diminishing presence of chipped lithics, there has been less discussion regarding ground or coarse lithics. Certain items, such as saddle querns, are seen as typical of the Bronze Age. However, a discrepancy can be seen in the treatment of other ground and coarse lithic objects, where the terminology and discussion of them is much vaguer. Percussor artefacts – anvilstones and hammerstones – are the necessary tool-kit for bipolar reduction. Their presence, along with other ground/coarse lithic objects, can inform on skill, knowledge or traditions as much as chipped lithics. The ground/coarse lithics from selected contexts will be analysed for typology and use-wear. The identification of a bipolar tool-kit is the main goal.

5.3 Research Parameters

The research focused on lithic material recovered from domestic sites. 'Domestic' was taken as indicating occupation/habitation/activity of a lower-status quotidian nature. The domestic aspect was further refined by a structural presence, i.e.: the footprint of a building had to have been interpreted within the excavation plans. The identification of settlement/habitation/occupation/domicile/*etc*. within the archaeological record presents challenges, e.g.: identifying a structure or determining the nature of activity (see Cleary 2007a: 51-54; and Carlin 2018: 20, 45, 46 for discussion). This can be further complicated by the presence of burials on demonstrably domestic sites. It is nearly easier to define the research focus by what is excluded: burials, megalithic sites, high-status sites. High-status sites include crannógs and hillforts. These can have structural elements present, such as at Knocknashee hillfort, Co. Sligo (Brandherm *et al*. 2018), or Clonfinlough crannóg, Co. Offaly (Moloney *et al*. 1993). However, they are representative of a limited section of society – typically seen as higher status than enclosed or unenclosed roundhouses (O'Brien 2017).

Excavation reports were reviewed to select ones with lithic material retrieved from suitable contexts, i.e.: secure contexts associated with structural evidence dated to the Chalcolithic and Bronze Age. This further restricted research material to more recent excavations. These reports were more easily accessible through resources like heritagemaps.ie or Digital Repository Ireland, and by contacting excavating companies directly. Targeted contexts included structural and associated features, such as hearths, pits, or stake-holes. A minimum number of objects on a site was sought.

These parameters changed as it became difficult to identify and access suitable case studies. The structural aspect was loosened to include spreads or burnt mounds in some cases. It also meant any number of lithics was acceptable, resulting in the inclusion of sites with a research assemblage as little as one artefact. This was particular true of the Chalcolithic, where the record is very thin for clear settlement with structures.

5.3.1 Study Area

The study area was defined by the provincial boundaries of Leinster and Munster – with County Clare being excluded (**Fig. 5.1**). Several reasons were behind this selection:

- O'Hare's research (2005) covered the full extent of the island. Following on from this, it was deemed better to conduct research at a more focused level.
- The province of Ulster has a widespread occurrence of flint nodules, both in-situ and *remanié*. It was thought that this natural prevalence of material would produce a differing archaeological record to the southern provinces, where flint is a scarcer resource, thus muddying interpretations and understanding.
- The River Shannon was viewed as a natural geographic delimiter on the western edge of the study area, which led to County Clare being excluded.
- The fact that many major developments have occurred within these two provinces in the last two decades, has resulted in a greater assemblage of material from them.

- The practical reason of accessing material in a different jurisdiction was also considered regarding the exclusion of the Ulster province.

5.3.2 Case Studies

A total of 45 case studies were selected for analysis (see **Appendix 2**). The regional dispersal, while taken from Leinster and Munster, was heavily weighted towards the east coast (**Fig. 5.1**), with a bias along road corridors. The dispersal across archaeological periods was quite mixed (**Table 5.1**), though reflective of the levels of the appearance of each in the record.

- Chalcolithic (CL)

  The Chalcolithic was represented by three sites. Two of these were in County Louth, and one in County Meath.

- Early Bronze Age (EBA)

  The Early Bronze Age was represented by four sites. Two of these were in County Meath, one in County Kildare, and one in County Dublin. The site in County Dublin, Carrickmines Great 63M (Conboy 2006), is noteworthy due to the large volume of lithics recovered. The footprint of a structure was interpreted from the arrangement of pits and post-holes. The site does not appear to be one of habitation, but more of production. It was included due to its unique nature.

- Middle Bronze Age (MBA)

  The Middle Bronze Age was represented by nine sites. Counties Meath and Tipperary both had three sites. Counties Carlow, Louth and Wicklow had one site each.

- Late Bronze Age (LBA)

  The Late Bronze Age was represented by five sites. Two of these were in County Tipperary, one each in Counties Dublin, Offaly, and Westmeath.

- Iron Age (IA)

  The Iron Age was included mostly out of interest. Only one site was ultimately included, located in County Meath. While searching for suitable sites, several excavation reports for this period were found. In Britain, the use of lithics into the Iron Age has been established

(Humphrey 2004), and the possibility that lithic use extends into historic periods in Ireland has been considered (Warren, Little 2017). A cursory review of a select group of Iron Age sites was thought to provide a starting point for a greater project.

- Multi-period (M-P)

Twenty-three sites were grouped as multi-period. Six were located in County Meath, and four in County Cork. Counties Louth, Tipperary and Wicklow had three sites. Counties Dublin, Laois, Offaly and Westmeath had one site each.

	Period					
	CL	EBA	MBA	LBA	IA	M-P
Number	3	4	9	5	1	23
Total						45

Table 5.1: Number of case study sites by archaeological period.

Analysed artefacts were recovered from contexts within: foundation trenches; post-holes; pits; hearths. The latter contexts occurred both internally and externally to structure footprints. Artefacts from spreads and deposits were included later. It was intended to discuss the occurrence of artefacts in contexts. However, as the analysis proceeded, a need for more substantive research on bipolar reduction meant that it was not possible to develop this contextual approach. This is a key requirement for future research.

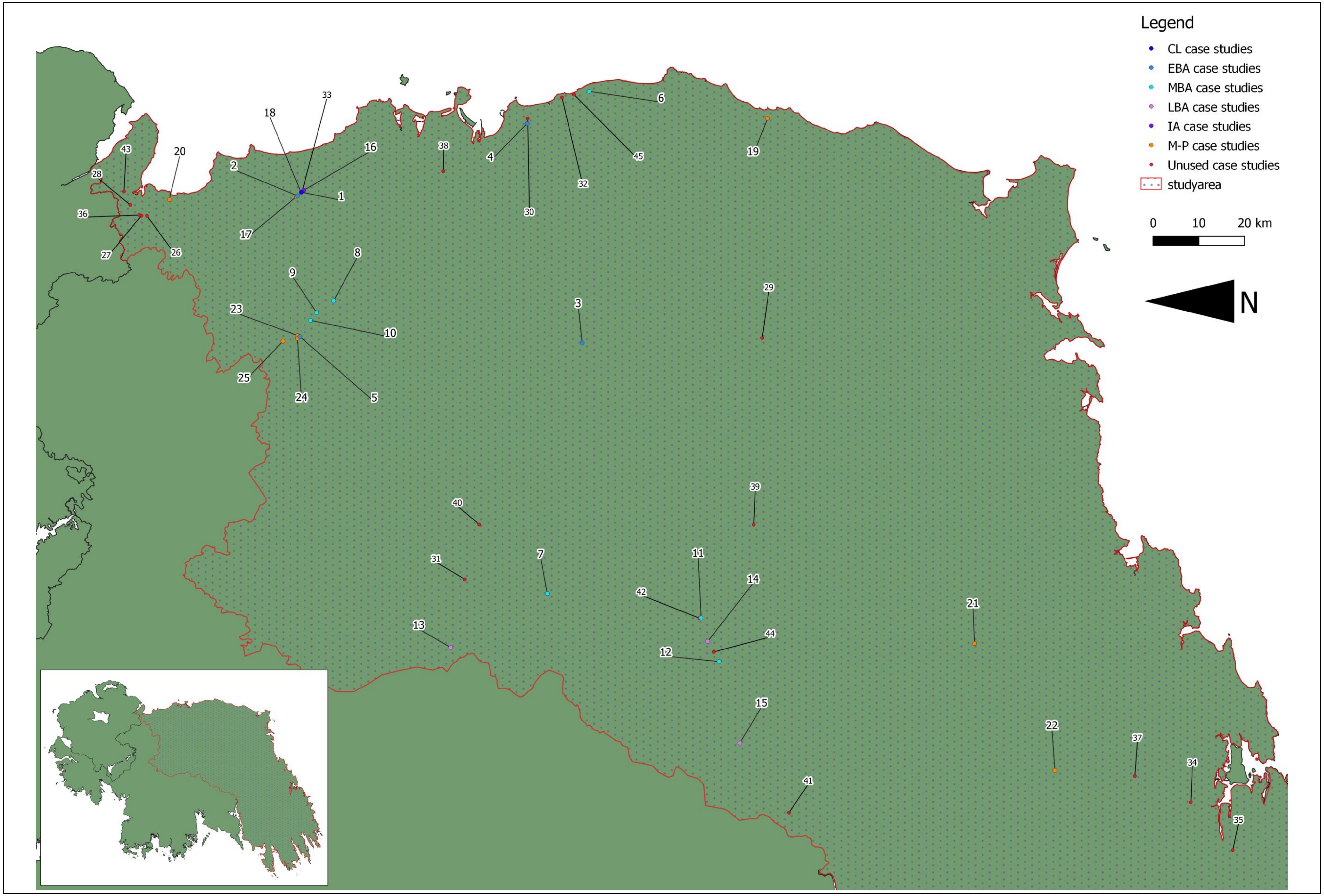


Fig. 5.1: Case studies map; insert shows study area in relation to island of Ireland.

5.4 Analytical Framework

This study entails a macroscopic analysis of lithic material recovered from selected contexts on excavated archaeological sites. Material is analysed through a broad framework, incorporating aspects of morphological, typological, and technological approaches. The technological facet was incorporated specifically to cover international studies on bipolar reduction attributes (see **Chapter 4**).

No detailed theoretical approach was taken. This was due to a lack of a standardised terminology or individualised glossaries in texts identified early in the literature review. As a result, it was thought most suitable to adopt a basic analysis, and review and incorporate any aspect that appeared to be relevant to understanding lithic traditions during the defined study period. This allowed for the necessary flexibility required to integrate previously uncited work on bipolar reduction. However, this approach was not without its pitfalls. The main drawback was the shifting parameters, which meant the analysis elements increased in number, becoming somewhat unwieldy. The identification of bipolar reduction using the markers was time-consuming. Establishing the extent of waves of percussion – in particular – was challenging. This had the effect of increasing analysis time for each lithic and decreasing the overall number of lithics analysed.

Basic metric and attribute elements were the starting point for the analysis (see **Appendix 4.B**). Lithic classification schema are taken from Inizan *et al*. (1999), with reference to Woodman *et al*. (2006) for localised formal typologies. Other publications are consulted in special reference to classification of bipolar-reduced material (see **Chapter 4**), and ground/coarse artefacts.

Four markers were used to identify bipolar or freehand reduction on debitage products. These were: the extent of the waves of percussion; the form of the bulb of percussion; the condition of the platform; and the type of termination. Each of these markers plays a contributing role in differentiating bipolar from freehand material. No one marker was taken as a clear indicator of bipolar reduction. A combination of two or more resulted in the categorisation as bipolar.

5.5 Database

A database was created in Microsoft Access to catalogue and analyse material (see **Appendix 4**), by a consultant – Gordon Green. These were decided upon in consultation with current publications detailing analyses, guides for lithic assessments, and other theses. The database carries seven tables[10] into which data is input. These divisions were created to reduce replicability and redundancy of data. The structure created allowed for one site table to be related to many context tables; and for one context table to be related to varying numbers of artefact tables. This structure was initially thought to be suitable due to the intended focus on contextual relationships.

- Table 1: [SITE]

  Data regarding archaeological site was recorded here. This included names, location details, archaeological period, dating, site description, *etc*. (see **Appendix 4.B.1**). This permitted each site to be entered once, from which all other relevant information then descended.

- Table 2: [CONTEXT]

  Data regarding archaeological context was recorded here. This included the nature, dimensions, content, *etc*. (see **Appendix 4.B.2**).

- Table 3: [CORE]

  Data regarding of debitage cores was recorded here. This included classification, dimensions, reduction characteristics, *etc*. (see **Appendix 4.B.5**).

- Table 4: [DEBITAGE][11]

  Data regarding of debitage products was recorded here. This included classification, dimensions, reduction characteristics, *etc*. (see **Appendix 4.B.4**). This table underwent significant additions due to the focus on bipolar reduction.

- Table 5: [PERCUSSOR]

  Data regarding ground/coarse lithic material was recorded here. This included classification, dimensions, markings, *etc*. (see **Appendix 4.B.3**). Two objects are required for bipolar reduction – a hammerstone and anvilstone. Hammerstones are frequently recorded. Anvilstones are rare in the archaeological record.

[10] Where tables are mentioned throughout the text, they will appear like [AAAAAA]. This is to differentiate table titles from analytical terms. Table titles only serve as an identifier within the Microsoft Access database structure and code contained within it. They are general-purpose identifiers and bear no significant meaning, even when they overlap with analytical terms.

[11] This table was originally titled [LITHIC]. With time, it became clear that this was an inappropriate terminology. [DEBITAGE] was viewed as more suitable and was substituted. The title [LITHIC] still appears in **Appendix 4**.

- Table 6: [UNCLASSIFIED][12]

  Data regarding material where the markers present were unclear if they were the result of intention or accident were recorded here. This included raw material, dimensions, *etc*. (see **Appendix 4.B.6**).

- Table 7: [NATURAL]

  Data regarding pieces identified as natural stones were recorded here. This included raw material, dimensions, *etc*. (see **Appendix 4.B.7**). This had two purposes. Firstly, bipolar reduction is the result of non-conchoidal fracture. Since this form of fracturing can occur naturally or incidentally, a view of the background lithology of a site is helpful in identifying cultural material, i.e.: intentionally fractured. Secondly, Tables 3-6 did not have capacity to record raw materials. Those tables were set up to record characteristics of human alteration. The question of raw materials relates to the nature of later prehistoric knapping, viewed as increasingly local in nature and characterised as self-sufficient.

[12] This table was originally titled [INDETERMINATE]. With time, it became clear that this was an inappropriate terminology. [UNCLASSIFIED] was viewed as more suitable and was substituted. The title [INDETERMINATE] still appears in **Appendix 4**.

6. Analysis

6.1 Introduction

Of the 45 sites selected for analysis, 25 were examined (**Table 6.1**), with one of these partially completed. The intended number was not reached due to: more time spent on individual pieces to identify bipolar reduction markers; problems accessing material from some sites; and access to National Museum of Ireland facilities curtailed due to COVID restrictions from March 2020 to June 2021.

The Chalcolithic (CL) and Multi-period (M-P) were the categories most affected by this – with only one of the selected CL sites analysed, and less then half of the M-P. All four sites for the Early Bronze Age (EBA) were analysed. However, the assemblage from Carrickmines Great 63M, Co. Dublin, was not completely analysed. The single Iron Age (IA) site was analysed. The majority of the sites selected for the Middle Bronze Age (MBA) and the Late Bronze Age (LBA) were analysed.

CL	EBA	MBA	LBA	IA	M-P
1	4	7	3	1	9

Table 6.1: Number of sites analysed, categorised by period.

Debitage and cores will provide for the greatest part of the analysis. The principal focus will be on aspects of bipolar reduction. This will be followed by some data addressing the issue of residuality on Chalcolithic and Bronze Age sites.

Percussors will be mentioned, though not discussed in detail. The examination of them was informative during the analysis. Issues arose during analysis due to the structure of the database, and a lack of clarity in terminology and scope. The analysis strayed beyond hammerstones and anvilstones, recording other ground/coarse lithic objects.

Unclassified entries will be briefly commented upon in relation to bipolar-reduced material. These were pieces which could not be confidently classified as debitage, but had scar patterns which did not look entirely natural. Drift (2012: 8-10) has developed an approach to sorting such material (see **Chapter 4.6**). To discuss these pieces properly would require the whole assemblage from a site and information on the background soils. As a result, they will not be discussed in depth.

Natural entries will be briefly commented upon in **Chapter 6.3.4.2 Geology**, only in relation to the site at Carrickmines Great 63M. They were recorded to give insight into the background lithology and acquired raw materials. However, due to the focus on other aspects of knapping in later prehistory throughout this thesis, a discussion of such is no longer relevant here.

The analysis is divided into two sections. The first deals with lithics of the Chalcolithic and Bronze Age. A standard approach is adopted – covering numbers, morphology, technology, and geology. In addition to these, an analysis of residuality is conducted. This is an unusual – if not unique – examination. But one that is deemed necessary by the frequent attribution of 'residual' to lithics returned from sites of the eras of interest.

The second section deals with the identification of bipolar reduction in the assemblage. This covers the identification of bipolar debitage using internationally established markers and classifications. There is a short consideration of the appearance of the bipolar tool-kit.

6.2 A Note on Carrickmines Great 63M

The site of Carrickmines Great 63M (hereafter CG63M) must be noted. It is discussed in more detail below (**Chapter 6.3.4**). The analysis of this assemblage was not completed – with 612 pieces analysed. Covid restrictions came into effect while this assemblage was being analysed. The original lithic analysis report numbers the assemblage at 1,390 pieces (Ballin 2006: 17). This means that 44% of the assemblage was investigated. The pieces came from 12 different contexts – fills of pits, fill of a hearth, and a spread. It is unclear as to what percentage of pieces from each context were analysed, as no detailed finds list was provided with the report. Contexts were identified from the report, but also from finds bags as they were removed from the storage box. This random approach to data collection was not an issue at the time of analysis, as it was expected to analyse all material.

The large size of the assemblage dominates the database (**Table 6.2**). The incomplete CG63M assemblage accounts for over one-third of the research material. CG63M was recorded under the 'Early Bronze Age' period. Any analyses separating material by period will be unbalanced by this.

Category	Overall Number	CG63M Number	CG63M Percentage
[CORE]	228	74	32
[DEBITAGE]	1,178	488	41
[PERCUSSOR]	60	1	2
[UNCLASSIFIED]	84	15	18
[NATURAL]	149	34	23
Total	1,699	612	36

Table 6.2: Relationship of material from CG63M to analysed assemblage.

6.3 Chalcolithic and Bronze Age Lithics

6.3.1 Introduction

The analysis of material from the 25 sites resulted in total number of 1,699 analysed artefacts (**Table 6.3**). The distribution of this material by site and period is shown in **Tables 6.4**, **6.5**, **6.6**, **6.7**, **6.8** and **6.9**. Numbers appear low for several sites. This is the result of selecting material recovered from secure contexts; although on many sites from the study periods, lithic numbers appear in a low absolute number. The Chalcolithic is the most under-assessed period, with only one site represented. The Iron Age is also represented by one, and with much less material. However, this period was never a primary focus so is less concerning.

Category	Number
[CORE]	228
[DEBITAGE]	1,178
[PERCUSSOR]	60
[UNCLASSIFIED]	85
[NATURAL]	149

Table 6.3: Categorisation of analysed material.

Category	[CORE]	[DEBITAGE]	[PERCUSSOR]	[UNCLASSIFIED	[NATURAL]	**Total**
Site	Rathmullan 6					
Total	10	49	-	5	1	65

Table 6.4: Chalcolithic – analysed material by site.

Category	[CORE]	[DEBITAGE]	[PERCUSSOR]	[UNCLASSIFIED	[NATURAL]	Total
Site	Donore 2					
	-	2	-	-	-	2
Site	French Furze					
	-	9	-	-	1	10
Site	Cookstown Great 3					
	-	1	-	-	-	1
Site	Carrickmines Great 63M					
	74	488	1	15	34	612
Total	74	510	1	15	3	625

Table 6.5: Early Bronze Age – analysed material by site.

Category	[CORE]	[DEBITAGE]	[PERCUSSOR]	[UNCLASSIFIED	[NATURAL]	Total
Site	Charlesland D					
	53	116	1	14	15	199
Site	Borris and Blackcastle AR31					
	-	6	2	4	8	20
Site	Boyerstown 3					
	1	1	-	-	-	2
Site	Grange 3					
	-	79	3	14	23	119
Site	Phoenixtown 3B					
	-	32	2	4	1	39
Site	Camlin 3					
	-	10	-	-	2	12
Site	Drumbaun 2					
	-	2	7	3	1	13
Total	54	246	15	39	50	404

Table 6.6: Middle Bronze Age – analysed material by site.

Category	[CORE]	[DEBITAGE]	[PERCUSSOR]	[UNCLASSIFIED	[NATURAL]	Total
Site	Rathnaveoge Lower 4					
	6	17	2	4	5	34
Site	Creggan Lower 1					
	4	36	3	5	8	56
Site	Benedin					
	2	7	-	7	36	52
Total	12	60	5	16	49	142

Table 6.7: Late Bronze Age – analysed material by site.

Category	[CORE]	[DEBITAGE]	[PERCUSSOR]	[UNCLASSIFIED	[NATURAL]	Total
Site	Platin-Lagavooren 1					
Total	-	3	9	-	-	12

Table 6.8: Iron Age – analysed material by site.

Category	[CORE]	[DEBITAGE]	[PERCUSSOR]	[UNCLASSIFIED]	[NATURAL]	**Total**
Site	Sheephouse 3					
	14	44	16	5	6	85
Site	Rathmullan 10					
	16	88	1	-	1	106
Site	Ballynattin					
	11	16	-	-	-	27
Site	Haynestown 1					
	13	44	1	-	-	58
Site	Ballylegan 207.2					
	-	4	4	1	1	10
Site	Caherdrinny 3					
	2	10	4	-	3	19
Site	Kilmainham 1C					
	13	74	1	4	3	95
Site	Gardenrath 2					
	-	8	1	-	-	9
Site	Cakestown Glebe 2					
	2	32	-	-	-	34
Total	71	320	28	10	14	443

Table 6.9: Multi-period – analysed material by site.

The statistical dispersal of numbers – derived from [CORE], [DEBITAGE], and [PERCUSSOR] columns – across sites reflects a recognised low occurrence (**Table 6.10**). While the maximum number may appear high, this is countered by the lower median values. This indicates that the dataset, i.e.: number of lithics on sites, is weighted towards a lower amount but skewed towards higher. An interesting shift is seen when CG63M is excluded. The change in the mean value is not reflected in the median – though the dataset remains skewed. CG63M is highlighted as an outlier in terms of the numbers of lithics present, as when included, the skew between mean and median is greater. Given the small number of sample sites, these numbers should be treated with caution.

Minimum	Maximum	Mean	Median	
1	563	58.28	25	*With CG63M*
1	170	37.25	20.5	*Without CG63M*

Table 6.10: Statistical values derived from lithic numbers on case study sites.

Despite the low absolute numbers, a high percentage, 34% [N=582], were identified as bipolar-reduced. This allowed for the application of internationally-derived bipolar markers to a substantial assemblage across the three sub periods of the Irish Bronze Age.

6.3.2 Assemblage

Table 6.11 shows the dispersal of categories within the analysed assemblage. Flakes are the predominant category. The flake-based nature of later prehistoric assemblages is well established, and is confirmed here. Irregular flakes appear in slightly greater numbers. Given this, the presence of blade material is higher than expected. This subjective expectation is based on reading of material, rather than any presented or established ratio. They appear in a ratio of 1:5, blades to flakes. This figure is complicated by segmented pieces – some of which were recorded as blades. Many of these have the dimensional attribute of blades, i.e.: 2L x W, but this mis-represents the overall difference in morphology, and the very different approaches to their creation.

Debitage		**Number**		**Percentage**	
Core		228		16	
*Flake**	*(regular; irregular)*	193	251	14	18
	(total)	444		32	
Blade		91		6	
Microblade		1		<1	
Chip		135		10	
Chunk		91		6	
Fragment		351		25	
Other		40		3	
Indeterminate		25		2	
Total		1406		100	

Table 6.11: Breakdown of lithic assemblage by debitage categories.
* = Flake total contributes to overall total; individual percentages worked from overall total.

The number of fragments is probably over-estimated. Proximal fragments with hinge terminations were interpreted as incomplete pieces. This was based on a reading of

Andrefsky's (2005: 89) description of medial fragments, wherein "intentionally snapped pieces or pieces broken upon detachment may exhibit step or hinge fractures". This statement was interpreted to mean that hinge fractures can be indicative of a broken piece, and mis-applied by not properly accounting for the termination in the analysis. Since bipolar reduction, which is associated with hinge terminations, is the dominant technique, it is likely that a quantity of proximal fragments are incorrectly recorded. These could possibly be either flakes or blades.

6.3.2.1 Geology

Geological types noted were:

Flint	=	1,263
Chert	=	112
Quartz	=	27
Quartz Crystal	=	2
Limestone	=	1
Indeterminate	=	1

Flint dominates the debitage, accounting for 89%. Chert is the next most recorded, at 8%. Quartz accounts for 2%, with three other geologies making up the final 1%. The geological character of the analysed assemblage likely reflects the eastern distribution of sites. Flint, in the form of *remanié* nodules, may have been a more accessible resource. The majority of flint resources were identified in counties with a coastal boundary. Flint is recorded as occurring down the east coast as nodules washed out from chalk deposits elsewhere (Woodman *et al*. 2006: 82, 83).

36% of flint material came from counties further inland – Kildare, Tipperary, Westmeath, and Meath. The presence of flint from sites in the areas could indicate importation of distant resources – from beaches or northern deposits (Cooper *et al*. 2018). However, flint is noted in glacial drift soils from inland areas (Finch *et al*. 1983: 12, 41, 55), meaning the raw material could have been retrieved within a 'local'[13] scale.

[13] The term 'local' is often seen in relation to lithic resources. It is poorly defined. Arthur (2010) notes Konso individuals travelling up to 25km one-way to retrieve lithic resources. While still a poor definition, this is used as a rough guide here.

Fifty pieces of primary flint debitage, from 203 pieces, were noted with possible sources. Forty-four pieces of primary debitage were noted as water-rolled. In these cases, the cortex was polished and had no chattering. These pieces all came from coastal counties: Dublin = 26; Louth = 4; Meath = 6; and Wicklow = 8. This may indicate a beach origin for these pieces. Five pieces of primary debitage were noted as possible *remanié*. Here, the cortex was noted as being rough, irregular and thin, with chattering present on some. Again, the counties were coastal: Dublin = 1; Louth = 1; Meath = 1; Wicklow = 2. One piece from Meath was noted with thick, chalky cortex. This could indicate it was recovered from a primary geological context, or soon after it was eroded out. The eight primary pieces recovered from Co. Meath come from two sites which are within 10km of the coastline. As such, despite the larger portion of the county being further inland, no comment can be passed on the movement of materials.

Chert is noted almost exclusively from inland counties – Meath (which has a small coastal region), Tipperary, and Westmeath – though was also recorded at one site in County Dublin. Chert is noted in glacial drift deposits and exposed bedrock across inland Ireland in various forms – gravel layers, nodules, bands (Conry 1987; Finch 1977; Finch, Ryan 1966; Gregory 1921). Chert is noted in the soils of County Waterford (Diamond, Sills 2011: 38, 71, 103, 221), and County Wexford (Culleton 1978: 298, 299, 302, 305) – both coastal counties. This means that it is a widely available resource across regions. The absence of chert in assemblages from sites in coastal counties, except at Carrickmines Great 63M, Co. Dublin, may indicate a preference for flint: due to easier access; or ease of working; or quality of material. This inference should be tempered by the small sample size.

Of the 148 pieces classed as natural, 53% [N=79] were chert, and 37% [N=54] were flint. While these numbers appear close in absolute terms, there is considerable relative difference. The 79 pieces of natural chert equate to a 70.5% ratio of the struck material. This is compared to a 4.3% ratio for flint. The remaining 20% included pieces of quartz, limestone, sandstone, and indeterminate geology. The predominance of chert may reflect its greater occurrence in soils, the greater difficulty in identifying reduction markers on chert in general, and the greater difficulty in separating intentional bipolar reduction from incidental more specifically.

Numbers of material and sites are too low to allow for substantive comment on variation by period. The dispersal is set out in **Table 6.12**. The dominance of chert in the Late Bronze Age likely reflects the geographic location of the case study sites – one from County Westmeath, and two from County Tipperary.

	CL	EBA	MBA	LBA	IA
Flint	59	551	266	6	3
Chert	0	3	38	59	0
Quartz	0	20	0	7	0
Limestone	0	0	1	0	0

Table 6.12: Geological materials for cores, flakes (regular, irregular), and blades, by period.

6.3.2.2 Reduction Stages

Flint is focused on here. The identification of reduction stages on chert and quartz is not a clearly established.

The majority of material was reduced to a secondary stage, with the primary being next (**Tables 6.13**, **6.14**). The presence of primary and secondary core material shows the early abandonment of cores, e.g.: tested cores. It is partly attributed to the presence of split pebbles. This predominance of primary and secondary material on sites of these periods has been noted before. It is attributed to the initial small size of the exploited resource, which does not allow for preparation of decorticated blanks by removing the cortex.

The Chalcolithic displays a greater parity between secondary and tertiary stages than other periods. With only one case study, this could reflect a site-specific instance. The low number of material listed under *LBA* is due to all core material from this sub-period being of either chert or quartz; and the majority of debitage products being of chert.

	Primary	Secondary	Tertiary
Core	88	87	31
Flake – Regular	50	73	40
Flake – Irregular	50	104	67
Blade	27	37	23
Total	215	301	161

Table 6.13: Reduction stages of flint pieces.

	CL	EBA	MBA	LBA	IA
Primary	9	71	77	0	0
Secondary	19	135	76	2	1
Tertiary	20	29	41	0	0

Table 6.14: Reduction stages of flint pieces, by period.

6.3.2.3 Dimensions

The dimensions of cores are given in **Figure 6.1** and **Table 6.15**. While they show a significant range, the display is simplified. The dimensions cover all material – including that such as split pebbles and third-phase bipolar cores, which have distinctive characters to those of more standard cores. **Figure 6.1** shows that there are no characteristic dimensions of any one period, nor any trend through them. Despite large variations in the range between periods, the mean and median values show a degree of consistency.

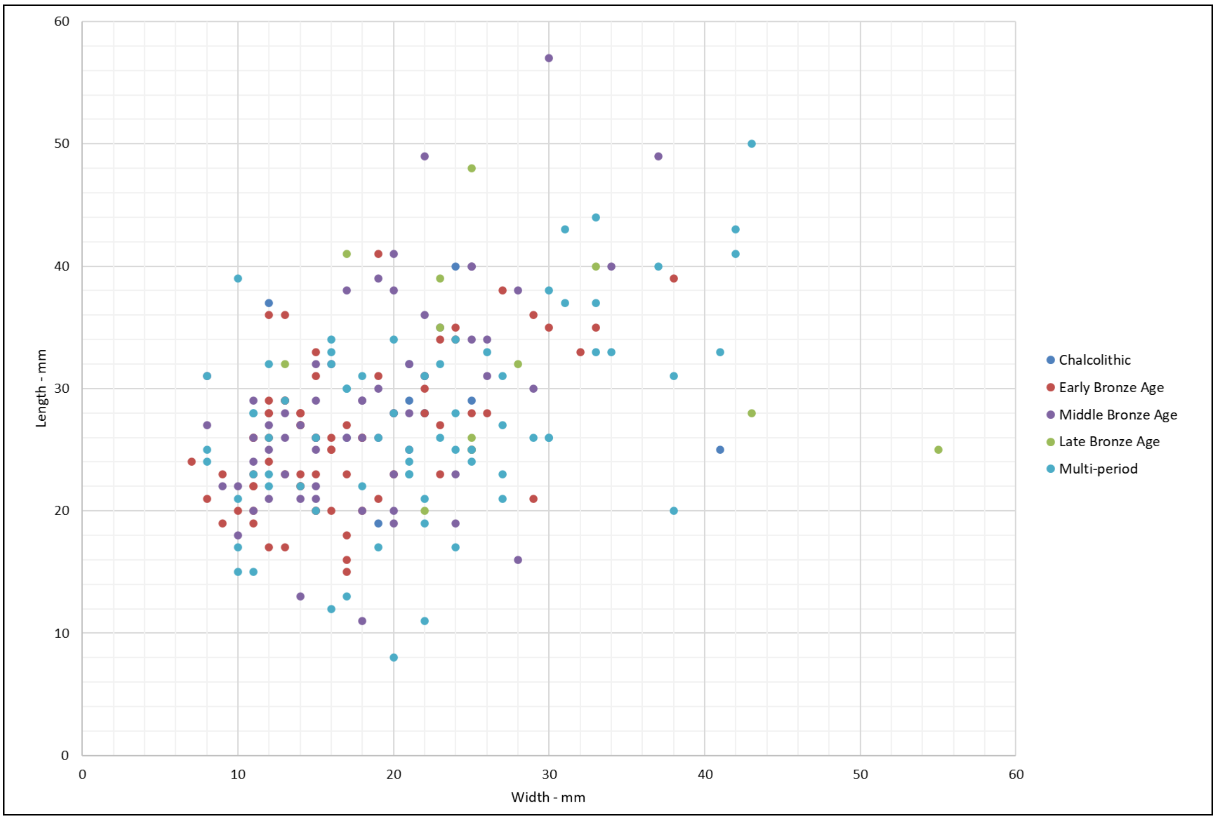


Fig. 6.1: Dimensions of core material.

		Minimum	Maximum	Mean	Median
CL	*L*	19	40	29.3	28.5
	W	15	41	22.4	21.5
EBA	*L*	15	41	26.24	26
	W	7	38	17.06	15
MBA	*L*	11	57	28.63	27
	W	8	37	18.45	18
LBA	*L*	20	48	32.58	32
	W	13	55	27.66	25
M-P	*L*	8	50	27.32	26
	W	8	43	21.90	21

Table 6.15: Statistical values for dimensions (Length, Width) of cores – in mm.

The dimensions of regular flakes are presented in **Figure 6.2** and **Table 6.16**. No characteristic dimensions are noted for any one period, and no trends are identified. Despite large variations in the range between periods, the mean and median values show a degree of consistency.

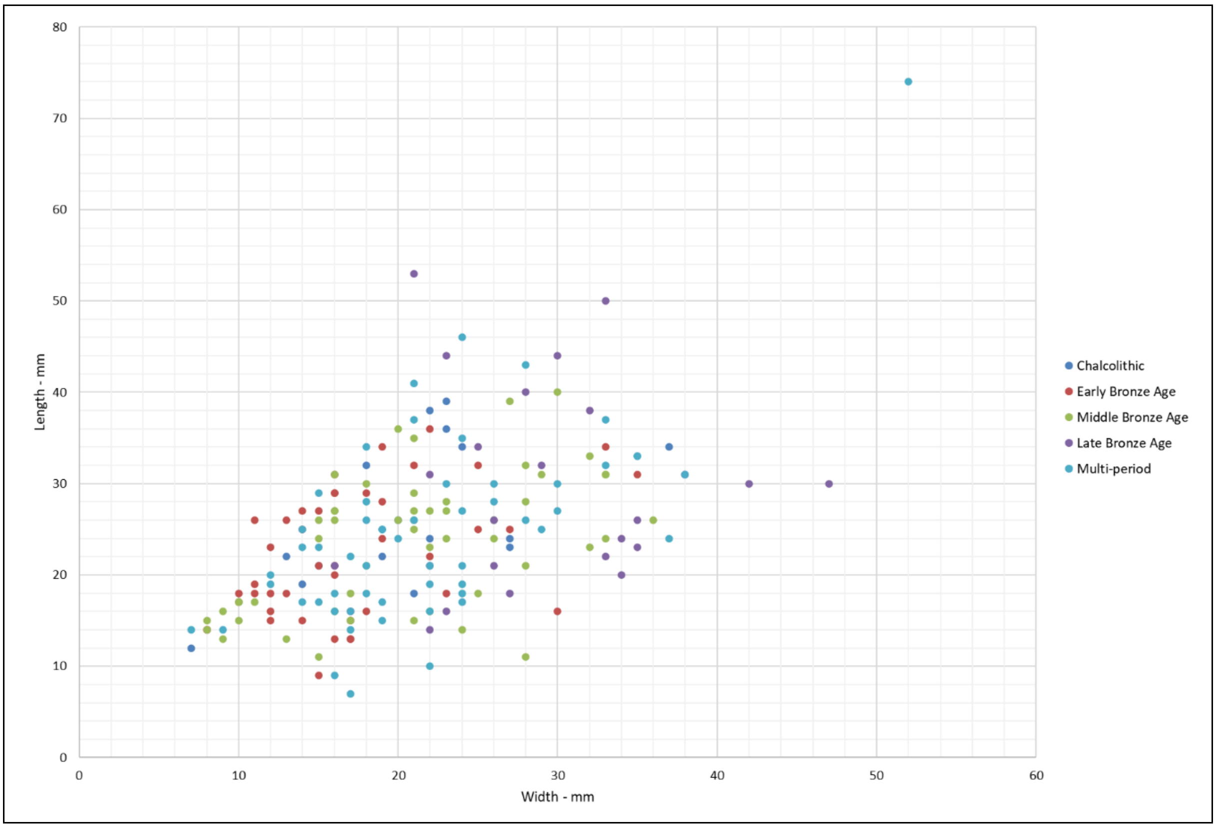


Fig. 6.2: Dimensions of regular flakes.
One piece did not have dimensions recorded.

		Minimum	Maximum	Mean	Median
CL	*L*	12	39	26.5	24
	W	7	37	20.75	21.5
EBA	*L*	11	40	23.55	24.5
	W	8	36	20.8	16
MBA	*L*	11	57	28.63	27
	W	8	37	18.45	18
LBA	*L*	14	53	29	26
	W	16	47	28.8	28
M-P	*L*	7	74	24.85	24
	W	7	52	21.98	21

Table 6.16: Statistical values for dimensions (Length, Width) of regular flakes – in mm.

The dimensions of irregular flakes are provided in **Figure 6.3** and **Table 6.17**. Again, the dispersal seen in **Figure 6.3** indicates no characteristic dimensions nor trends for periods. Despite large variations in the range between periods, the mean and median values show a degree of consistency. There is a difference when compared with regular flakes. The mean and median of regular flakes show slightly greater proportions throughout periods than irregular ones, more so in length.

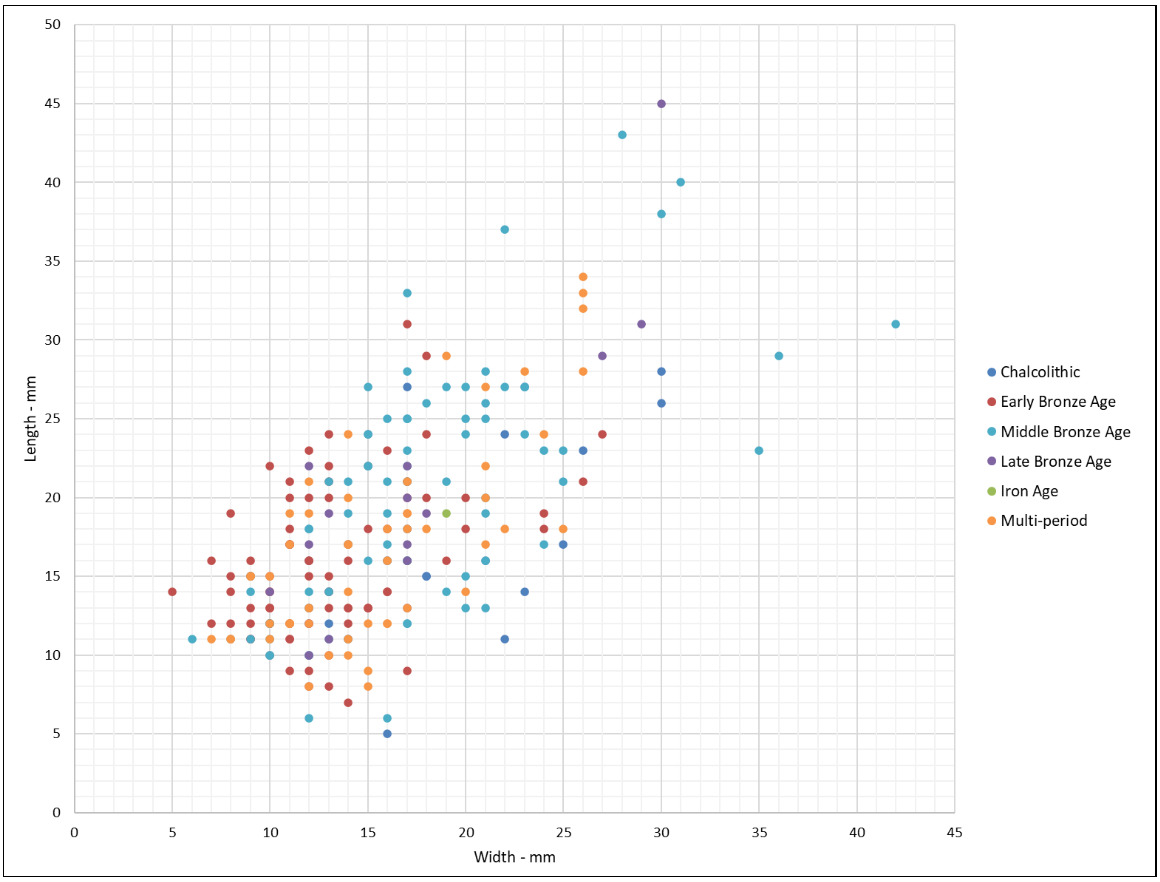


Fig. 6.3: Dimensions of irregular flakes.

		Minimum	Maximum	Mean	Median
CL	*L*	5	28	18.44	16.5
	W	12	30	20.05	19.5
EBA	*L*	7	31	15.65	15
	W	5	27	13.11	12
MBA	*L*	6	43	19.86	19.5
	W	6	42	17.63	17
LBA	*L*	10	45	19.81	18
	W	10	30	17.06	17
M-P	*L*	8	34	17.13	17
	W	7	26	15.66	15

Table 6.17: Statistical values for dimensions (Length, Width) of irregular flakes – in mm.

The dimensions of blades are given in **Figure 6.4** and **Table 6.18**. **N**o characteristic dimensions are noted, nor any trends through periods. There appears to be some variation between periods. The Chalcolithic mean and median for length are considerably higher than either the Early and Middle Bronze Age here, or all periods in the other data. They exceed Chalcolithic core material in their maximum length also. This could indicate a number of possibilities. They were produced early in the reduction process, with flakes produced subsequently, and the cores displaying a size associated with flake production. Alternatively, the blades were produced elsewhere and brought to this site, accounting for the discrepancy. The Early and Middle Bronze Age figures are quite different. However, the fit with the figures seen in other categories for these eras.

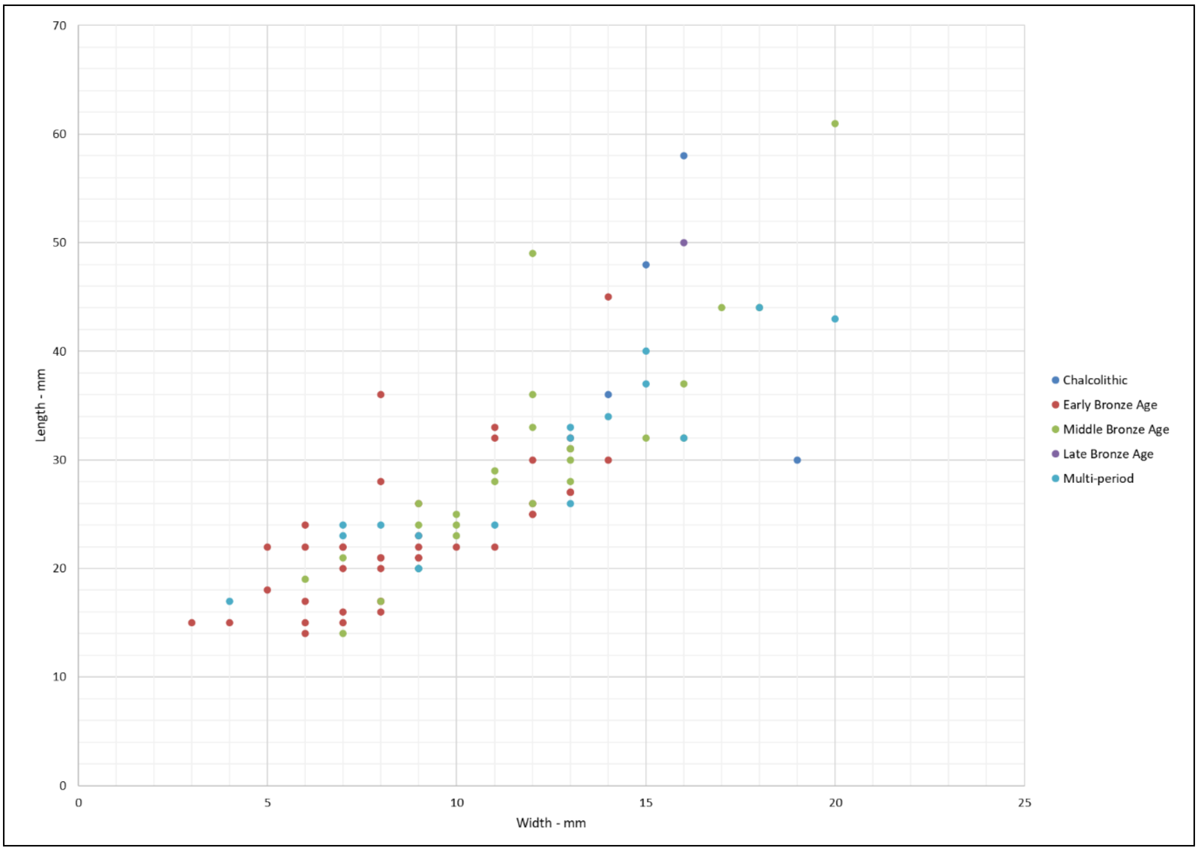


Fig. 6.4: Dimensions of blades.
One piece is missing as width was not recorded.

		Minimum	Maximum	Mean	Median
CL	*L*	30	58	43	42
	W	14	19	16	15.5
EBA	*L*	14	45	23.33	22
	W	3	14	8.92	8
MBA	*L*	14	61	30.15	28.5
	W	6	20	11.88	12
M-P	*L*	17	44	29.17	26
	W	4	20	11.82	13

Table 6.18: Statistical values for dimensions (Length, Width) of blades – in mm.

6.3.2.4 Primary Technology

Of primary interest was the identification of bipolar-reduced material (**Table 6.19**), using markers established by international research. Focusing on the cores, flakes, and blades allows for the best examination of reduction techniques. Together, these categories number 743 pieces.

Bipolar-reduced material dominated the assemblage. The technique was confirmed in 54.2% [N=403] of cores, flakes, and blades. Another 18.7% [N=139] were possible (**Tables 6.20**, **6.21**).

Freehand reduction was not prominent within the assemblage, accounting for approximately 17%. It was confirmed on 12.7% [N=95] of the material, with a further 4.4% [N=33] suspected (**Tables 6.22**, **6.23**).

The remaining 10% [N=73] of pieces included material that was indeterminate, or cores that displayed a combination of techniques or were classed as tested.

	Period						
Category	*CL*	*EBA*	*MBA*	*LBA*	*IA*	*M-P*	**Total**
Bipolar	1.3	24.6	13	1.6	0	13.7	54.2
Bipolar Possible	1.5	5	7.3	1.3	0	3.6	18.7
Freehand	1.3	0.8	3.4	2.7	0.1	4.4	12.7
Freehand Possible	0.8	0.7	1.5	0.5	0	0.9	4.4
Indeterminate	1.5	1.6	3.4	0.8	0	2.7	10
Total							100

Table 6.19: Percentages of reduction categories – cores, flakes, and blades, by period.

	Period						
Category	*CL*	*EBA*	*MBA*	*LBA*	*IA*	*M-P*	**Total**
Bipolar	5	120	42	7	0	47	221
Bipolar Possible	10	37	51	8	0	27	133
Total	15	157	93	15	0	77	354

Table 6.20: Numbers of bipolar-reduced material – flakes and blades, by period.

	Period						
Category	*CL*	*EBA*	*MBA*	*LBA*	*IA*	*M-P*	**Total**
Bipolar	5	63	54	5	0	55	182
Bipolar Possible	1	0	3	2	0	0	6
Total	6	63	57	7	0	55	188

Table 6.21: Numbers of bipolar-reduced material – cores, by period.

	Period						
Category	*CL*	*EBA*	*MBA*	*LBA*	*IA*	*M-P*	**Total**
Freehand	8	5	25	19	1	32	90
Freehand Possible	6	5	11	3	0	7	32
Total	14	10	36	22	1	39	122

Table 6.22: Numbers of freehand-reduced material – flakes and blades, by period.

	Period						
Category	*CL*	*EBA*	*MBA*	*LBA*	*IA*	*M-P*	**Total**
Freehand	2	1	0	1	0	1	5
Freehand Possible	0	0	0	1	0	0	1
Total	2	1	0	2	0	1	6

Table 6.23: Numbers of freehand-reduced material – cores, by period.

6.3.2.5 Modified Types

A total of 120 objects were identified as modified or possibly modified types (**Table 6.24**). This equates to approximately 10% of the lithic products. The nature of retouch was not formally recorded and is not discussed. The modified assemblage is dominated by convex scrapers, confirmed and possible. They account for over 50% of all retouched pieces. This is followed by pieces displaying retouch or possible retouch, 27%.

Modified Piece	Number	Percentage
Awl/Borer	2	2
?Fabricators/Rods	1	1
?Petit Tranchet *(Derivative)*	1	1
?Piercer	1	1
Plano-convex Form	1	1
?Polished Axehead	1	1
Polished Form	1	1
Retouched Piece	23	19
?Retouched Piece	10	8
Scraper	1	1
Scraper – Concave	3	2
?Scraper – Concave	2	2
Scraper – Convex	48	40
?Scraper – Convex	15	13
Scraper - Hollow	3	2
Wedge	4	3
?Wedge	3	2
Total	120	100

Table 6.24: Presence of modified types in the analysis material.

Whether wedges should be included as a modified type is open to question. The secondary flaking that occurs is modification by use, rather than modification for use. This can also be the case for pieces displaying a small number of irregular retouch scars.

Despite the low numbers and irregular collection of data across periods, a decreasing trend of modified to unmodified lithics is indicated (**Table 6.25**; **Fig. 6.5**). This is seen in the Chalcolithic, Middle Bronze Age, Late Bronze Age, and Iron Age material. The Early Bronze Age ratio is much lower due to large quantity of debitage from CG63M. Without this site, the Early Bronze Age ratio is comparable to that of the Late. The variance in site numbers and analysed material from period to period could be creating this impression.

	Period						
Piece	*CL*	*EBA*	*EBA (- CG63M)*	*MBA*	*LBA*	*IA*	**Total**
Modified	14	4	1	51	7	0	76 (73)
Unmodified	34	495	10	193	53	3	778 (293)
Ratio	1:2.4	1:123.8	1:10	1:3.8	1:7.6	-	1:10.2 (1:4)

Table 6.25: Numbers and ratios of modified and unmodified lithics, by period.

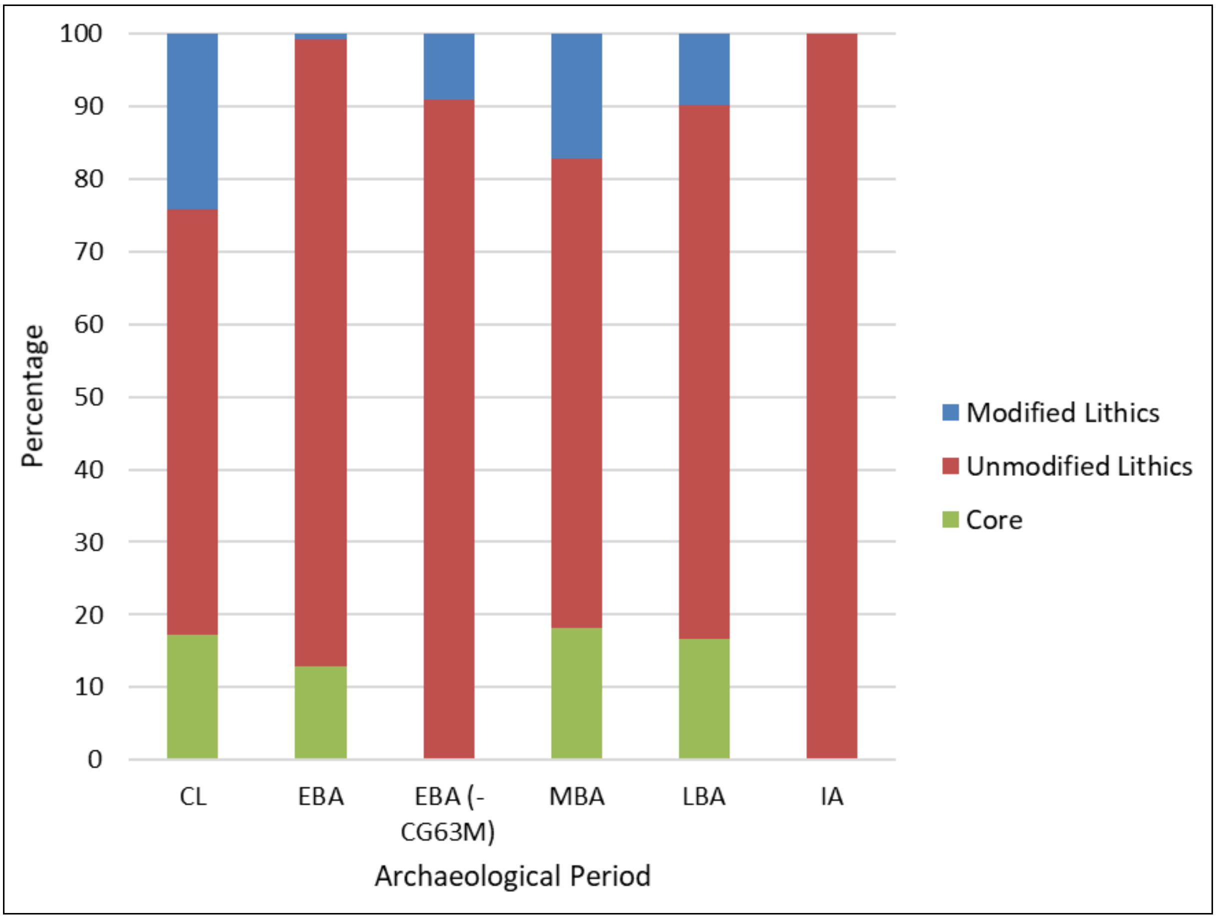


Fig. 6.5: Ratios of modified lithics to unmodified lithics to cores, by period.

Modified lithics were present on 18 of the 25 sites. The site of Grange 3, Co. Meath, produced 35 pieces, 29% of the overall number. This site was periodised as Middle Bronze Age, due to the presence of two structures dated to this period (Kelly 2010). However, the site exhibited intensive activity – with other phases dated to the Chalcolithic (kiln with burnt spread and pit), Middle-Late Bronze Age (ring-ditch, cremation pit), Late Bronze Age (cremation pits), Iron Age (metalworking), and Early Medieval (cereal processing). It was attempted to select contexts associated with the structures. With the degree and longevity of activity, it is possible that some modified pieces represent residual or infiltrated elements.

- Scrapers

Scrapers are the modified lithic most associated with the Chalcolithic and Bronze Age. Seventy-two examples were recorded in total, with 17 of these possible. Convex scrapers are most associated with the research periods. There were 48 confirmed and 15 possible examples. One piece was a dual scraper, with retouch on both concave and convex edges.

Three lithics were hollow scrapers, and five were concave. These are discussed in **Chapter 6.3.3**.

The reduction technology was visible on 41 pieces, with the remaining 23 being indeterminate. Bipolar reduction was predominant, accounting for 46.9%. This was confirmed in 17 examples and possible 13. Freehand reduction was attributed to 17.2%, where six pieces were confirmed and five were possible. This distribution mirrors the appearance of reduction techniques in the overall assemblage discussed above.

In terms of geology, flint was the principal medium, accounting for 75% of pieces. Of these, ten were worked at a primary stage, 15 at secondary, and 24 at tertiary. Chert followed at 23.4%. The remainder comprised quartz. The quartz example is possible, which reflects the difficulty in identifying working on this medium. The percentages here reflect the overall geological composition of the assemblage. The increase in chert may be due to the easier recognition of modified types, as opposed to unretouched debitage.

There were 33 complete convex scrapers (**Table 6.26**). From these, a majority [N=22] indicated manufacture on irregular flakes. This debitage class is the most numerous present in the assemblage. The remaining examples were made on regular flakes [N=5], chunks [N=3] and a blade. One piece was of indeterminate class and two were recorded as other.

Period	Site	Find Number	Material
CL	Rathmullan 6	01E0294:12:173	Flint
		01E0294:12:553	Flint
		01E0294:12:554	Flint
		01E0294:18:30	Flint
		01E0294:18:39	Flint
		01E0294:18:42	Flint
EBA	Carrickmines Great 63M	02E0700:6:678*	Quartz
MBA	Grange 3	E3123:54:3	Flint
		E3123:54:10*	Flint
		E3123:54:22*	Flint
		E3123:54:42	Flint
		E3123:54:44	Flint
		E3123:54:47	Flint
		E3123:54:56*	Flint
		E3123:54:57*	Flint
		E3123:54:70	Flint
		E3123:54:73**^**	Chert
		E3123:54:90	Flint
		E3123:54:94	Flint
		E3123:54:95	Chert
		E3123:54:104.1	Chert
		E3123:54:104.3	Chert
		E3123:54:124	Flint
		E3123:54:127	Chert
		E3123:54:128*	Chert
		E3123:54:134	Chert
		E3123:54:146	Flint
		E3123:54:152	Chert
		E3123:142:7*	Flint
		E3123:142:10*	Flint
		E3123:253:2*	Flint
		E3123:504:1	Flint
		E3123:504:6	Chert
		E3123:507:1	Chert
	Camlin 3	E3580:456:133	Flint
		E3580:456:149	Flint
		E3580:654:739	Chert
	Charlesland D	03E0146:58:22	Flint
		03E0146:61:1*	Flint
		03E0146:209:1*	Flint
		03E0146:281:3	Flint
LBA	Rathnaveoge Lower 4	E3628:145:163	Chert
		E3623:524:302	Chert

Table 6.26: Convex scrapers on periodised sites.
* = possible example
^ = dual scraper example

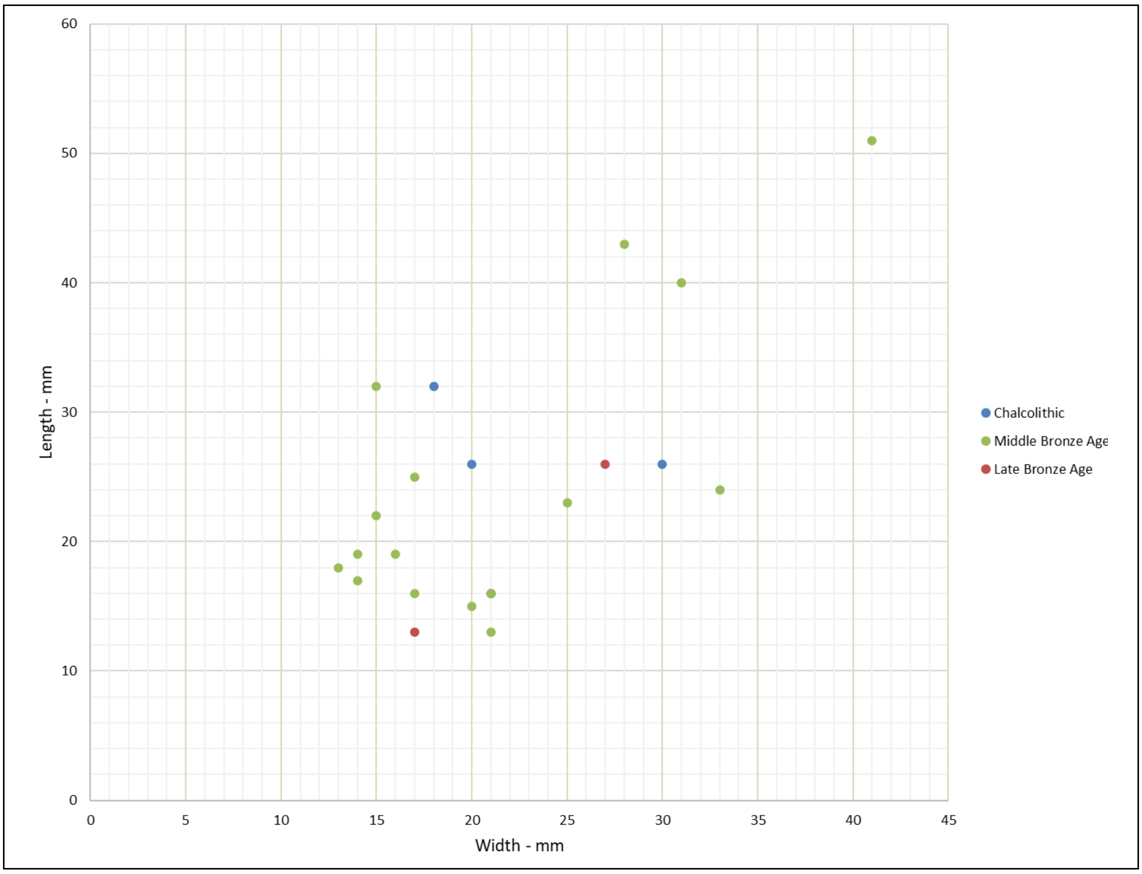


Fig. 6.6: Dimensions of complete convex scrapers and the dual scraper.

The dimensions of complete convex scrapers show a grouping below 30mm length and 25mm width (**Fig. 6.6**). This displays a degree of overlap with the phased cores recorded. Pieces outside of these limits fall within the upper limits of the length for cores, but exceed those for widths.

Of particular note is the outlier **E3580:640:149**, measuring 51mm L x 41mm W, which is one of the pieces classed as 'other'. This was due to it being interpreted as created on a split pebble, which was inferred from the ventral surface and the primary reduction sequence. The dimensions here are slightly greater than the largest split pebble noted above.

Of the 39 incomplete examples, eight were noted as possibly being deliberately broken (**Table 6.27**). This was inferred from a longitudinal breakage, which ran along the centre axis or a lateral. These breaks were noted in similar ways to bipolar reduction of debitage – the faces of the break appeared 'sheared', or had *écaillé* retouch present at the ends. Breaking of scrapers in this fashion has been noted on sites of the Chalcolithic previously (McDevitt 2010). This activity is only indicated by the low numbers recorded here, though may continue into the Middle Bronze Age.

Period	Site	Find Number	Material
EBA	Carrickmines Great 63M	02E0700:6:678*	Quartz
MBA	Grange 3	E3123:54:44	Flint
		E3123:54:94	Flint
M-P	Sheephouse 3	00E0811:456:3*	Flint
		00E0811:690:5*	Flint
		00E0811:690:7*	Flint
		00E0811:716:1*	Chert
	Rathmullan 10	00E0813:69:3	Flint

Table 6.27: Convex scrapers with longitudinal break read as a bipolar strike, by period.
* = possible example

- Retouched pieces

There were 33 retouched pieces catalogued – 23 confirmed and ten possible. There is an association of un-diagnostic retouched flakes with the Bronze Age, though it is difficult to establish whether this is as characteristic of the period or not. The examples came from sites in the Chalcolithic, Early Bronze Age, Middle Bronze Age, Late Bronze Age, and several classed as multi-period (**Table 6.28**).

The reduction technology was visible on 20 pieces, with the remaining 13 being indeterminate. Bipolar reduction was predominant, accounting for 33.3%. This was confirmed in four examples and possible seven. Freehand reduction was attributed to 27.3%, where six pieces were confirmed and three were possible.

In terms of geology, flint was the principal medium, accounting for 72.7% of pieces. Of these, five were worked at a primary stage, nine at secondary, and ten at tertiary. Chert followed at 24.2%. There was one possible example on limestone. The percentages here reflect the overall geological composition of the assemblage. The increase in chert may be due to the easier recognition of modified types, as opposed to unretouched debitage.

There were 15 complete retouched pieces. Nine were manufactured on flakes – regular [N=5] and irregular [N=4]. The remaining examples were made on chunks [N=2] and a blade. One piece was of indeterminate class and two were recorded as other. The two 'other' were possibly a re-used core and natural flake.

The dimensions of complete retouched pieces show a grouping below 30mm length and 30mm width (**Fig. 6.7**). This displays a degree of overlap with the flake material recorded.

Period	Site	Find Number	Material
CL	Rathmullan 6	01E0294:9:1	Flint
		01E0294:12:172	Flint
		01E0294:12:556	Flint
EBA	Carrickmines Great 63M	02E0700:15:1001	Flint
MBA	Borris and Blackcastle AR31	E2374:4:600*	Limestone
		E2374:929:449*	Chert
	Grange 3	E3123:54:91	Chert
		E3123:54:102*	Flint
		E3123:142:3*	Chert
		E3123:253:5	Chert
	Charlesland D	03E0146:36:1	Flint
		03E0146:58:9	Flint
		03E0146:58:39	Flint
		03E0146:327:2	Flint
		03E0146:385:4*	Flint
		03E0146:394:1*	Flint
LBA	Creggan Lower 1	E2658:29:1	Chert
		E2658:135:1	Chert
		E2658:192:5*	Chert

Table 6.28: Retouched pieces on periodised sites.
* = possible example

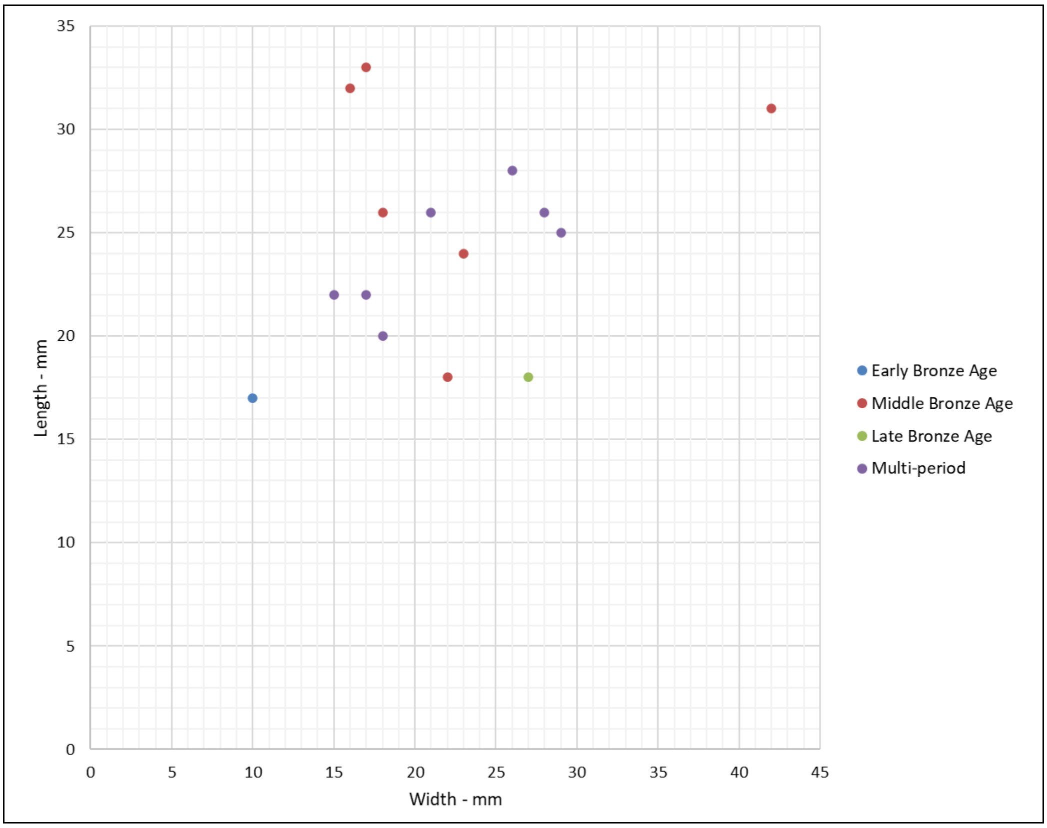


Fig. 6.7: Dimensions of complete retouched pieces, by period.

- Wedges

There were six wedges catalogued – four confirmed and three possible. These are presented here, not out of any strong association with the study periods, but more to highlight them and counter the fact they are often overlooked. As shown in **Chapter 4.3.4**, they are challenging to identify. When they are, though, it does give a much more nuanced understanding of lithic use on sites. The examples came from sites in the Chalcolithic, Early Bronze Age, Middle Bronze Age, and one classed as multi-period (**Table 6.29**).

Period	Site	Find Number	Material
CL	Rathmullan 6	01E0294:18:43*	Flint
EBA	French Furze 11	02E0541:366:60	Flint
MBA	Borris and Blackcastle AR31	E2374:4:1	Flint
	Grange 3	E3123:328:1*	Chert
	Camlin 3	E3580:737:151	Flint
	Charlesland D	03E0146:58:33*	Flint
M-P	Kilmainham 1C	E3140:11:20	Flint

Table 6.29: Wedges, by period.
* = possible example

These were identified by the presence of opposing *écaillé* retouch, which had varying extents, but that was not associated with waves or bulbs of percussion (**Plates 6.1**, **6.2**). They display a variability in size (**Fig. 6.8**). While this does not indicate anything toward characteristics due to the small sample, it does highlight the range of material that should be looked for on sites.

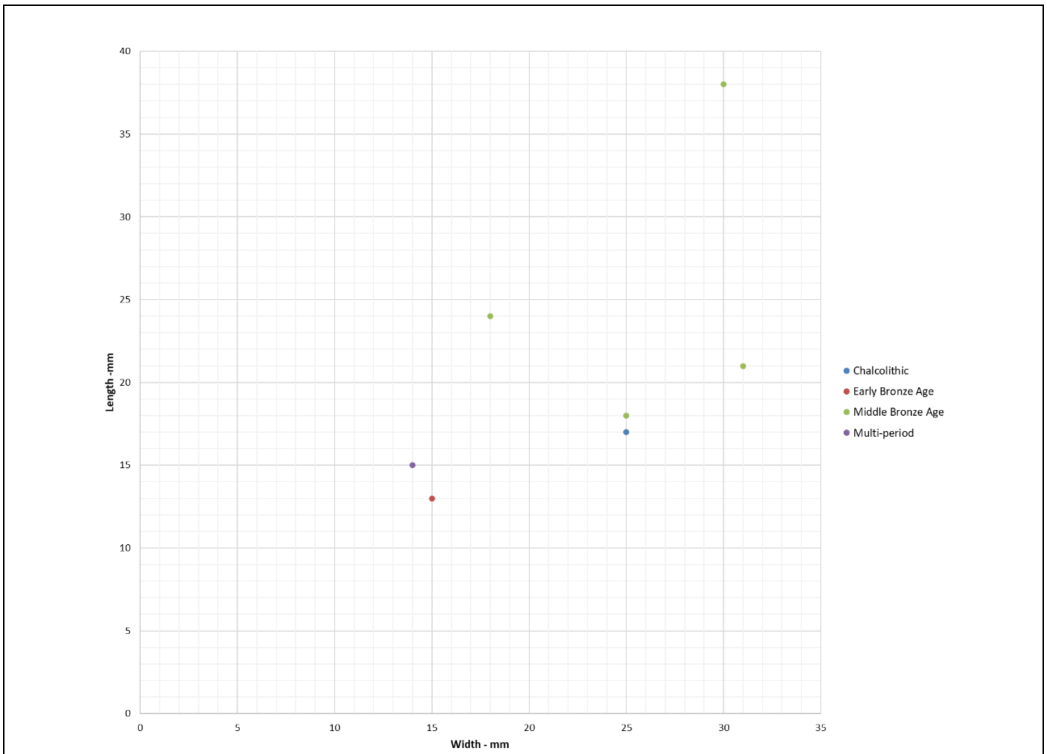


Fig. 6.8: Dimensions of wedges, by period.

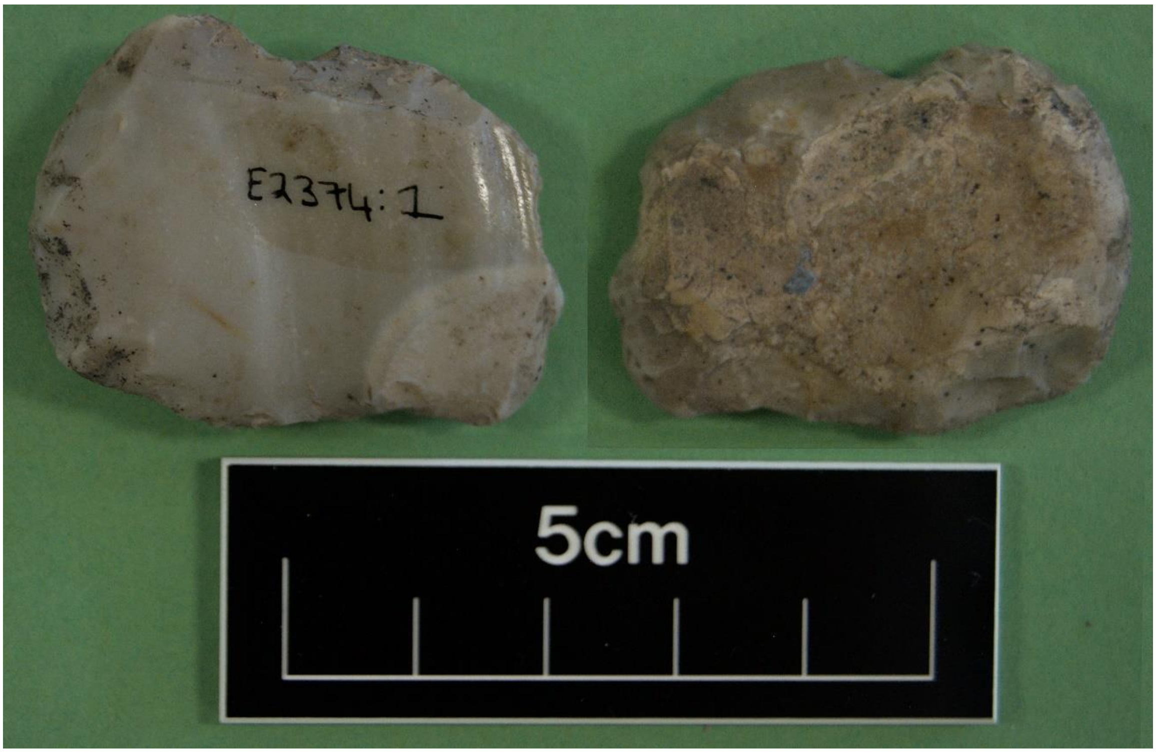


Plate 6.1: Wedge from Borris and Blackcastle AR31, Co. Tipperary, **E2374:4:1**.
Reproduced with the kind permission of the National Museum of Ireland.

Plate 6.2: Possible wedge from Kilmainham 1C, Co. Meath, **E3140:11:20**.
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- Re-sharpening Flakes

There were 29 re-sharpening flakes catalogued – 26 confirmed and three possible – from six sites (**Table 6.30**). Thought not a formal modified lithic themselves, their presence indicates such items. These were identified by a combination of: small size; curving profile; dorsal scars indicating previous retouch. Their presence also intimates a 'curation'[14] of some pieces, as well as secondary working.

Period	Site	Number of Pieces
EBA	Carrickmines Great 63M	7
MBA	Drumbaun 2	1*
	Grange 3	2
	Phoenixtown 3B	8*
M-P	Kilmainham 1C	8*
	Rathmullan 10	3

Table 6.30: Re-sharpening flakes, by period.
* = (includes) possible example

6.3.3 Residuality

Residual pieces are positively identified in the hollow scrapers (Woodman *et al*. 2006: 163). The concave scrapers are also seen as residual. This form is more associated with the Neolithic – due to their similarity to hollow scrapers (Driscoll 2013: 49; Robertson *et al*. 2010: 35; Bergh 2009: 111; Bamforth, Woodman 2004: 25; Nelis 2004: 164). A fragment of a possible polished axehead presents a more challenging identification. Lithic axeheads are viewed as dating from the Mesolithic to the Bronze Age (Cooney, Mandal 1998), with an unsupported suggestion of their manufacture into the Early Medieval (Gibson 2012: 64). These have been found in Chalcolithic and Bronze Age contexts – mostly funerary, but some domestic (Sheridan *et al*. 1992: 400). The spectre of residuality raises its head where these are concerned, as the continuation of production is not always strongly asserted or recognised (Driscoll 2009; Fredengren 2002: 154; Sheridan *et al*. 1992: 400). The single piece here is interpreted as residual.

No core material was taken into consideration. Five cores were categorised as 'platform', and three as 'combination'. This indicates that they displayed evidence of freehand reduction. The

[14] When referring to the curation of lithics, the following definition is adopted (Andrefsky 2005: 254): "the amount of use extracted from the potential maximum amount of use available in a specimen". However, the quantification of this is yet to be reliably measured (*ibid*.: 175).

Bronze Age, and to a lesser degree the Chalcolithic, is associated primarily with bipolar reduction, with freehand seen as rare or non-existent (O'Hare 2005). How well this view is established amongst analysts is hard to discern. Analysts, who appear to have previously dismissed freehand reduction, have started to propose or accept the use of a 'simple' or 'flat' platform technique into the Bronze Age (Woodman 2016: 75; Sternke 2009d: xli). Since there is no guidance to identify 'simple' or 'flat' platform reduction or discussion on the morphology of such platform cores present in later prehistoric centuries, no attempt was made to separate contemporaneous and residual freehand material. This reasoning was similarly applied to removals, e.g.: freehand flakes.

Residuality is attributed to the three hollow scrapers, the five concave scrapers, and the polished axehead fragment (**Table 6.31**). The inclusion of the axehead is a deliberate overweighting of the residual figure. This is done to present a higher confirmed rate, rather than under-representing it. This was thought best due to a lack of developed discussion on: 1) lithic working traditions of this period in general, and more specifically on ground lithic objects; and 2) the nuances of residuality, e.g.: heirlooms, and how exactly they should be understood in terms of lithic assemblages.

Residual items account for 7% [N=9] of modified pieces. From the total number of lithic products, this represents a confirmed residual rate of 0.7%. This is interpreted here as a low rate of residuality – although such a rate has not been noted in any other publications, so there is no comparative. Rather the determination 'low' is offered on the basis of anecdotal reading of reports – wherein residuality is often proposed for non-diagnostic pieces, resulting in a perceived high rate.

Period	Site	Modified Type	Find Number
CL	Rathmullan 6	Scraper - Hollow	01E0294:12:19
		?Scraper - Concave	01E0294:18:39
		?Scraper - Concave	01E0294:18:39
EBA	Donore 2	Scraper - Hollow	01E0399:22:1
MBA	Grange 3	Scraper - Concave	E3123:508:1
LBA	Creggan Lower 1	Scraper - Concave	E2658:45:30
M-P	Gardenrath 2	Scraper - Hollow	E3145:35:4
	Sheephouse 3	?Polished Axehead Fragment	00E0811:331:2
	Rathmullan 10	Scraper - Concave	00E0813:12:4

Table 6.31: Residual artefacts identified in analysis.

6.3.4 Carrickmines Great 63M

The site of Carrickmines Great 63M, Co. Dublin, was unique amongst those selected for analysis. The site is interpreted as a "specialised flint knapping site" (Conboy 2006: 7), and in the lithic analysis report as "special activity/purpose camp" (Ballin 2006: 23, 30). This is primarily for lithics, though grain processing is also posited. The structure defined by the excavation was a small rectangular example, differing from the general round-house style on other sites. The artefactual assemblage similarly differs – a large number of lithics, and a quantity of grains, along with a small amount of the more-frequently found pottery.

The analysed assemblage came from 12 contexts. These included fills of pits, fill of a hearth, fill of a post-hole, fill of a natural depression, and a spread.

Analysis and commentary on this site is limited by several issues with the final report. These include: the lack of detailed context and finds registers; the attached environmental report is for a different site; and radiocarbon dates were not included.

6.3.4.1 Assemblage

A total of 612 objects were examined. Of these, 562 pieces were determined to be artefacts, with 15 pieces being unclassified and 34 natural. There was one percussor recorded.

Debitage	**Number**
Core	74
Flake – Regular	40
Flake – Irregular	84
Blade	41
Chip	81
Chunk	48
Fragment	159
Other	29
Indeterminate	6
Total	562

Table 6.32: Breakdown of lithic assemblage by debitage categories.

Core Type	Number
Bipolar	53
Platform	1
Split Pebble	10
Tested Pebble	4
Indeterminate	6
Total	74

Table 6.33: Breakdown of core material.

Fourteen bipolar cores were recorded as phased. This includes one possible first-phase core on quartz, and two second-phase cores. The majority, 11 pieces, were third-phase cores.

Fifty artefacts were recorded as segmented pieces. Sixteen of these were recorded as cores, and 34 as debitage. This division was based on the angle at the interface of the two interior faces.

6.3.4.2 Geology

From CG63M (**Table 6.34**), flint accounts for 94%, quartz for 5%, and chert 1%. Some material from CG63M was recorded as natural. Eighteen pieces were noted as possible raw material , of which 16 were flint and two were quartz. Most of the flint pieces had polished cortex, with little to no chattering present, indicating a water-rolled source. These could have been gathered from beaches, of which the nearest is approximately 5km east of the site . Another possibility is that they were collected from nearby rivers, after nodules had been washed in from soils. Just under 6km to the northwest, the bedrock geology changes from various granites to Lucan Formation, consisting of dark limestone and shale (GSI 2020). This would be the closest potential zone for collecting in-situ chert (after Driscoll *et al*. 2016), though realised sources could be located farther afield. Given the similar distances between varying raw material resources, the dominance of flint indicates a clear preference for this material. It also indicates a selective procurement process within the region – travelling to an area, rather than gathering what was at hand, i.e.: *remanié* flint. The presence of *remanié* chert nearer to the site could also account for its limited presence.

	Raw Material – Geology		
Category	*Flint*	*Chert*	*Quartz*
[CORE]	67	2	5
[DEBITAGE]	473	0	15
[UNCLASSIFIED]	8	1	6
[NATURAL]	30	1	3
Overall	578	4	29
Total			611

Table 6.34: Raw materials present on CG63M, ordered by database category.

6.3.4.3 Reduction Stage

Flint core and debitage material is focused on here, accounting for 540 pieces. The identification of reduction stages on chert and quartz is not a clearly established.

The majority of material was reduced to a secondary stage, 53.1% [N=287], with tertiary being next, 25.4% [N=137], followed closely by primary, 21.5% [N=116]. The reduction stage of major debitage classes is laid out in **Table 6.35**. The presence of primary and secondary core material shows the early abandonment of cores, e.g.: tested cores. It is partly attributed to the presence of split pebbles. This predominance of primary and secondary material on sites of these periods has been noted before. It is attributed to the initial small size of the exploited resource, which does not allow for preparation of decorticated blanks by removing the cortex.

	Primary	*Secondary*	*Tertiary*
Core	27	36	4
Flake – Regular	13	23	3
Flake – Irregular	16	49	16
Blade	15	24	2
Total	71	132	25

Table 6.35: Reduction stages of flint pieces in major debitage classes.

6.3.4.4 Primary Technology

Bipolar reduction dominated the debitage. For core material, counting bipolar and split pebble (**Table 6.33**), it was identified on 85.1% of pieces. For flakes (regular, irregular) and blades bipolar reduction was seen on 94% of pieces (**Table 6.36**).

	Reduction Category			
Debitage	*BP + ?BP*	*FH + ?FH*	*Indeterminate*	**Total**
Flake – Regular	38	1	1	40
Flake – Irregular	77	3	4	84
Blade	40	0	1	41
Total	155	4	6	165

Table 6.36: Reduction categories for major debitage classes.

6.3.4.5 Modified Types

Three modified pieces were recorded: a convex scraper (**02E0700:6:678**); an awl/borer (**02E0700:10:955**); and a retouched piece (**02E0700:15:1001**). This represents a ratio of modified to unmodified pieces of 1:161.7. When this is compared to the ratios of modified and unmodified pieces across periods in **Table 6.25**, it indicates a greater presence of unmodified material at the site. Some of this indicates waste material. However, other unretouched 'tools', e.g.: segments, flakes, and blades, are also included in the unmodified figure. The ratio therefore likely under-represents the production level of the site.

6.3.4.6 Percussors

One percussor was analysed. This was an elongated pebble, with a plano-convex profile, which was had a polished feel. It measured 115mm L x 53mm W x 26mm T, and weighed 243.92g. No obvious use-wear was noted. Some abrasions were present, but it was not clear if they were archaeological in nature.

The excavation report notes the presence of four large stones in C43, which produced two pieces of flint (Conboy 2006: 3). None of the large stones were recovered. The feature was located outside the footprint of the structure, roughly two metres to the southwest. The largest stone was described as having a relatively flat surface and measured 0.44m x 0.12m x 0.15m (*ibid.*). No photographs, detail drawings, or detailed description of the object are provided. Though no definitive evidence that it was utilised was seen, it is suggested that it may have been used in the knapping process (*ibid.*) – as an anvilstone. If this were the case, it would be an example of a static anvilstone.

6.3.4.7 Summary

CG63M is an unusual site. A large quantity of lithics recovered from such a small area, with a tentative date to the Early Bronze Age, very much contrasts other sites of the period. The lithic material recorded is predominantly flint and has a high presence of primary and secondary material. The assemblage is dominated by non-retouched debitage, with modified lithics few in number. Knapping tools are not demonstrably present, with only one possible percussor analysed. This indicates a site where preliminary knapping took place, but where any tools produced were not used.

6.3.5 Conclusion

The analysis has confirmed the presence of lithic material on Chalcolithic and Bronze Age settlement sites. Scrapers are the most prevalent modified lithic, followed by retouched pieces. Re-sharpening flakes and core material on sites indicate a degree of knapping taking place at them.

A rate of residuality has been set out and determined to be low. Such a rate has not been formally established before. The determination low is in contrast to an anecdotal reading of lithic analysis reports and its suggested presence on sites.

6.4 The Occurrence of Bipolar Material

6.4.1 Introduction

The 542 pieces produced by bipolar reduction will be looked at in more detail here (**Table 6.37**). The identification of bipolar reduction took on a greater focus as the project progressed. The general lack in Irish reports of a uniform understanding amongst analysts, coupled with poorly presented schema, meant it was difficult to adapt Irish usage to this research. As a result, international sources, which supported schema with extensive visual aids, substantive descriptions, and supporting experimental investigations, were referred to. The applicability of these to Irish material was sought, by looking at diagnostic markers, and core typologies.

	Period							
Category	*CL*	*EBA*	*EBA (- CG63M)*	*MBA*	*LBA*	*IA*	*M-P*	**Total**
Bipolar	10	183	2	96	12	0	102	403 (222)
Bipolar Possible	11	37	0	54	10	0	27	139 (102)
Total	21	220	2	150	22	0	129	542 (324)

Table 6.37: Numbers of bipolar-reduced material – cores, flakes, and blades, by period.

6.4.2 Bipolar cores

The analysis identified 228 pieces that were classified as core material (**Table 6.38**). Of these, 82.5% [N=188], were associated with bipolar reduction. Three pieces were noted as displaying a combination of reduction methods, i.e.: freehand and bipolar. They are not included with the bipolar material. Bipolar core phases, split pebbles, and segmented pieces are discussed in detail.

Core Type	**Number**	**Percentage**
Bipolar	164	72
?Bipolar	4	2
Split Pebble	18	8
?Split Pebble	2	1
Platform	5	2
?Platform	1	0.5
Combination	3	1
Tested Pebble	11	5
?Tested Pebble	1	0.5
Re-used Form	3	1
Indeterminate	16	7
Total	228	100

Table 6.38: Categories of core material.

6.4.2.1 Core phases

Phases of bipolar core reduction were identified during the literature review. Research by Peña (2011) (see **Chapter 4.3.1**) has shown that bipolar cores display particular markings and morphology which relates to the extent of reduction. Three phases are noted: 1 = early working stage, some scars; 2 = developed working stage, *écaillé* and removal scars on both poles and faces; 3 = exhausted, core has sheared into sections. During the analysis, an attempt was made to identify phased pieces.

Thirty-eight pieces were noted with phases:

- First phase

  Two first-phase bipolar cores were identified. One was on chert, the other on quartz. The latter was a tentative identification due to the nature of the geology. The chert example was noted as having exterior surface and weathering rind visible in places. *Écaillé* retouch was visible at one pole. The opposing edge had the exterior surface present. While some crushing was seen, it is possible that the harder surface impacted the development of scars. No complete removals were evident, leading to it being classed as first-phase.

- Second phase

  Eight artefacts were identified as second-phase bipolar cores (**Plate 6.3**). Seven on these were on flint, and one on chert. The chert example and one flint had no exterior surface present, while the seven other flint cores had been reduced to a secondary stage. Two examples showed removals on one axis, with five having been rotated once. One piece had been rotated one more than one axis.

Plate 6.3: Second-phase bipolar core from Haynestown 1, Co. Louth, **08E0476:12:6**.
Reproduced with the kind permission of the National Museum of Ireland.

- Third phase

Twenty-eight artefacts were identified as third-phase bipolar cores (**Plate 6.4**). These pieces displayed a triangular or quadrangular cross-section. Of the faces, typically two displayed portions of removals, while the other one or two had a sheared appearance. There could be difficulty in differentiation, as there is little difference between a dorsal scar and sheared surface. If *écaillé* retouch was visible, this aided in identification of faces, as it is usually more developed in association with removals, than shearing.

Plate 6.4: Third-phase bipolar core from Carrickmines Great 63M, Co. Dublin, **02E0700:5:1217**.
Reproduced with the kind permission of the National Museum of Ireland.

The sizes of the core phases display some patterning (**Fig. 6.9**). The majority of third-phase cores have a width of 15mm or less, with first- and second-phase ones having widths greater than 15mm. The two wider third-phase pieces may indicate the reduction of larger raw materials. There is a single second-phase core with a width of 11mm – this may be misidentified.

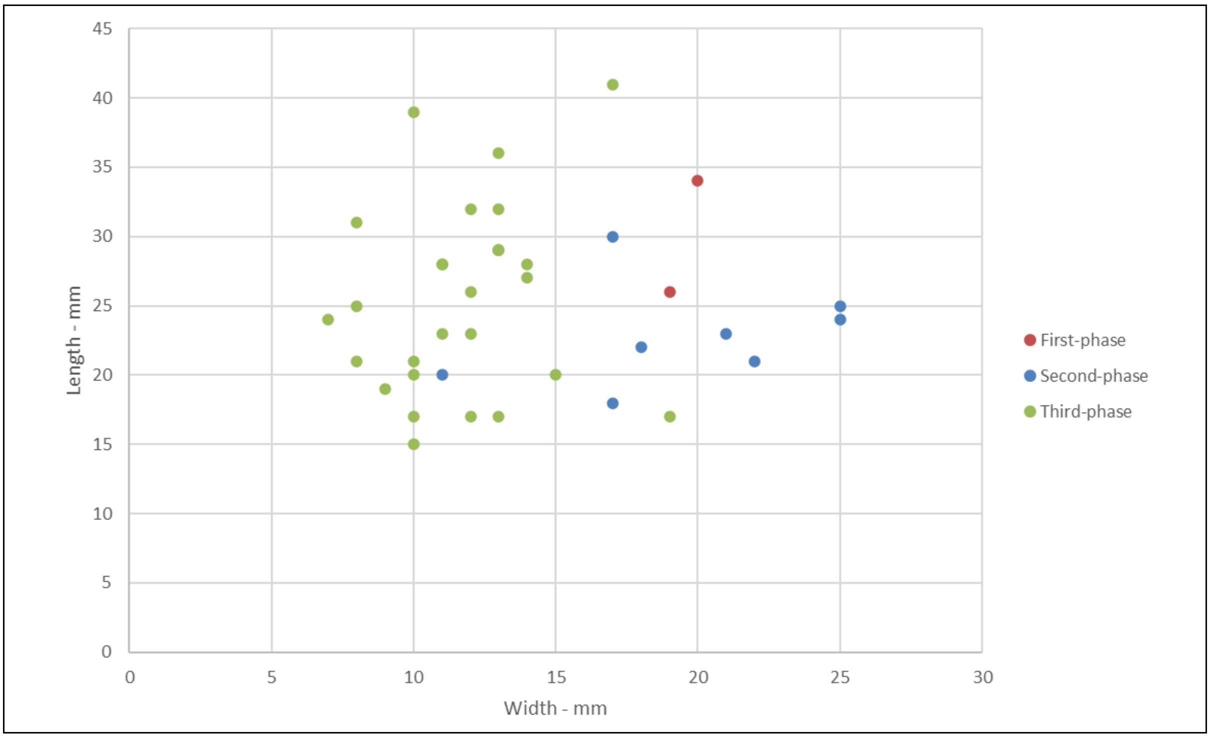

Fig. 6.9: Dimensions of phased bipolar cores.

These pieces came from seven sites. Two sites – Carrickmines Great 63M and Sheephouse 3 – returned pieces of each phase. Three sites – Rathnaveoge Lower 4, Rathmullan 10, and Haynestown 1 – returned phase 2 and 3 pieces. Two sites – Kilmainham 1C and Ballynattin – returned phase 3 cores. The presence of all three phases on Sheephouse 3 could be taken to indicate the exhaustive reduction of material. However, the pieces were recovered from three different contexts, so contemporaneity is difficult to establish. That Carrickmines Great 63M produced pieces of all three phases – though with one dubious quartz piece – is not surprising. Given its interpretation as a knapping camp (Conboy 2006), it should display pieces at various stages of reduction. The presence of developed/exhausted bipolar cores, i.e.: second- or third-phase, on the other sites, provides support for the interpretation of self-sufficient Bronze Age households (Ginn 2016).

6.4.2.2 Split pebbles

Split pebble s accounted for 8.7% of core material, with 18 confirmed pieces and two possible (**Table 6.39**). They are discussed here, though there is some debate as to their technical classification as core or product. Split pebbles are created by vertical axial bipolar reduction (**Plate 6.5**). This means that the ventral face should be straight, differentiating them from horizontal axial bipolar pieces. Seventeen pieces were at a primary reduction stage, with three secondary. The high percentage of primary pieces is to be expected. Split pebble reduction is presented as being used on small raw materials. The three secondary pieces could indicate raw material where the cortex was not present when gathered, or that two or more strikes were needed to split the pebble, with initial blows producing cortical debitage.

Period	Site	Find Number
CL	Rathmullan 6	01E0294:12:456*
EBA	Carrickmines Great 63M	02E0700:6:607
		02E0700:6:611
		02E0700:8:1214
		02E0700:8:1223
		02E0700:10:1027
		02E0700:10:1139
		02E0700:14:938
		02E0700:16:374
		02E0700:16:425
		02E0700:24:781
MBA	Charlesland D	03E0146:34:1
		03E0146:58:37*
M-P	Kilmainham 1C	E3140:11:30
		E3140:442:15
	Sheephouse 3	00E0811:588:7
		00E0811:603:1
	Rathmullan 10	00E0813:73:1
	Ballynattin	04E0712:25:7
		04E0712:107:2

Table 6.39: Split pebble material by period.
* = possible examples

The dimensions show clustering between 20-40mm length, 10-25mm width, and 7-9mm thickness (**Fig. 6.10**). Several larger pieces appear, with outliers above 40mm length and 25mm width. This indicates a size range of raw materials exploited. An overlap with phased bipolar cores is seen. The minimum dimensions of split pebbles correspond with those of the majority of phased pieces. The maximum length dimension of phased cores is exceeded by two split pebbles. The maximum width dimension is slightly greater in a number of split pebbles. This indicates alternative practices in reducing similar resources. It would be difficult to reduce the split pebbles further so that they take the form of phased bipolar cores.

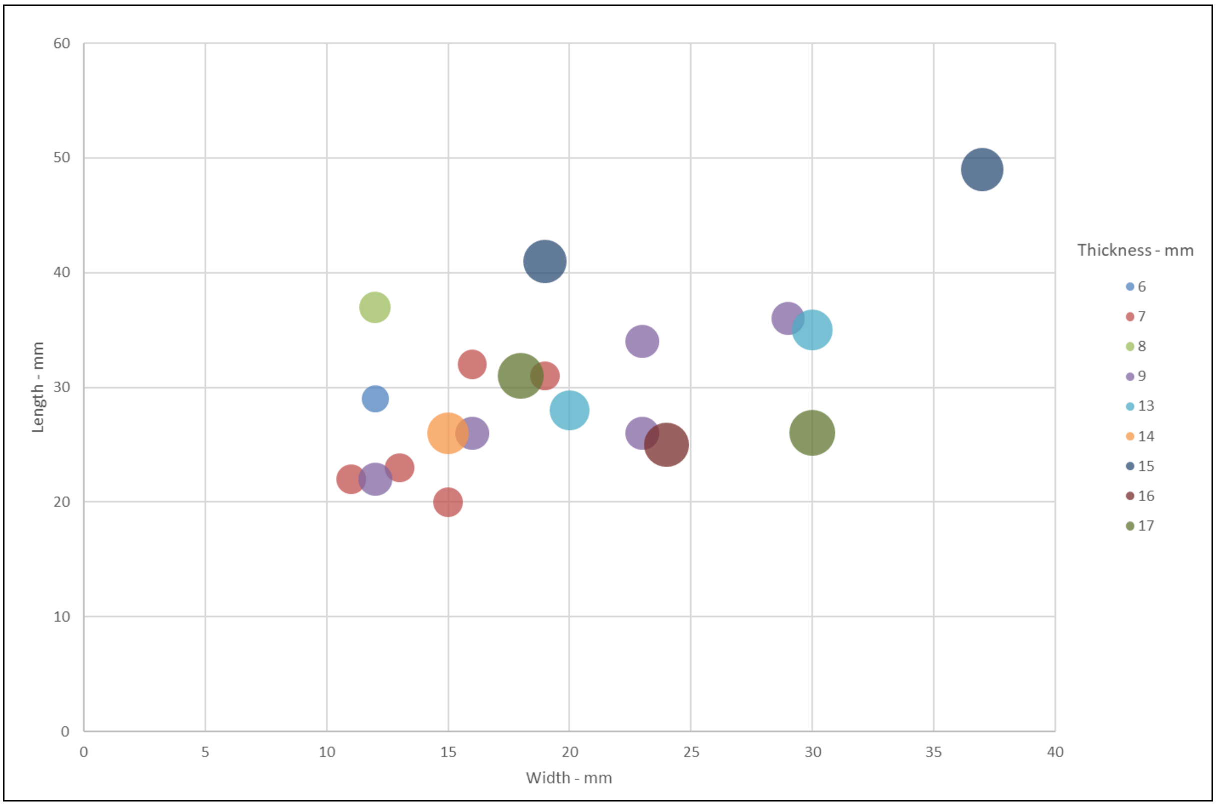

Fig. 6.10: Dimensions of split pebbles [N=20].
Chart displays three dimensions: Length = Y-axis; Width = X-axis; Thickness = size/colour of bubble.

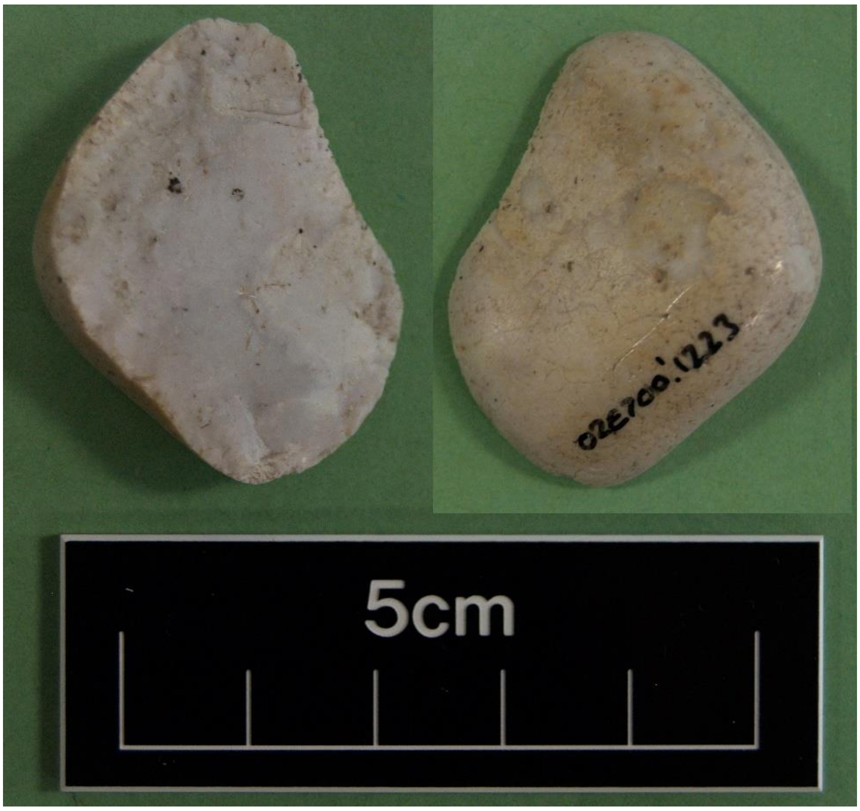

Plate 6.5: Split pebble from Carrickmines Great 63M, Co. Dublin, **02E0700:8:1223**.
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However, an alternative explanation may be posited. The pieces classed as 'split pebble' could be the tail end of resource that has been sliced (see **Chapter 4.2.1**). In this case, the split pebble portion would be equal to the final flake removed. This could produce a flat vertical axial bipolar face, rather than the curved one associated with horizontal axial bipolar.

6.4.3 Bipolar Debitage

The identification of bipolar debitage utilised four markers: waves of percussion; bulb of percussion; platform; and termination. Confirmed bipolar material predominantly displayed a minimum of three definite markers (**Table 6.40**). Confirmed material displaying two definite markers, and up to two indeterminate markers, accounted for 11.4%. These may have been better recorded as possible bipolar.

Possible bipolar material displayed a greater variation in the combination of markers (**Table 6.41**). A minimum of three definite markers was seen on 61% of pieces. It could be argued that these pieces should be moved to confirmed bipolar. This indicates a degree of subjective assessment on the part of the analyst. Given that only complete waves of percussion were seen as approaching a diagnostic trait of bipolar reduction, it could be that possible bipolar pieces displayed the other three markers – making confirmation less sure. Pieces with two definite markers, and up to two indeterminate, accounted for 27.1% of the material. Material with one definite marker represents 6%, and a further 4.6% displayed only indeterminate markers. It may be better to class pieces with so few definite markers as indeterminate reduction.

The presence of 81 pieces of possible bipolar material with three or more confirmed markers indicates the analyst's learning. In the following analysis, these were left as possible, rather than being migrated to confirmed bipolar.

	Combination of markers						
	4	3 + ?1	3	2 + ?2	2 + ?1	2	**Total**
Number	115	16	67	2	7	14	221

Table 6.40: Combinations of definite and indeterminate (?) markers on confirmed bipolar material.

		Number
Combination of markers	4	32
	3 + ?1	17
	3	32
	2 + ?2	2
	2 + ?1	10
	2	24
	1 + ?3	3
	1 + ?2	1
	1 + ?1	3
	1	3
	0 + ?3	5
	0 + ?2	1
	Total	133

Table 6.41: Combinations of definite and indeterminate (?) markers on possible bipolar material.

6.4.3.1 Reduction Markers

Bipolar debitage is discussed here [N=354]. The following results for markers were obtained for confirmed bipolar (BP) and possible bipolar (?BP):

- BP: Bulb of Percussion:

  A Bulb of Percussion were noted as present on 137 pieces, and absent on 71. It was indeterminate for 13 pieces (**Fig. 6.11**).

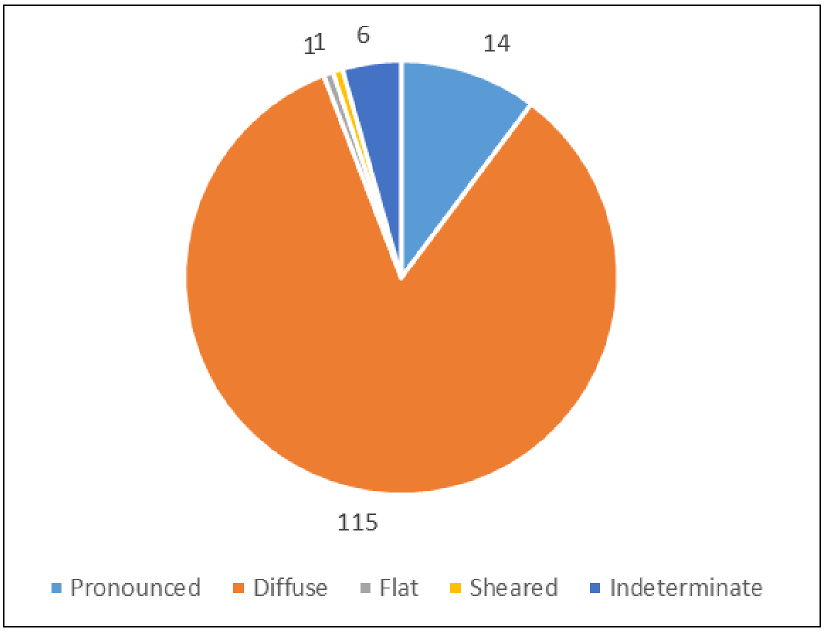

Fig. 6.11: Bulb of Percussion, where present, by type – bipolar.

- ?BP: Bulb of Percussion:

A Bulb of Percussion were noted as present on 50 pieces, and absent on 63. It was indeterminate for 20 pieces (**Fig. 6.12**).

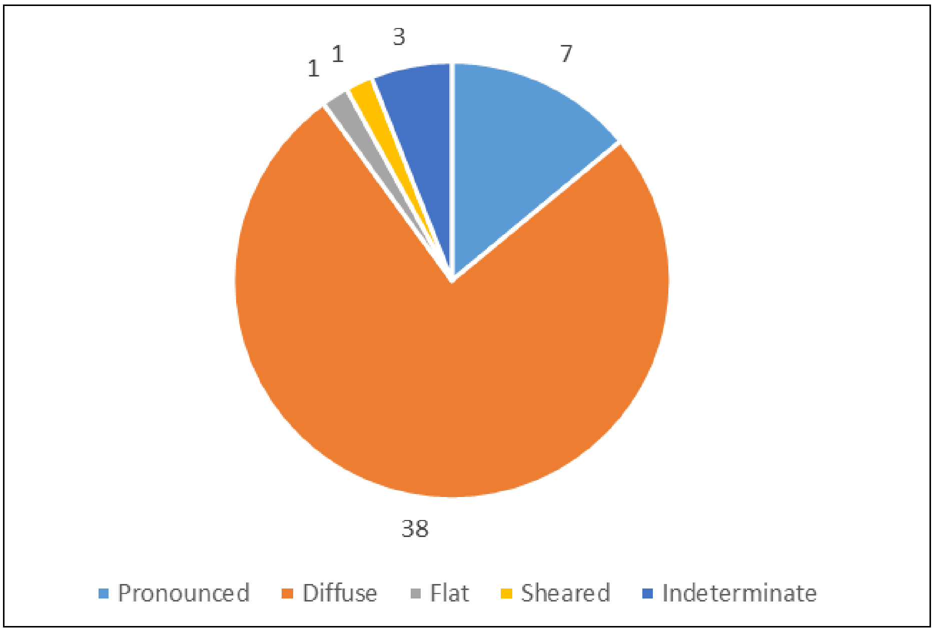

Fig. 6.12: Bulb of Percussion, where present, by type – bipolar possible.

Issues can be identified with the markers and their use. Regarding bulbs of percussion, the presence of a sheared bulb and a flat bulb indicates this. The differentiation between an extremely diffuse bulb, a flat one and no bulb is incredibly subjective. The 134 pieces with no bulb recorded could be interpreted as a having a flat bulb. Bipolar reduction is associated with flat faces. The presence of pronounced bulbs on 3.5% of confirmed bipolar pieces shows that this is not always true.

The presence of two sheared bulbs highlights another issue. This indicates the presence of a hinged bulb of percussion. While only rarely noted explicitly in the Bulb_of_Percussion database field, other pieces were recorded as having them in the Notes database field. The confirmed bipolar pieces produced 37 examples. These were both positive and negative in form.

- BP: Waves of Percussion:

Waves of Percussion were noted as present on 198 pieces, and absent on 18. They were indeterminate for five pieces (**Fig. 6.13**).

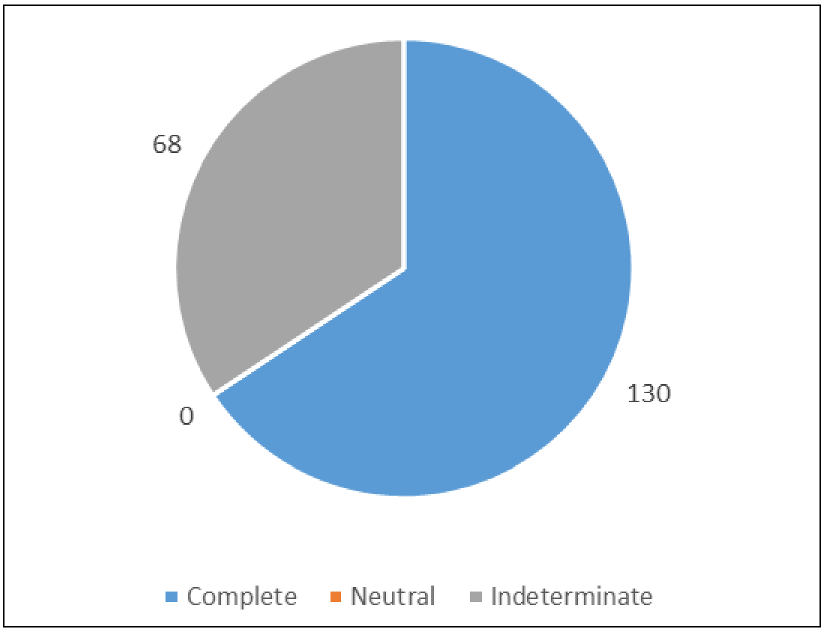

Fig. 6.13: Waves of Percussion, where present, by type – bipolar.

- ?BP: Waves of Percussion:

Waves of Percussion were noted as present on 87 pieces, and absent on 32. They were indeterminate for 14 pieces (**Fig. 6.14**).

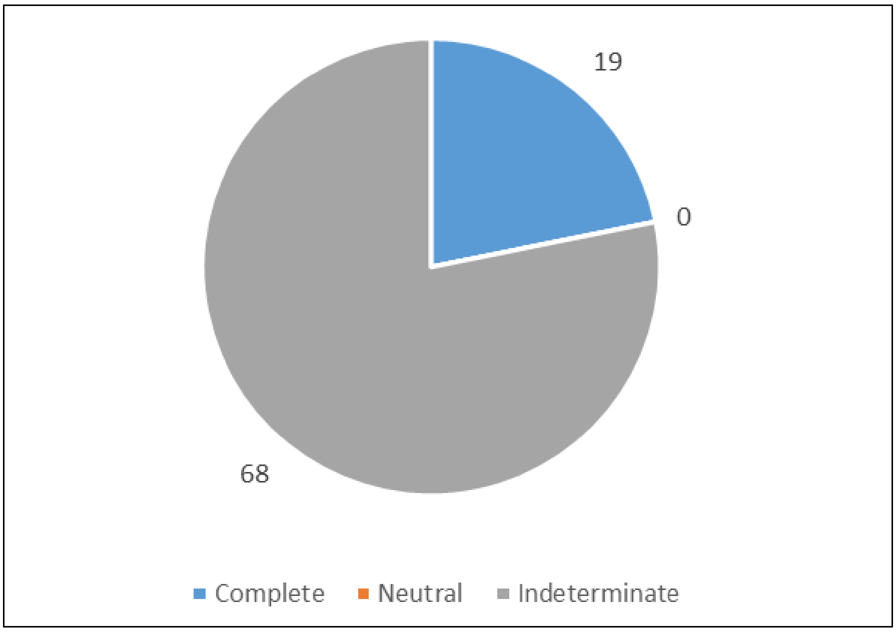

Fig. 6.14: Waves of Percussion, where present, by type – bipolar possible.

It was expected that there would be no pieces displaying neutral waves of percussion. The presence of these discounts bipolar percussion. Neutral waves are only created during conchoidal percussion which involves a Hertzian cone, i.e.: freehand reduction.

The recording of 19 pieces which had waves of percussion with a complete extent as possible bipolar is due to a technical detail. Whether waves of percussion with a complete extent were definitive of bipolar reduction was undetermined at the time of analysis. The possibility that other forms of direct percussion, e.g.: pressure flaking, or forms of indirect percussion, e.g.: punch, create non-conchoidal fracture patterns remains undiscussed. Presenting experimental work on long blade production using indirect percussion, Pelegrin (2006: 42, 45, 47) discusses some features – but not waves of percussion. Examining the images provided of proximal ventral ends (*ibid*.: 46 – Fig. 3), some of the waves appear to have a complete extent – mirroring those produced by bipolar reduction.

However, the understanding of what reduction techniques are in play during an archaeological period should help in clarifying which was responsible. In this case, it is likely that all pieces with waves of percussion with a complete extent are the result of bipolar reduction. Indirect forms of percussion are not thought to have been utilised in Chalcolithic and Bronze Age Ireland (see Woodman *et al*. 2006; O'Hare 2005).

- BP: Platform:

A platform was noted as present on 211 pieces, and absent on eight. It was not clear on a further two (**Fig. 6.15**).

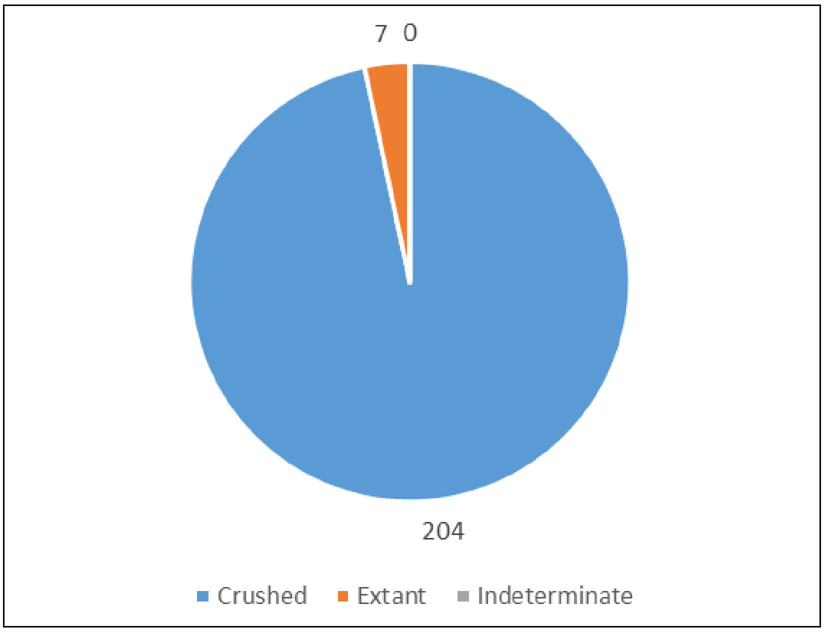

Fig. 6.15: Platform, where present, by type – bipolar.

- ?BP: Platform:

A platform was noted as present on 105 pieces, and absent on 14. It was not clear on a further 14 (**Fig. 6.16**).

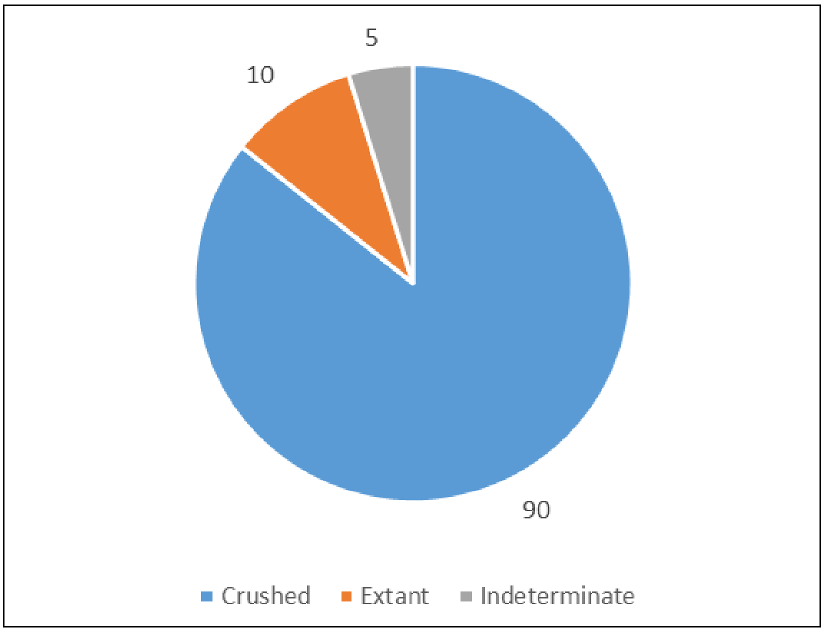

Fig. 6.16: Platform, where present, by type – bipolar possible.

Opposed crushing is frequently seen as an indicator of bipolar reduction – axial strictly speaking. This could be inferred as an assemblage-level identifier, i.e.: not present on each piece. However, the lack of a comprehensive description of bipolar reduction makes this difficult to establish.

This general view is challenged by the presence of 17 pieces which have extant platforms. These pieces variously displayed hinged, feathered and 'other' terminations. It cannot be stated whether extant platforms only appear with axial or non-axial bipolar, due to the variation in terminations. Sixteen examples were on flint, and one on chert. While this only represents 3.1% of all bipolar material assessed here, it does challenge the view that such reduction is only evidenced by crushing.

- BP: Termination:

Terminations were noted as present on 207 pieces, and absent on five. It was not clear on seven (**Fig. 6.17**).

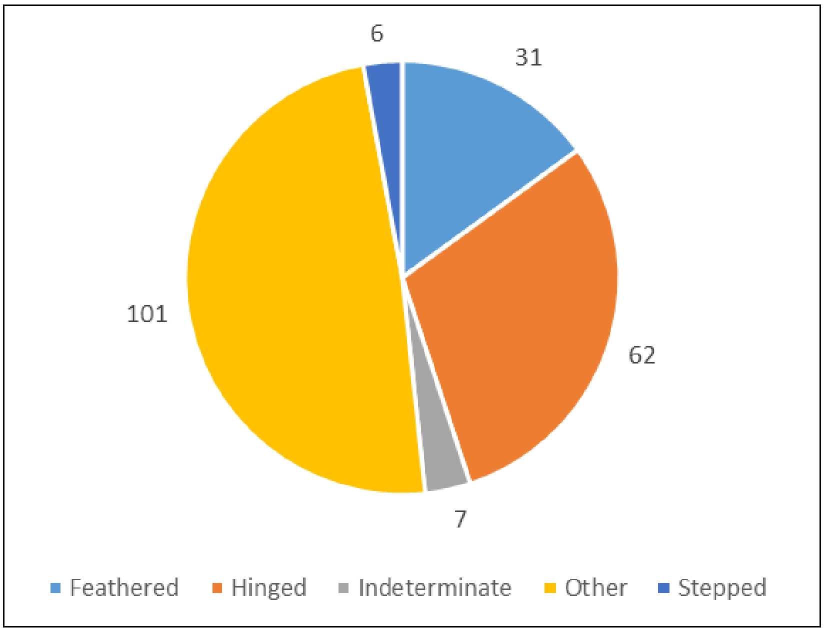

Fig. 6.17: Termination, where present, by type – bipolar.

- ?BP: Termination:

Terminations were noted as present on 115 pieces, and absent on four. It was not clear on 14 (**Fig. 6.18**).

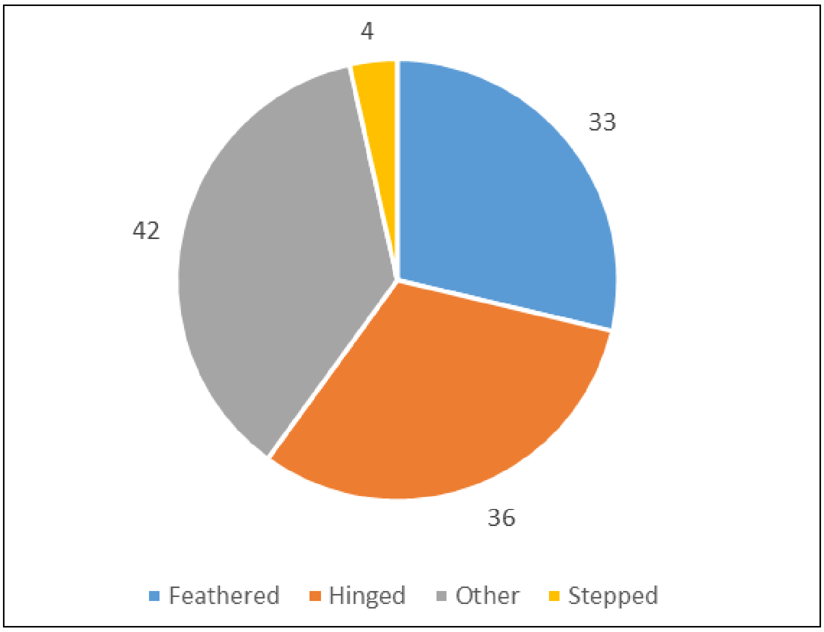

Fig. 6.18: Termination, where present, by type – bipolar possible.

It was expected that there would be no pieces displaying a plunging termination. The presence of these discounts bipolar percussion. Plunging terminations are prohibited by the anvil impact point. The impact force of the hammerstone is incapable of travelling beyond the contact point of the opposing anvilstone. Fractures cannot be initiated from the side opposing the hammerstone and above the anvil surface.

The use of 'other' as a termination type is inappropriate. It is too vague to be useful. It was used for the purpose of identifying terminations associated with bipolar reduction. The terms 'bipolar' or 'crushed' were not used as the former was a loaded term and the latter could be misleading.

Bipolar reduction is associated with several variable markers. These can be strongly characteristic, e.g.: waves of percussion with a complete extent, or bulbs of percussion which can be diffuse, hinged or sheared. These still require some clarity, as there is likely to be overlap with other reduction methods, such as indirect percussion. This method also produces non-conchoidal fracture markers, so variation would be seen elsewhere on pieces. Crushed platforms are typically associated with bipolar reduction. The presence of extant platforms recorded here may indicate this is not always the case. Less characteristic are the terminations. There is a large degree of overlap with those produced through other reduction methods. Plunging terminations are characteristic in a negative sense – if this is present, the piece cannot be bipolar.

6.4.3.2 Categories of reduction

Two principal categories of bipolar reduction are recognised – axial and non-axial. It is possible that non-axial pieces are evident within the data. Assuming that ideal bipolar reduction produces waves of percussion with a complete extent, a diffuse or flat bulb of percussion, and a crushed platform in both categories, variation in the termination could be used to further categorise pieces. Also, it may be possible to identify horizontal axial bipolar material due to the distinct curvature of the ventral face (**Fig. 4.2**: 2).

In non-axial bipolar percussion, with an eccentric impact point (**Fig. 4.2**: 4, 6), a feathered termination could be produced. The curving distal end is allowed for by the in-set anvil point. This interpretation varies from the predictable line of fracture displayed in **Figure 4.2**; although it is thought to be a reasonable alternative.

Eleven bipolar pieces displayed a feathered termination, alongside the three other markers (**Table 6.42**). This represents a presence of 5% for non-axial pieces within the confirmed bipolar material, and 1% of the overall removals.

Period	Site	Find Number	Material
EBA	Carrickmines Great 63M	02E0700:10:948	Flint
		02E0700:10:1205	Flint
		02E0700:14:968	Flint
MBA	Phoenixtown 3B	E3130:1115:12	Flint
	Charlesland D	03E0146:58:62	Flint
		03E0146:58:98	Flint
		03E0146:164:2	Flint
LBA	Creggan Lower 1	E2658:199:6	Chert
M-P	Kilmainham 1C	E3140:412:3	Flint
	Sheephouse 3	00E0811:163:3	Flint
	Haynestown 1	08E0476:58:1	Flint

Table 6.42: Non-axial bipolar lithics.

A total of 54 pieces displayed hinged or stepped or other terminations, alongside the three other markers. It cannot be said whether these represent axial or non-axial bipolar. Both hinged and stepped terminations could occur with either. It should also be considered that those terminations can be the result of later breakage. The ‘other’ classification, while associated with bipolar pieces, is too vague to allow further interpretation.

Sixteen pieces, from six sites, were identified as horizontal axial bipolar (**Table 6.43**). This was due to the presence of a mirror-symmetrical curve[15] on the ventral face, curving around the horizontal axis (**Plates 6.6**, **6.7**). Eleven pieces were worked at a primary stage, with four secondary and one tertiary pieces. The predominance of primary pieces is to be expected. This sub-category is associated with opening pebble resources.

Period	Site	Find Number	Material
EBA	Carrickmines Great 63M	02E0700:5:1247	Flint (P)
		02E0700:6:601	Flint (P)
		02E0700:9:849	Flint (S)
		02E0700:10:1136	Flint (P)
		02E0700:14:942	Flint (P)
		02E0700:16:385	Flint (P)
MBA	Grange 3	E3123:6:4	Flint (T)
	Charlesland D	03E0146:19:1	Flint (S)
		03E0146:327:1	Flint (P)
M-P	Rathmullan 10	00E0813:5:7	Flint (S)
		00E0813:147:11	Flint (P)
	Ballynattin	04E0712:25:1	Flint (P)
		04E0712:25:10	Flint (P)
		04E0712:25:19	Flint (P)
	Haynestown 1	08E0476:12:24	Flint (S)
		08E0476:62:1	Flint (P)

Table 6.43: Horizontal axial bipolar lithics.

[15] This is a subjective description of the profile. Whether the curve produced by horizontal axial bipolar reduction is true mirror-symmetric, in the mathematical sense, is unestablished.

Plate 6.6: Bipolar slice/decapitation flake from Haynestown 1, Co. Louth, **08E0476:62:1**.
Reproduced with the kind permission of the National Museum of Ireland.

Plate 6.7: Bipolar slice/decapitation flake from Haynestown 1, Co. Louth, **08E0476:62:1**.
Reproduced with the kind permission of the National Museum of Ireland.

6.4.3.3 Segmented pieces

A total of 54 segmented pieces were identified (**Plates 6.8**, **6.9**). Of these, 17 were categorised as cores and 37 as debitage. All pieces are discussed in this section. While there is a suggestion that broader segments may act as cores, the separation of material as core and debitage during the analysis was not strict – there being some admixing of classifications when compared through size charts. Most material was at either the primary [N=28] or secondary [N=25] reduction stage; with only one debitage entry noted as tertiary. All pieces were flint.

Figure 6.19 displays the sizes for complete segmented pieces, both core and debitage. There is considerable variation in the material. Some of the smaller material – with dimensions of <20mm L x <10mm W x < 5mm T – may be considered 'waste', or unintentional by-products. These had the same profile as larger pieces, but the diminutive size gave a subjective impression of non-intent. Given Knarrström's (2001: 108) production strategy for segments – where pebbles are first split, and then the halves further split – it is interesting that the maximum dimensions for these pieces fall just within those of split pebbles.

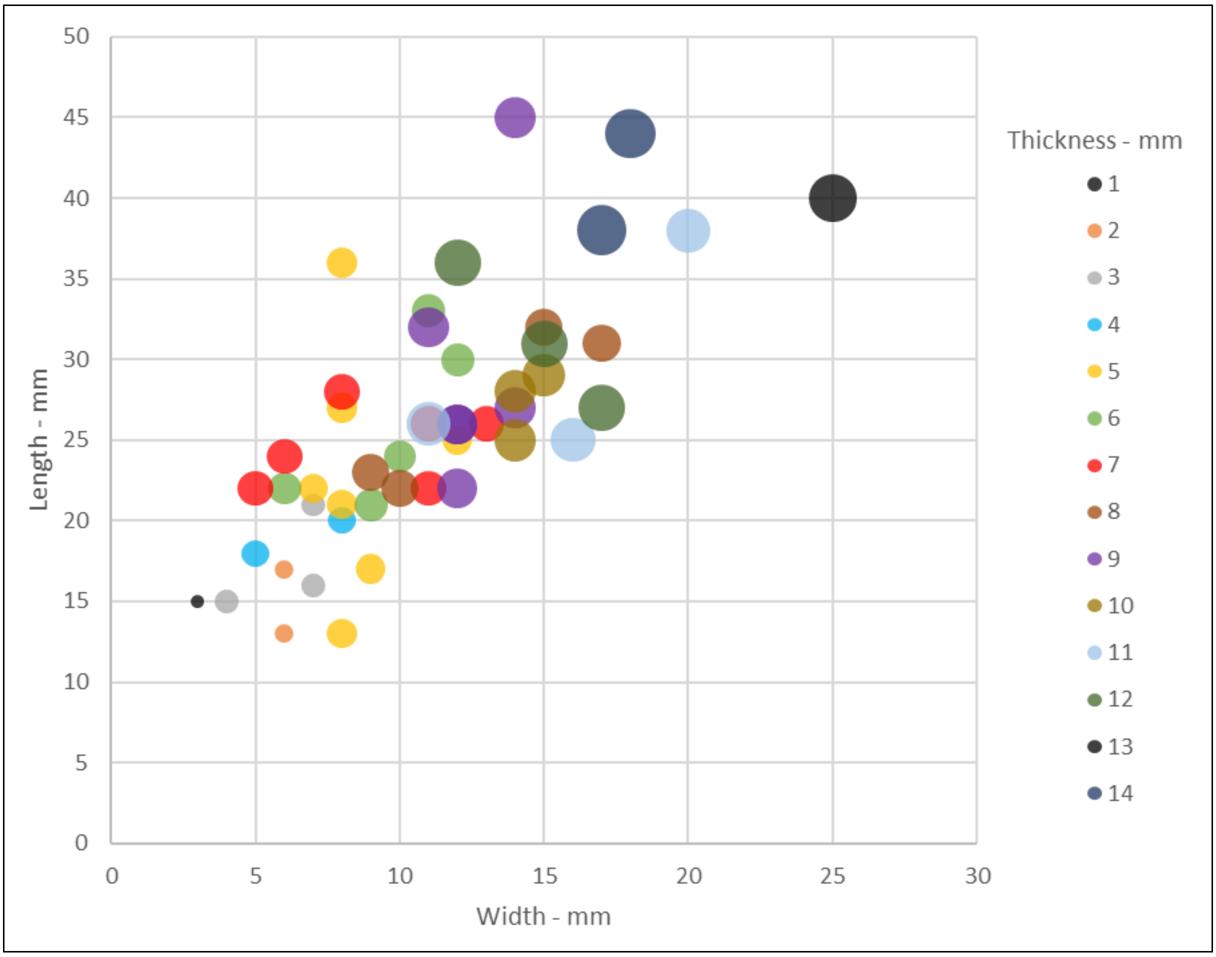

Fig. 6.19: Dimensions of segmented material (complete) [N=48].
Chart displays three dimensions: Length = Y-axis; Width = X-axis; Thickness = size/colour of bubble.

The fact that all pieces recorded were of flint may be of interest, though a much larger sample is needed to validate this. Chert only appeared in small quantities from two of the sites: CG63M – two chert cores; and Kilmainham 1C – four chert lithic products. However, the material may also play a role. Chert or other materials may not be as conducive to this pattern of fracturing, and therefore are not reduced so. This view would need to be investigated further, either through targeted analysis or experimental research.

Plate 6.8: Segmented piece from Charlesland D, Co. Wicklow, **03E0146:64:2**.
Reproduced with the kind permission of the National Museum of Ireland.

Plate 6.9: Possible segmented piece from Charlesland D, Co. Wicklow, **03E0146:346:1**.
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6.4.4 Bipolar tool-kit – percussors

The presence of bipolar-reduced material on sites implies the need for a bipolar tool-kit, i.e.: a hammerstone and an anvilstone. Hammerstones are frequently noted on archaeological sites, although the corresponding anvilstone is rarely recovered. As with other aspects, these pieces can be poorly defined and/or described. Sixty pieces were recorded within the [PERCUSSOR] table. Of these, 14 were identified as passive percussors (**Plates 6.10**, **6.11**), 35 as active, six as active/passive, and five were indeterminate. The identification of anvil- and hammerstones was the primary aim (**Table 6.44**). The experimental work that their identification was based on displayed anvilstones with clear signs of working – breaks, chipping, . The archaeological examples recorded here did not have this level of clarity. There are indications of pocking or chipping of surfaces, but they are more ephemeral.

However, the system of recording was not sufficient to allow for a proper analysis of coarse lithic material. The fields generated in the database were not nuanced enough to record the variety of markings that could be found. This was a consequence of attempting to simplify the approach of studies that looked in detail at macro-use-wear marks. This assessment would have benefitted from having a reference system for faces and edges, which would allow for use-wear to be noted in relation to each and then the overall patterning derived.

Period	Site	Name	Find No.	Category
MBA	Borris and Blackcastle AR31	Anvil-/Pounder/Grinding Stone	E2374:2671:640	Active/Passive
	Grange 3	Anvilstone/Pounder	E3123:229:1	Active/Passive
	Phoenixtown 3B	?Rubbing/Hammer-stone	E3130:1001:225	Active
	Drumbaun 2	Hammerstone	E3912:134:1	Active
LBA	Rathnaveoge Lower 4	?Hammerstone	E3623:25:24	Active
M-P	Caherdrinny 3	Hammerstone	E2422:405:2	Active
		Hammerstone	E2422:2665:1	Active
	Ballylegan 207.2	?Anvil/Rubbing-stone	E2265:78:42	Active/Passive
		Hammerstone	E2265:78:43	Active
		?Hammerstone	E2265:78:44	Active
	Sheephouse 3	?Anvil/Bed-stone	00E0811:18:1	Passive
		Anvilstone	00E0811:94:5	Passive
		Rubbing/Hammerstone	00E0811:102:4	Active
	Haynestown 1	Rubbing/Anvil/Hammer-stone	08E0476:38:1	Active/Passive

Table 6.44: Objects identified as hammerstones and anvilstones, by period and category.

The four active/passive pieces displayed impacts and abrasion on a surface, and no marks in the edge zones. For the passive pieces, one displayed surface abrasion and impacts, while the marks on the other were indeterminate. The edge zones displayed possible impacts, and no abrasion marks were noted.

The active pieces displayed a more complex set of a marks. All eight pieces displayed edge impacts, with four pieces also having surface impacts. The rubbing/hammerstone **00E0811:102:4** displayed edge abrasion. Hammerstone **E2265:78:43** displayed surface abrasion. On the back of this, we could say it has been mis-identified, and is more correctly a 'rubbing/hammerstone'. The possible rubbing/hammerstone **E3130:1001:225** was not recorded as having any abrasion. In this case, it would be more correctly recorded as a hammerstone.

Plate 6.10: Anvilstone from Sheephouse 3, Co. Meath, **00E0811:94:5**.
Reproduced with the kind permission of the National Museum of Ireland.

Plate 6.11: Anvilstone from Sheephouse 3, Co. Meath, **00E0811:94:5**.
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6.4.5 Effect of Geology

For complete pieces, the visibility of the reduction method was seen to vary with raw material (**Table 6.45**). Both flint and chert displayed information of reduction markers to roughly the same extent – the former 78%, and the latter 83%. The visibility of markers on quartz was reduced compared to these, being noted on 44% of pieces.

	Reduction				
Rock Type	*Bipolar*	*Bipolar Possible*	*Freehand*	*Freehand Possible*	*Indeterminate*
Flint	34	29	10	6	21
Chert	15	14	51	5	15

Table 6.45: Representation of reduction techniques on rock types (percentage).

Most bipolar reduction experiments focus on flint, with some work conducted using quartz. The development of markers on these mediums is well catalogued and understood. Chert – as identified in Irish analyses, i.e.: silicate deposit in limestone – is a key resource in Irish lithoculture. However, this form of siliceous rock is less frequently seen, or not all, in experimental knapping – these focussing on quartz and (as identified in Ireland) flint. The difference in structure, e.g.: bedding planes or cortex, likely affects the production of debitage and the development of markers.

6.4.5.1 Unclassified material and bipolar material

Eighty-five pieces were recorded as unclassified. These were placed under this category due to lack of confirmed bipolar markers, but whose form did not appear entirely natural. This may be related to the effects of geology on reduction markers. Pieces of interest had geologies of flint, chert, and quartz.

Ten pieces were recorded under other geologies: granite = 1; sandstone = 2; indeterminate = 7. They refer to pieces which may or may not be ground/coarse lithic artefacts, and will not be discussed here.

A stark difference can be seen in the ratios of unclassified objects to struck through raw materials. Regarding flint [N=41], only one piece out of approximately every 27 [1097:41] was of unclear origin. With chert [N=26] this increases massively, to one out of five pieces [63:13]. And again, with quartz [N=8], where nearly a third of the analysed pieces were unclassified

[13:4]. This is likely a consequence of the differing structures of various geologies and their effects on the development of knapping markers (Driscoll 2010; Driscoll, Warren 2007).

CG63M returned 15 unclassified pieces – chert = 1; quartz = 6; flint = 8. This represents 3% of the debitage classes. Drift (2012b: 9) has proposed an algorithm for sorting pieces by natural or intentional bipolar reduction. This was developed in response to an automatic classification of non-conchoidal pieces as natural. Non-conchoidal pieces can be classed as intentional if the excavated site has defined archaeological features with undisturbed contexts, or where contexts are disturbed, a typologically-correct assemblage is recovered with a low natural incidence. In an independent analysis, i.e.: commercial lithic report, the material could be related back to the specific site conditions it was recovered from, and it would be reasonable to migrate these pieces to debitage, using Drift's Algorithm B (*ibid*.).

6.4.6 Conclusion

Bipolar reduction has been confirmed using international markers. This was done using a combination of four markers. This shows their replicability and reproducibility by independent research, and validates their use in lithic analyses per the scientific method. The results of the analysis were largely affirmative of the understandings presented by other researchers. Where there is some questionable results, they are attributed to the learning curve of this researcher.

The use of multiple indicators is advised as no one marker is thought to be diagnostic. The complete extent of waves of percussion would appear to be, though there are other methods of non-conchoidal fracturing, e.g.: punch, so cannot be. However, a thorough understanding of lithic traditions should allow for one method to be settled upon.

Geology is a compounding factor in the identification of bipolar reduction, and perhaps all lithic reduction more generally. Referring specifically to the Irish setting, the lack of experimental work on chert leads to difficulty in understanding the products of knapping and their identification.

7. Discussion

7.1 Introduction

The discussion will focus on two broad areas: lithics from Chalcolithic and Bronze Age Ireland; and the identification of bipolar reduction. The former discussion will relate the results of the analysis to current understandings of the lithic tradition of these periods; and compare the settlement material analysed to lithic material in burials. The latter will comment on the use of international markers, and the pieces identified. Reference to the bipolar tool-kit, and issues with terminology will also be made.

7.2 Chalcolithic and Bronze Age Assemblages

The evidence presented here supports some of what is already known about Chalcolithic and Bronze Age assemblages. It also introduces some new aspects, and challenges others. Some points are left unaddressed as there is insufficient understanding to discuss them.

- The assemblage is flake-based.

The dominance of flakes conforms with the understood flake-based nature of lithic traditions of these eras. Blades appear in not insignificant numbers, approximately one blade to five flakes.

Elsewhere, analysts have pointed to a decrease in size of lithics from the Early Bronze Age to the Middle Bronze Age (Sternke 2011c: 93; O'Hare 2005). This trend is only seen in a comparison of Chalcolithic to Early Bronze Age material. In all material – cores, regular flakes, irregular flakes, and blades – from the site of Rathmullan 6, Co. Meath, the mean and median values for length and width are larger than those of succeeding period. This should be treated with extreme scepticism due to the small Chalcolithic sample size – 65 lithics from one site.

The periodised comparison of dimensions of cores, regular flakes, and irregular flakes from the Early Bronze Age into the Middle and Late Bronze Ages does not confirm the above view.

The statistical values for the mean and median dimensions of regular and irregular flakes, and blades indicate an increase in length from the Chalcolithic and Early Bronze Age into the Middle and Late Bronze Ages. This roughly corresponds with the core data – showing a decrease in size from the Chalcolithic to the Early Bronze Age, but then increasing into the Middle and then Late Bronze Age.

- There are limited modified types.
    - Scrapers, convex particularly, are the dominant form.

Scrapers are the most prevalent modified lithic. Retouched lithics occur frequently. Other modified forms are present, but were recorded in small numbers. A decreasing trend appears in the data. From the Chalcolithic on, less modified pieces appear on sites. A spike is seen in the Middle Bronze Age presence, with the Early and Late Bronze Age ratios roughly equal.

At first, this appears to conform to the view that there are limited typologies. There are two issues here. Firstly, a false equivalence between retouching and utilisation, which has resulted in a fixation on formally-retouched pieces being the only valid 'tools'. Unretouched blades, flakes and segmented pieces can be components of composite tools, e.g.: inserts in a haft to create a sickle, or can simply be used in hand. Secondly, this limitation is a blinkered view which ignores the presence of various ground lithic forms. This aspect is more complicated due to a lack of identification of contemporaneity in production and use. These aspects have not been looked for previously, so knowledge on them is scant. Tied into this is the compounding issue of residuality, which remains underdiscussed.

In **Chapter 2**, a lithoculture was presented for the Chalcolithic and Bronze Age. Components identified in this analysis – segmented pieces and wedges – have been added. By laying out objects made from stone materials, we can see a large range of material present.

Lithoculture				
Lithic			**Stone**	
Chipped	**Ground**	**Coarse**		
Arrowhead - barbed-+-tanged	Axe-hammer	Anvilstone	Boulder burial	Rock art
	Axehead	Bedstone	Cairn	Standing stone
Arrowhead - hollow-based	Battle-axe	Burnisher	Cist	Stone circle
Blade	Bead	Cushion stone	House foundation	Stone pair
Core	Bracer	Hammerstone	Field boundary	Stone row
Flake	Button - V-perforated	Hoe	Fulacht fia	Wall
Plano-convex form	Gaming piece	Manuport	Mettled surface	*Wedge tomb*
Scraper - convex	Macehead	Maul		
Segmented piece	Mould – bivalve	Rubber stone		
Split pebble	Mould – cut	Touchstone		
Wedge	Portable rock art	Whetstone		
	Spindle whorl			
Other	Pottery inclusion			

Table 7.1: Proposed lithoculture (non-exhaustive; non-definitive) for Chalcolithic and Bronze Age Ireland, with descending divisions for lithic material, and components. Components added in course of this research are in **bold** and underlined.

- Bipolar reduction dominates.
    - This is an *ad hoc* and expedient reduction technique.

Bipolar reduction is the dominant technology. However, its establishment here utilised international markers. The insular Irish approaches were unreproducible, introducing significant problems for the general understanding of this aspect of lithic traditions. The approach used here replaced demonstrably negative classifications of the reduction technique with neutral scientific terms. As to its *ad hoc* and expedient nature, this is a subjective interpretation – and will vary from interpreter to interpreter. Here, it is not agreed with. It is also held that such interpretations should not be applied categorically to reduction techniques. Rather they should be applied on a case-by-case basis. The identification of bipolar core phases shows a repeated pattern of reduction. The presence of horizontal axial bipolar pieces could indicate a combined approach, whereby bipolar reduction 'opened' a resource which was further reduced by freehand. The *chaîne opératoire* of split pebbles and segmented pieces shows a diligent application of an appropriate technique to available resources.

The appropriateness of bipolar reduction is underpinned by the geological resources available. The technique is strongly associated with working small resources (Pargeter, Eren 2017; Hiscock 2015a; 2015b). The raw materials available to Irish knappers – not only in the Bronze Age, but also in other periods – are presented as small, erratic pieces recovered from secondary contexts (Woodman, Scannell 1993: 61; Green, Zvelebil 1990: 62; Peterson 1990: 92; Woodman 1984: 3, 6). Experimental work (Low 1997) has shown that, when working with small resources, a controlled[16] approach was necessary. This counters the popularised associations of bipolar reduction with 'bashing', 'smashing', 'splintering', and 'shattering' (Gibson 2016: 69; Sternke 2010b: clvii; cf. Sternke 2009a: 5; Nelis 2009a; O'Hare 2005).

- The knapping is unskilled, especially compared with preceding periods.

As to levels of skill, comment will not be passed. The presentation of bipolar reduction in the Chalcolithic and Bronze Age to-date has been negative and dismissive. Its presence in the Neolithic has been treated differently – despite early identification by some analysts, others have only recently accepted/acknowledged it. And when they have, only with a modified version of bipolar reduction – one suitably skilled for the period. This shows an inherent bias within the understanding of lithic traditions: Mesolithic and Neolithic = good; Bronze Age = bad. Before this can be properly addressed, Neolithic and Mesolithic assemblages will need to be assessed for bipolar reduction using: the markers compiled here; and the standards set out here. Then a fair comparison of lithic traditions – skill or other – can be made.

- There is a diminishing presence.

A similar stance is taken to the diminishing presence. Comparing the ratios of number of lithics to the number of sites by the sub-periods in this research indicates a variable presence through time (**Table 7.2**). However, the research assemblage is neither substantial nor balanced enough to validate these comparisons, and they should be treated cautiously.

	CL	EBA	EBA (-CG63m	MBA	LBA	IA
Number of lithics	59	584	12	300	72	3
Number of sites	1	4	3	7	3	1
Ratio	59:1	146:1	4:1	42.9:1	24:1	3:1

Table 7.2: Ratios of lithic (core and debitage) occurrence to site by period.

[16] The use of 'controlled' here should not be conflated with the alleged category of 'controlled bipolar reduction' (see **Chapter 3**). The validity of this category has not been demonstrated in a scientific manner.

As to the broader discussion of inter-period presence, no comment will be passed. With very distinct settlement patterns from the Early Neolithic through to the Iron Age, it is very difficult to establish a general trend where no in-depth analyses of the subjective site categories exist, e.g.: with no analysis of the combined lithic assemblage from Early Neolithic rectangular houses how can commentary be validated? And how has this commentary spanned the several hundred years where settlement is largely indicated by pit complexes rather than structures – making direct comparison more difficult?

- Bronze Age settlements are self-sufficient.

The presence of cores on sites supports the view that some settlements were self-sufficient in lithic production. They indicated the reduction of resources for the production of blades/flakes/segmented pieces. The presence of 22 pieces determined to be re-sharpening flakes indicates either the creation or maintenance of formal retouched lithics on settlement sites.

But, the site of Carrickmines Great 63M indicates that there was production beyond individual sites. It remains a unique site in the Bronze Age archaeology of Ireland. CG63M was positioned as a 'specialised knapping site' by the director (Conboy 2006: 7, 9) and 'a special purpose camp' by the lithic analyst (Ballin 2006: 30), with the function of producing and repairing scrapers. Given the predominance of scrapers on sites of the period, this may indicate an avenue of centralised production. Due to the incomplete analysis here, along with an incorrect specialist report and absent radiocarbon dates, no further comment will be passed. The site deserves a comprehensive review in order to best present it.

7.3 Comparing material from settlements and burials

Several projects have looked at the burial traditions of the Chalcolithic and earlier part of the Bronze Age. It was not possible to merge the data due to possible overlap of sites, inconsistent terminology, and poor definition of pieces. With each project, a percentage of lithic occurrence is presented. This is a simplified figure, as it does not account for multiple pieces in a single grave. As such, their frequency of presence is overstated.

Mount (1997) examined 225 burials in the south-east, covering Counties Carlow, Dublin, Kildare, Kilkenny, Laois, Wexford, and Wicklow. Lithic material was noted in 34 burials, 20.9% (**Table 7.3**).

Category	**Number**	**Percentage**
Ball	1	2.1
Battle-axe	1	2.1
Bead	5	10.6
Bracer	1	2.1
Other (flint)	14	29.8
Pendant	1	2.1
Plano-convex knife	9	19.2
Scraper	9	19.2
Stone	6	12.8
Total	47	100

Table 7.3: Lithic material from Early Bronze Age burial sites (after Mount 1997).

Category	**Number**	**Percentage**
Arrowhead	16	8.9
Axe	9	4.9
Ball	1	0.5
Bead	3	1.6
Blade	2	1.1
Core	2	1.1
Fabricator	2	1.1
Flake	27	14.9
Fragment	14	7.7
Knife	30	16.6
Pebble	14	7.7
Pendant	3	1.6
Quern	2	1.1
Scraper	25	13.8
Stone	12	6.6
Whetstone	2	1.1
Unknown	3	1.6
Jet	9	4.9
Lignite	1	0.5
Shale	4	2.2
Stone	1	0.5
Total	182	100

Table 7.4: Lithic material from Early Bronze Age burials (after Fraser 2013).

Based on Waddells' (1990) gazetteer of Bronze Age burials, Frazer (2013) analysed 1,556 individual graves. Lithic material was present in 11.6% of the burials (**Table 7.4**). Several items of non-siliceous rock types were categorised separately by Frazer – they are combined here.

From an analysis of 30 burial sites, Baine (2014) identified ten with only Bronze Age material – referring to the Early and Middle Bronze Age periods. This produced 51 single burial deposits and 32 multiple deposits (*ibid*.: 207, 216). A review of the mortuary material presented three categories: definite lithic material; including lithic material; and non-lithic material (**Table 7.5**). The first category covered material such as pieces of flint, chert, quartz, or objects like pebbles, balls, or marbles. These items amounted to 42. The knapped lithic objects are not described by typology. The second category included classifications that may or may not be lithic. The description was not always clear in the text. This incorporated objects like axeheads, beads, buttons, or pendants. This category amounted to 83. It should be noted that 64 pieces were jet beads in one necklace. The third category referred to all other materials, e.g.: pottery, metal, bone. These pieces amounted to 117. Definite lithic items account for 17.4% of the mortuary material, though this is an underestimate of the true number.

Category	**Number**	**Percentage**
Axe~	1	0.4
*Ball/Pebble/Marble**	7	2.9
Bead/Spacer/Tube~	79	32.6
*Bone pin^*	6	2.5
*Flint/Chert/Quartz**	35	14.6
*Metal^*	10	4.1
Pendant~	1	0.4
*Pottery (Neolithic)^*	0	0.0
*Pottery (Bronze Age)^*	101	41.7
V-perforated button~	2	0.8
Total	242	100

Table 7.5: Categories of artefacts from Early and Middle Bronze Age burials (after Baine 2014).
* = definite lithic
~ = including lithic
^ = non-lithic

McSparron (2017) analysed graves that were part of the Single Burial Tradition dated to the Late Chalcolithic and Early Bronze Age. He recorded 63 lithic objects in relation to 496 individual graves (**Table 7.6**). This indicates a presence of 12.7%.

Category	Number	Percentage
Arrowhead	3	4.8
Flake	24	38.1
Hone stone	2	3.2
Knife	3 (4)*	4.8
Plano-convex knife	13	20.6
Quern (fragment)	1	1.5
Scraper	17	27.0
Total	63	100

Table 7.6: Lithic material from Single Burial Tradition graves in the Late Chalcolithic and Early Bronze Age (after McSparron 2017).
* = 4 knives are initially mentioned, only 3 are discussed in the relevant section

Burial practices from the latter centuries of prehistory are less researched, with only one reference uncovered. McGarry (2008) analysed late prehistoric burials in Ireland, divided into two periods. The first period, 1300BC-AD400, covered 108 burial sites (*ibid*.: 18). Lithic material was recovered on 18 sites, 16.7% (**Table 7.7**).

Category	Number	Percentage
Arrowhead	1	1.6
Bead	3	4.8
Bracelet	2	3.2
Gaming piece	1	1.6
Mould	1	1.6
Scraper	7	11.4
Spoon	1	1.6
Stone	25*	40.3
Struck lithic	21^	33.9
Total	62	100

Table 7.7: Lithic material from Late Bronze Age and Iron Age burial sites (after McGarry 2008).
* = 21 pebbles came from Burials 8/9 at Knowth, Co. Meath
^ = Ask F, Co. Wexford, was noted as having several pieces of chert/flint – included in count as 2

Averaging the percentage of the presence of lithics across the four early Bronze Age studies gives a result of 14.1%. This figure remains the same when the fifth project, the Late Bronze Age and Iron Age material, is included. This compares to a 70% presence of 'lithic' material and 60% of 'stone' on Bronze Age settlement sites (Cleary 2007b).

From the various mortuary studies, a deliberate inclusion of lithic material into Bronze Age burials is seen. Baine's (2014: 210, 218) study put them second only in quantity to pottery sherds – 17.4% to 41.7%. This ratio would likely shift and show a greater relative presence of lithics was the Minimum Number of Vessel count for pottery, rather than sherds, compared. Lithics occur in greater numbers than metal counterparts. Via Baine (*ibid*.), metal accounted for ten of the 117 non-lithic objects, 4.1%. Mount (1997: 140) records metal present at six sites, 2.8%, and notes it as "extremely rare". Through Waddell's gazetteer (1990), 73 objects were noted in less than 5% of graves (Fraser 2013: 96). McSparron (2017: 164-181) identified a total of 41 metal objects to the 496 graves – 8.3%. The first three studies show a similar degree of occurrence. This rises with McSparron's (2017) study – though remains below the presence of lithic material. That metal is under-represented in these studies due to decay is possible.

In the Late Bronze Age and Iron Age, the presence of metal in mortuary contexts increases. McGarry (2008) recorded a greater number and variety of metal objects in burials of this period. They were too dispersed throughout the text to summarise. However, this should not be read as a sign that metal was replacing lithic. The variety of grave goods expanded greatly, with glass and other materials also increasing their presence (*ibid*.: 175-180).

The type of material present in settlement and burial contexts displays interesting comparisons. Flakes are the dominant debitage type noted from settlements, accounting for 32%. This is mirrored by their presence in burials. Flake is recorded as the most common lithic category by McSparron (2017), and by Fraser (2013) as the second most common. Mount (1997) records a general category of 'Other (flint)' as the most common occurrence. This likely includes flakes, but it cannot be said it is only flakes. A similar situation is noted in the Late Bronze Age and Iron Age burials, where McGarry (2008) records the generalised 'struck lithic' category as second most numerous.

Scrapers are the dominant modified type noted from settlements, at 53% for confirmed and possible pieces. This is also seen in burials. McSparron (2017) and Mount (1997) note them as the second most frequent category, while Fraser (2013) lists them as third. This pattern continues into the final centuries of prehistory. McGarry (2008) noted scrapers as the third most common lithic category.

An interesting contrast is the presence of knives and/or plano-convex knives. Mount (1997) and McSparron (2017) use the latter term exclusively, while Fraser (2013) uses just the former. It is presumed that Fraser incorporates plano-convex knives and lithics interpreted as 'knives' into the one category. They have a greater presence in burials than on settlements. Fraser (2013) records them as the most common category, Mount (1997) as joint second with scrapers, and McSparron (2017) as third. From the settlement evidence analysed, only one plano-convex form was recorded. A second knife may be present in the PTD recorded. These – lopsided forms at least – have been suggested as knives, though this is not definitive (Woodman *et al*. 2006: 153, 154). Even with this speculative addition, the number of formal knives appearing on settlements does not approach that in burials.

A comparison shows that the assemblage components of burial material reflects that occurring in settlement contexts. Lithic occurrence in burial contexts continues even after the introduction and spread of ironworking. This likely indicates a continued lithic tradition into the latter centuries of prehistory.

The exceptions to this are the plano-convex knife and arrowhead. These have a greater occurrence in burials. It could be that these objects were made specifically for burial; or that they were used by their owners and then deposited with them upon interment; or that settlements were not seen as suitable for deposition. The reason cannot be conclusively discerned here. More focused studies – considering the complexity of burial practices specifically in relation to lithics, and the types and occurrence of plano-convex forms throughout prehistory – are required.

7.4 Bipolar Reduction

The established dominance of bipolar reduction is represented in the material. However, its establishment here follows the detailed approaches of international research, rather than poorly defined insular standards. The literature review produced a combined summary of insights from various researchers. This allowed for defined, replicable markers to be established, run complementary to each other, and applied in an analysis of Irish material.

The varying Irish approaches were unsatisfactory. Where the basic term ‘bipolar’ is applied, it accurately depicts the reduction, but details none of the nuances. In the case of more developed terminologies, the names entail loaded words. By describing a technique as ‘smash-it-and-see’, there is a strong implication of randomisation, carelessness, and a lack of skill. While this can be true (watch Kononenko 2009), it is equally likely that the technique is applied with intention and skill (watch Cormack 2014). There is no evidence seen here or presented elsewhere, that indicates such a classification can be discerned from the markers left on lithics. This reasoning similarly applies to other classifications, for example 'controlled bipolar'. While this term goes some way towards rectifying the general negative view of bipolar reduction, it is still weighted. This classification is associated with the Neolithic by the analyst. Here, we see the attribution of an undefined 'better' version of bipolar reduction with an archaeological period associated with a greater degree and higher quality of lithic working. The latter aspect may be true, but given the underwhelming treatment of bipolar reduction to date, the former is not held to be. A comparative study of bipolar material from different periods is needed if variations in quality of working wish to be established.

By removing adjectival titles, which subjectively describe the quality of working, and installing attribute-based classifications, material can be approached with more balance. This will allow bipolar material to be assessed in a similar frame to freehand material. In fact, contrasting the terminologies associated with the two reduction techniques shows that there are no loaded terms, implying a quality of working, associated with freehand reduction. There is a significant difference in titling a core 'single platform' or 'multi-platform' as opposed to 'smash-it-and-see' or 'controlled bipolar'. A flake from a freehand single platform core could have been the product of somebody carelessly hitting two stones together, as much as a third-phase bipolar core is the product of somebody carelessly crushing one stone between two others. Or it could be that both display a modicum of ability.

7.4.1 Bipolar Debitage

Using international markers for bipolar reduction, it was possible to identify several types of bipolar debitage. Their establishment allows for a more nuanced understanding of bipolar knapping on Irish sites, and a more comprehensive understanding of lithic knapping across the country and periods.

7.4.1.1 Cores

The presence of bipolar core phases in Chalcolithic and Bronze Age assemblages is established within this data. Not noted in analyses or discussions of Irish material previously, the addition of these categories expands our comprehension of lithic traditions of these eras. Their presence establishes an understanding of the stages of bipolar reduction through qualified means.

7.4.1.2 Products

The presence of axial and non-axial bipolar removals in Chalcolithic and Bronze Age assemblages is established within this data. Not noted in analyses or discussions of Irish material previously, the addition of these categories expands our comprehension of lithic traditions of these eras. In the analysis here, the nuance between vertical axial and horizontal axial bipolar was easily identified. While it may seem to be a minor distinction, it gives analysts, and subsequently excavation directors and others on down the line, a more detailed view on how individuals engaged with lithic materials. The difference between slicing a resource horizontally or vertically impacts on how many products are retrieved from it, the size of the debitage product(s), and how we understand the *chaîne opératoire* of a site.

The presence of segmented pieces in Chalcolithic and Bronze Age assemblages is established within this data. Absent from analyses or discussions of Irish material until this point, its recognition aids our understanding of later prehistoric lithic reduction and use. Studies elsewhere have established a *chaîne opératoire* for the production of these pieces, as well as confirming their utilisation through use-wear analysis (Knarrström 2001). The site of CG63M affords an opportunity to re-assess interpretations following this. Amongst the lithic material retrieved, 12 split pebbles – of which ten were analysed here. In the original analysis, these pebbles were described as "early stage bipolar cores" and being "tested by the application of bipolar technique and subsequently discarded" (Ballin 2006: 21). In this case, bipolar core is thought to refer to the standard pillowed form, which produces flakes. This interpretation could be correct. However, using the *chaîne opératoire* established by Knarrström, these pieces could now be interpreted as cores for segmented pieces, and the first stage of a two-stage production process. The pattern of test and discard can no longer be assumed without reasoning for split pebbles. Either interpretation should be supported with reference to the recovery context and associated artefacts. If this information is not available to the lithic analyst, both interpretations should be presented to the excavation director, who can incorporate as they see fit.

7.4.1.3 Wedges

The presence of wedges in Chalcolithic and Bronze Age assemblages is documented within this data. Noted only rarely in analyses or discussions of Irish material previously, the addition of this category expands our comprehension of lithic traditions of these eras. These pieces are difficult to identify. The examples identified here, were previously recorded as: flakes (Walsh 2011: Vol. 2 – clxxvi; Kelly 2010: lviii; Ó Maoldúin 2008); scraper (Stevens 2010: 90) or scraper/tip of a knife (Flynn 2011: 429, Appendix A – 5); a bipolar core on a flake (Bolger 2011: xxvi). The few papers that explore their morphology and markings allow for their categorisation with diligent analysis. Their identification within assemblages can give insight into activities taking place. Experimental work has shown their use in several activities, e.g.: bone splitting, wood working (Peña 2011; Brun-Ricalens 2006). Their presence on sites intimates such potential uses.

7.4.2 Terminological Issues

There were issues identified with the terminology employed during the analysis.

- Issue 1

  Chunks – defined as "a piece with neither platform nor ventral surfaces" (Woodman *et al*. 2006: 86) – may be second- or third-phase bipolar cores, at least in some cases. These cores lack defined platforms to begin with, and as a result of the vertical fracturing, the ends are only indicative of being worked. The surfaces display the partial scars of removals, *écaillé* retouch near proximal and distal ends, and one or possibly two surfaces will appear sheared. None of these would qualify a face as ventral, i.e.: containing a bulb of percussion, eraillure scar, or such. Waves of percussion may appear on the sheared face, but in the same sense that bulbs of percussion appear on dorsal scars.

  These differing classifications result in significantly differing interpretations. Chunks are seen as being an "accidental knapping product or the product of heat shatter" (Woodman *et al*. 2006: 86). This means that there is neither intention nor deliberateness in production, and indicates a carelessness or lack of skill on the part of the knapper. On the other hand, if they are third-phase bipolar cores, they demonstrate: a level of skill – by working small pieces; and an exhaustive *chaîne* *opératoire* – the core is reduced until it fractures. The presence of one or the other or both in an assemblage provides for different appreciations of a lithic tradition.

- Issue 2

  The designation 'sheared' for faces on bipolar pieces becomes questionable. It is frequently seen in literature relating to bipolar-reduced material (Pargeter, Eren 2017: 4; Duke, Pargeter 2015: 349; Zaidner 2013: 8-10; Kuijt *et al*. 1995: 120; Flenniken, White 1985: 133, 143). However, the term is poorly defined. Zaidner (2013: 18) describes sheared surfaces as a result of wedging which "does not leave marks on the ventral surface", making their identification, along with that of bulbs of percussion and butts, difficult. Inizan *et al*. (1999) do not list nor use the term in their treatise on lithic terminology. In this research, sheared was used to designate a ventral or dorsal face that was interpreted as secondary to the struck face, i.e.: the face intended for creating a removal. Often this was defined by the relationship between a face and polar crushing, *écaillé* retouch, or dorsal removals. Considering this, it is likely that sheared faces are no different to struck faces created through bipolar reduction. On many pieces, the sheared faces displayed similar characteristics to struck faces, e.g.: waves of percussion with a complete extent. If the term is used, it should be clearly defined.

- Issue 3

  Of the 28 third-phase bipolar cores, four were recorded as fragments. They were viewed as broken subsequent to their initial formation through human reduction. This raises a peculiar question. The classification of a lithic as a third-phase core means that the core has fragmented into two or more pieces. 'Complete' – displaying crushing or écaillé retouch at both ends – pieces were not actually complete cores. They are fragments of whole cores, though their classification regards them as whole. When identified and discussed it should be borne in mind that they are fragments, rather than complete cores. This brings about the possibility of Minimum Number of Cores (MNC) – "estimate of the minimum number of cores necessary to account for the complete and fragmentary core in an assemblage" (Hiscock 2002: 252). MNC is an analytical method rarely considered or applied in lithic analyses (*ibid*.: 251). The assessment of cores presents problems in defining the minimum number – revolving around variations in flake scars or numbers of fragments (*ibid*.: 257). However, where non-heat-shattered third-phase bipolar cores are concerned, some of these problems are reduced. The predicted fracture of the core creates definable fragments, with sheared faces playing a greater role than removal scars. MNC for third-phase bipolar cores could be calculated by: raw material, cross-section, length, thickness, colour, or a combination of these .

Given the small quantity of material recovered on the majority of sites, this is unlikely to be useful. However, for sites such as the Carrickmines Great 63M workshop, Co. Dublin, or the Corrstown Bronze Age village, Co. Down, which produced large assemblages, this may be an analytical approach of benefit.

7.4.3 Bipolar Tool-kit

The lack of anvilstones within reports is of concern. Given their necessity in bipolar reduction, and the prevalence of this technique in the late Irish prehistory, the absence jars. It could be that anvils were not of stone, but rather organic material, like wood or bone. These are less likely to be preserved. Another possibility is that anvilstones are not recognised by excavating archaeologists and are therefore not recovered nor analysed. It may be that some have been recovered and not recognised as such by analysts. The cursory assessment of passive coarse lithic pieces here identified some potential examples. Again, international research was used in order to identify pieces. This provided good direction. However, rock type may play a role. The rock types used in experimental work and examined in studies is different to those commonly seen on Irish sites. This may have an impact in how marks develop, and so on to their identification.

Further to this, the purported anvilstone at CG63M raises a methodological issue regarding the excavation of static anvilstones. Given the potential size of these objects, recovery may not be possible. In consequence, their detailed recording in the field becomes paramount. The use of techniques such as photogrammetry makes this easier to achieve. Photogrammetric modelling of percussors has been combined with GIS analyses to provide insights into their use (Benito-Calvo *et al*. 2018; Caricola *et al*. 2018; Benito-Calvo *et al*. 2015; Dubreuil *et al*. 2015; Caruna *et al*. 2014). These articles modelled archaeological or experimental percussors which had been retained. However, the recording capabilities displayed can be achieved with unrecoverable objects. 3-D recording – using various methods – is increasingly applied in the field (Marín-Buzón *et al*. 2021; Howland *et al*. 2014). This is typically seen in trench modelling, though, again, the application to a specific large-scale object would be achievable. While second to having the physical object, a high-quality digital recording improves later analyses. Additional consultation with a lithic analyst would be advised to make sure that the quality of recording is sufficient, and that the digital format is accessible.

8. Conclusion

8.1 Introduction

This thesis set out to study the nature of lithics on Chalcolithic and Bronze Age domestic sites by examining artefacts recovered from secure contexts. This was achieved to the extent that a typo-technological study of a limited assemblage from secure contexts was undertaken. However, the contextual aspect of the analysis was not completed due to more concerning aspects arising, which required in-depth research. These related to the general comprehension of lithics during the first eras of metal use, and, more specifically, standards of lithic analysis. A larger assemblage was not analysed due to more time spent on the bipolar aspect of each lithic piece. A comprehensive review of bipolar reduction was undertaken. This was due to a severe lack of accessible, workable standards in place. This resulted in a second major strand of research appearing. It was necessary to establish a rational system for analysing bipolar material from literature and assess its applicability and/or suitability for Irish material.

8.2 Research Objectives

The objectives of this research were set out in three broad categories. These have met varying levels of success. The shifting emphasis of the research meant that they could not be fully developed, instead having to respond to several concerning areas as they arose.

1) The consideration of Chalcolithic and Bronze Age lithics presents a mixed result. The overall number of pieces analysed falls far short of the initial goal. The contextual analysis had to be discarded. However, the technological understanding of lithic reduction, specifically relating to bipolar, has been vastly improved. Additional typologies, previously overlooked, have been identified.
2) A preliminary survey of residuality was successfully carried out. A rate of residuality has been established – set at 0.7%. This was done by identifying diagnostic material and comparing it to all other material. Given the absence of any previous attempt to formalise this aspect, what the result means is not entirely clear. Here, it is taken to

indicate a low occurrence of earlier material in later contexts. This provides support for the interpretation of continued production and use of lithics into the latter centuries of prehistory, and identifies a casual over-attribution of residual material in later contexts. However, this rate sits in a context of anecdotal reading of residuality in lithic analysis reports and, to a lesser extent, other non-specialist publications. It should be treated cautiously until comparative rates appear.

3) The assessment of the bipolar tool-kit largely failed. The analysis devised proved ineffective. The structure set out for recording use-wear was not sufficient to deal with the potential complexity of marks, which undermined any analysis or discussion. Additionally, the initial constraints, i.e.: hammerstone and anvilstone, were not abided by, resulting in unrelated data being in-put to the database.

8.3 Chalcolithic and Bronze Age Lithics

Lithics during the Chalcolithic and Bronze Age have a long but sporadic history of research. There has been little published research on assemblages of the periods. This has led to a situation where accepted views of the lithoculture are espoused, but supporting documentation is rare. This research has found some of these views to be true – bipolar reduction is the principal knapping technique, convex scrapers are the principal modified lithic. However, a large number of claims have been found to be erroneous or lacking in any rational basis.

There are variations of the *chaîne opératoire* visible in the material analysed. The identification of core material on sites indicates the procurement of raw materials – primarily flint, with some chert. This material is then reduced on site. The use of bipolar reduction during these periods is confirmed. The presence of variations of bipolar reduction – axial, non-axial – was established. The presence of segmented pieces was established. This allows for a possible re-interpretation of some split pebbles as cores to be applied in cases. Freehand material was also identified in the assemblage. This most likely represents a continued application of this reduction method, rather than residual material. Debitage products included regular and irregular flakes, and blades. The analysed material showed some little variation in dimensions through periods. There was a slight increase in size moving from the Early Bronze Age moving into the Middle and Late sub-periods. This contradicts earlier claims about a diagnostic decrease in the size of debitage products through time.

Most debitage products display no secondary modification. This does not exclude a functional use, nor imply a use-and-discard scenario. Some secondary modification of pieces occurs. Scrapers are the dominant modified type, followed by informal retouched flakes. The curation of scrapers is indicated by the identification of re-sharpening flakes on some sites. Lithic objects are finally either discarded or deposited. The presence of wedges, identified using categorical markers established in international research, has been confirmed.

Evidence for the self-sufficiency of Bronze Age sites was seen in the presence of core material and re-sharpening flakes on several sites. In contrast to this, the site of Carrickmines Great 63M, Co. Dublin, indicates the presence of a centralised production of pieces, for an undefined region. Here, the large-scale gathering of raw materials is evident, with the production of specific modified types ensuing through the application of bipolar reduction. The formal modified types, i.e.: convex scrapers, at this site are the same as those on others. The prior and subsequent stages of this *chaîne opératoire* variation are unclear – due to the incomplete analysis here, and the incomplete final report. Further analysis in necessary to establish the nature of this site and its *chaîne opératoire*.

From a review of mortuary studies, the material in burials is seen to reflect that on domestic sites. This dualism implies a level of continued production and use, as a disparity would be expected if these were ‘heirlooms’ or chance inclusions occurring in either sphere. The exceptions are the plano-convex knife and arrowhead which have greater occurrences in burial contexts.

8.4 Bipolar Reduction

The identification of bipolar reduction was not done using Irish terminologies. These were found to be either inaccessible or underdeveloped. The inability to utilise these parameters was a major hindrance to the progression of the planned research, leading to the abandonment of the contextual analysis. Instead, a thorough review of bipolar research from the international stage was undertaken. Literature from various decades and countries was reviewed to find commonalities and contradictions. The various markers used by different researchers were assessed and the most appropriate were applied in this study of Irish material. This introduces a replicable and reproducible standard of analysis for bipolar reduction onto the Irish scene.

The review challenged many of the views around bipolar reduction. Within Irish literature, it is often portrayed poorly. This is a one-sided point of view. Yes, it can be crude, but it can also be applied with skill to produce consistent forms.

8.5 Moving forward

"Against a thing so difficult to manage as this Heracles devised an ingenious scheme and commanded Iolaüs to sear with a burning brand the part which had been severed, in order to check the flow of the blood."

– Diodorus Siculus, The Library of History IV.11.6 (trans. Oldfather)

Much as Heracles could not defeat the Hydra by himself, establishing a new narrative for and approach to lithics in metal-using eras cannot be done single-handedly. Misconceptions need to be challenged, oversights need to be addressed, latent attitudes need to be confronted. The lack of published material by researchers pertaining to this period – despite post-graduate projects undertaken, despite analysts developing schema – has created more problems than solved. General synopses often contradict the specialist material, showing a lack of awareness and connection between the two areas. A great deal of the mis-understanding of lithics in the Chalcolithic and Bronze Age can be laid at the feet of this individualistic approach, compounded by the lack of communication and standardisation amongst analysts. If we are to improve our understanding of lithics during the first eras of metal use, and later periods, a co-operative approach needs to be established.

A basic requirement is that all analysts produce glossaries that explain their terminologies and dating schema, allowing for them to be understood and reproduced. This does not require all analysts to adhere to a strict universal protocol of nomenclature and methodology – though this avenue could be taken.

A standard of publication should also be sought. It is not acceptable for foundational theses to be left on library shelves. This severely restricts access to the very reasons why a lithic analyst is accepted as a specialist, and why certain beliefs/attitudes/approaches towards lithic material are espoused. Nor is it appropriate for deliberations on material to solely take place within the pages of a contracted lithic analysis report. Access to commercial reports can be extremely limited, and so to see lithic reports referencing other lithic reports as validation, with no published reference available, undermines the ability of others to follow the information in these technical documents.

An initial step has been taken here. The configuration of a lithoculture for Chalcolithic and Bronze Age Ireland provides a clear model for critique by analysts. This should not be seen as 'the' or 'an' understanding of Chalcolithic and Bronze Age lithics. Rather it is an analytical tool to aid in the understanding and research of the lithic tradition of these periods. This will allow for a systematic approach to lithics of metal-using eras through research that is both targeted and connected. By viewing the Mesolithic and Neolithic through this lens, a comparative assessment of Chalcolithic and Bronze Age lithics through time will be better made.

Improved understanding of bipolar reduction will create a clearer picture, as will a better grasp of how changing societies viewed their tools and what they required of them. Restraint needs to be shown by analysts in how far interpretations can be taken. Care needs to be taken with how analyses are presented. Greater discussion between excavating archaeologists and lithic specialists will enhance the picture of their occurrence on later prehistoric, and possibly historic, sites.

Bibliography

Adachi, M., Yamamoto, K., Sugisaki, R. 1986. Hydrothermal Chert And Associated Siliceous Rocks From The Northern Pacific: Their Geological Significance As Indication Of Ocean Ridge Activity. *Sedimentary Geology* 47: 125-148.

Anderson, P.C., Rodet-Belarbi, I., Moreno-García, M. 2014. Sickles With Teeth And Bone Anvils. In Gijn, A. van, Whittaker, J.C., Anderson, P.C. (eds) *Explaining And Exploring Diversity In Agricultural Technology Vol. 2*: 118-132. Oxford: Oxbow Books.

Anderson, P.C., Whittaker, J.C. 2014. Experiments With Harvesting Techniques: Neolithic Sickles And Uprooting. In Gijn, A. van, Whittaker, J.C., Anderson, P.C. (eds) *Explaining And Exploring Diversity In Agricultural Technology Vol. 2*: 106-108. Oxford: Oxbow Books.

Andrefsky, W. 2005. *Lithics: Macroscopic Approaches To Analysis*. Cambridge: Cambridge University Press.

ApSimon, A.M. 1969. The Earlier Bronze Age In The North Of Ireland. *Ulster Journal Of Archaeology* 32: 28-72.

Arnoldussen, S., Steegstra, H. 2015. A Bronze Harvest: Dutch Bronze Age Sickles In Their European Context. *Palaeohistoria* 57: 63-109.

Arthur, K.W. 2010. Feminine Knowledge And Skill Reconsidered: Women And Flaked Stone Tools. *American Anthropologist* 112(2): 228-243.

Ballin, T.B. 2021. *Classification Of Lithic Artefacts From The British Late Glacial And Holocene Periods*. Oxford: Archaeopress.

--- 2017. *Lithic Assemblages: A Guide To Processing, Analysis And Interpretation*. BAJR Guide 49.

--- 2014. *A Beaker Period Lithic Assemblage From Rathdown, Co. Wicklow, Ireland*. Unpublished lithics report.

--- 2006. The Lithic Assemblage. In Conboy, G. *Final Report Archaeological Excavation Of A Hearth, Pits And Postholes (Site 63M), South Eastern Motorway, Co. Dublin*. VJK Ltd.: unpublished excavation report.

--- 2002. Later Bronze Age Flint Technology: A Presentation And Discussion Of Post-barrow Debitage From Monuments In The Raunds Area, Northamptonshire. *Lithics* 23: 3-28.

--- 2000. Classification And Description Of Lithic Artefacts: A Discussion Of The Basic Lithic Terminology. *Lithics* 21: 9-15.

--- 1999. Bipolar Cores In Southern Norway: Classification, Chronology And Geography. *Lithics* 20: 13-22.

Ballin Smith, B., Ballin, T., Miller, J. & Ramsay, S. 2003. The Excavation Of Two Bronze Age Roundhouses At Townparks, Antrim Town. *Ulster Journal Of Archaeology* 62: 16-44.

Bamforth, D.B., Woodman, P.C. 2004. Tool Hoards And Neolithic Use Of The Landscape In North-Eastern Ireland. *Oxford Journal Of Archaeology* 23(1): 21-44.

Bandeh-Ahmadi, N. 2018. *Anthropological Generations: A Post-Independence Ethnography Of Academic Anthropology And Sociology In India*. University of Michigan: unpublished PhD thesis.

Barkley, J., Brannon, N., Nicol, S., Sloan, B. 2014. The Excavation Of A Bronze Age Settlement At Skilganaban, County Antrim. *Ulster Journal Of Archaeology* 72: 1-54.

Baron, J., Kufel-Diakowska, B. (eds) 2011. *Written In Bones: Studies On Technological And Social Contexts Of Past Faunal Skeletal Remains*. Wrocław: Uniwersytet Wrocławski.

Bayley, D. 2010. *E3145: Gardenrath 2 – Final Report*. IAC: unpublished excavation report.

Becker, K. 2006. *Hoards And Deposition In Bronze Age Ireland*. University College Dublin: unpublished PhD thesis.

Becker, K., Ó Néill, J., O'Flynn, L. 2008. *Iron Age Ireland: Finding An Invisible People*. The Heritage Council: Project Report 16365.

Bell, D. 2016. Rivet-hole Production In The Bronze Age. *Journal Of Irish Archaeology* 25: 17-30.

Benito-Calvo, A., Carvalho, S., Arroyo, A., Matsuzawa, T., Torre, I. de la. 2015. First GIS Analysis Of Modern Stone Tools Used By Wild Chimpanzees (*Pan Troglodytes Verus*) In Bossou, Guinea, West Africa. *PLoS ONE* 10(3).

Benito-Calvo, A., Crittenden, A.N., Livengood, S.V., Sánchez-Romero, L., Martínez-Fernández, A., Torre, I. de la, Pante, M. 2018. 3D 360° Surface Morphometric Analysis Of Pounding Stone Tools Used By Hadza Foragers Of Tanzania: A New Methodological Approach For Studying Percussive Stone Artefacts. *Journal Of Archaeological Science* 20: 611-612.

Bergh, S. 2009. Black Is The Colour … Chert, Concave Scrapers And Passage Tombs. In O'Connor, B., Cooney, G., Chapman, J. (eds) *Materialitas – Working Stone, Carving Identity*: 105-112. Prehistoric Society Research Paper 3.

Bolger, T. 2012. *00E0813: Rathmullan 10 – Final Report*. IAC: unpublished excavation report.

--- 2011. *M1 Northern Motorway: Rathmullan 6 – Final Report*. IAC: unpublished excavation report.

Boutoille, L. 1012. The Coppersmith And The Caster: Initial Thoughts On Irish Stone Casting Mould Hoards. *Ulster Journal Of Archaeology* 71: 5-15.

Bower, N., Hegarty, L., Lugowski, S., Miciak, M. 2011. *Archaeological Excavation Report Caherdrinny 3, Co. Cork*. Eachtra Archaeological Projects: unpublished excavation report.

Bradley, S.E. 2017. *Archaeological And Geochemical Investigation Of Flint Sources In Britain And Ireland*. University of Central Lancashire: unpublished PhD thesis.

Brady, C. 2007. Lithic Analysis. In McQuade, M. *Final Report At Ballylegan, N8 Cashel To Mitchelstown Road Improvement Scheme*. Margaret Gowan & Co. Ltd.: unpublished excavation report.

Brandherm, D. 2009. The Social Context Of Early Bronze Age Metalworking In Iberia: Evidence From The Burial Record. In Kienlin, T.L., Roberts, B.W. (eds) *Metals And Societies: Studies In Honour Of Barbara S. Ottoway*: 172-180. Universitätsforschungen Zur Prähistorischen Archäologie: Band 169.

Brandherm, D., McSparron, C., Boutoille, L., Kahlert, T., Bonsall, J. 2018. Prehistoric Hilltop Settlement In The West Of Ireland. *PAST* 89: 1-3.

Briggs, C.S. 2009. Erratics And Re-cycled Stone: Scholarly Irrelevancies Or Fundamental Utilities To Lithic Studies In Prehistoric Britain And Beyond? *Internet Archaeology* 26.

--- 2001. The Past And Future Of Irish Implement Petrography. *Ulster Journal Of Archaeology* 60: 32-46.

--- 1988. Stone Resources And Implements In Prehistoric Ireland: A Review. *Ulster Journal Of Archaeology* 51: 5-20.

Bril, B., Parry, R., Dietrich, G. 2015. How Similar Are Nut-cracking And Stone-flaking? A Functional Approach To Percussive Technology. *Philosophical Transactions Of The Royal Society B* 370(20140355).

Brindley, A.L. 2007. *The Dating Of Food Vessels And Urns In Ireland*. NUIG: Bronze Age Studies 7.

--- 2002. Preliminary Report On Prehistoric Pottery From Excavations At Carrickmines Great, Co. Dublin (02E0700). In Conboy, G. 2006. *Final Report Archaeological Excavation Of A Hearth, Pits And Postholes (Site 63M), South Eastern Motorway, Co. Dublin*. VJK Ltd.: unpublished excavation report.

Brookes, D.T., Etkina, E. 2015. The Importance Of Language In Students' Reasoning About Heat In Thermodynamic Processes. *International Journal Of Science Education*. DOI: 10.1080/09500693.2015.1025246.

Brück, J. 2019. *Personifying Prehistory: Relational Ontologies In Bronze Age Britain And Ireland*. Oxford: Oxford University Press, Incorporated.

--- 2007. The Character Of Late Bronze Age Settlement In Southern Britain. In Haselgrove, C., Pope, R. (eds) *The Earlier Iron Age In Britain And The Near Continent*: 24-38. Oxford: Oxbow Books.

--- 2006. Fragmentation, Personhood And The Social Construction Of Technology In Middle And Late Bronze Age Britain. *Cambridge Archaeological Journal* 16(3): 297-315.

--- 2004. Material Metaphors: The Relational Construction Of Identity In Early Bronze Age Burials In Ireland And Britain. *Journal Of Social Archaeology* 4(3): 307-333.

--- 1999. Houses, Lifecycles And Deposition On Middle Bronze Age Settlements In Southern England. *Proceedings Of The Prehistoric Society* 65: 145-166.

Brück, J., Davies, A. 2018. The Social Role Of Non-metal 'Valuables' In Late Bronze Age Britain. *Cambridge Archaeological Journal* 28(4): 665-688.

Brun-Ricalens, F. le. 2006. Les Pièces Esquillées: État Des Connaissances Après Un Siècle De Reconnaissance. *Paleo* 18: 95-114.

Caricola, I., Zupancich, A., Moscone, D., Mutri, G., Falcucci, A., Duches, R., Peresani, M., Cristiani, E. 2018. An Integrated Method For Understanding The Function Of Macro-lithic Tools. Use Wear, 3D And Spatial Analyses Of An Early Upper Palaeolithic Assemblage From North Eastern Italy. *PloS ONE* 13(12).

Carlin, N. 2018. *The Beaker Phenomenon? Understanding The Character And Context Of Social Practices In Ireland 2500-2000 BC*. Leiden: Sidestone Press

--- 2011*. A Proper Place For Everything: The Character And Context Of Beaker Depositional Practice In Ireland Volume 1*. University College Dublin: unpublished PhD thesis.

--- 2006. Appendix 16: M3 Research Report On Bronze Age Houses In Ireland. In O'Neill, T. *M3 Clonee-North Of Kells Contract 2 Dunshaughlin – Navan: Report On The Archaeological Excavation Of Skreen 3, Co. Meath*. ACS Ltd.: unpublished excavation report.

Carlin, N., Brück, J. 2012. Searching For The Chalcolithic: Continuity And Change In The Irish Final Neolithic/Early Bronze Age. In Allen, M.J., Gardiner, J., Sheridan, A. (eds) *Is There A British Chalcolithic?: People, Place And Polity In The Later Third Millennium*: 193-210. Oxford: Oxbow Books.

Carvalho, A.F., Gibaja, J.F., Cardoso, J.L. 2013. Insights Into The Earliest Agriculture Of Central Portugal: Sickle Implements From The Early Neolithic Site Of Cortiçóis (Santarém). *Comptes Rendus Palevol* 12: 31-43.

Cavers, G. 2006. Late Bronze Age And Iron Age Lake Settlement In Scotland And Ireland: The Development Of The 'Crannog' In The North And West. *Oxford Journal Of Archaeology* 25(4): 389-412.

Chapple, R.M. 2010. *The Excavation Of An Enclosed Middle Bronze Age Cemetery At Gransha, Co. Londonderry, Northern Ireland*. Oxford: Archaeopress.

--- 2007. Late Prehistoric Recycling At Ballyboley, County Antrim. *Ulster Journal Of Archaeology* 66: 1-5.

Chapple, R.M., Moore, D.G., Dunne, C.M. 2009. Excavations At Ballyloran, Larne, County Antrim. *Ulster Journal Of Archaeology* 68: 1-26.

Clarke, A. 2003. Report On The Flint Assemblage From: 02E0541, Site 11 Tully East, French Furze, Co. Kildare. In Ó Maoldúin, R. 2008. *Kildare Town Bypass: Archaeological Excavation Of Early Bronze Age Structure And Associated Features, Final Report 02E0541, Site 11, French Furze, Tully East Townland, Co. Kildare*. VJK Ltd.: unpublished excavation report.

Clarke, L. 2009. *M3 Clonee-North Of Kells Contract 3 Navan Bypass: Report On The Archaeological Excavation Of Boyerstown 3, Co. Meath*. ACS Ltd.: unpublished excavation report.

Cleary, K. 2007a. *Irish Bronze Age Settlements: Spatial Organisation And The Deposition Of Material Culture*. University College Cork: unpublished PhD thesis.

--- 2007b. *Irish Bronze Age Settlements: Spatial Organisation And The Deposition Of Material Culture - Database*. University College Cork: unpublished PhD database.

Cleary, R.M. 2000. The Potter's Craft In Prehistoric Ireland With Specific Reference To Lough Gur, Co. Limerick. In Desmond, A., Johnson, G., McCarthy, M., Sheehan, J., Shee-Twohig, E. (eds) *New Agendas In Irish Prehistory: Papers In Commemoration Of Liz Anderson*: 119-134. Bray: Wordwell.

Cleary, R.M., Lanting, J., Ó Donnabháin, B., Power, C., Lennon, A-M., Anderson, E., Wijngaarden-Bakker, L.H. van. 1995. Later Bronze Age Settlement And Prehistoric Burials, Lough Gur, Co. Limerick. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 95C(1): 1-92.

Coffey, G. 1908. Irish Copper Halberds. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 27: 94-114.

Conboy, G. 2006. *Final Report Archaeological Excavation Of A Hearth, Pits And Postholes (Site 63M), South Eastern Motorway, Co. Dublin*. VJK Ltd.: unpublished excavation report.

Conry, M.J. 1987. *Soils Of County Laois*. An Foras Taluntais: Soil Survey Bulletin No. 41.

Cooney, G., Grogan, E. 1999. *Irish Prehistory: A Social Perspective*. Bray: Wordwell.

Cooney, G., Mandal, S. 1998. *The Irish Stone Axe Project*. Bray: Wordwell.

Cooper, Z., Bowdler, S. 1998. Flaked Glass Tools From The Andaman Islands And Australia. *Asian Perspectives* 37(1): 74-83.

Cooper, M.R., Troll, V.R., Lemon, K. 2018. The 'Clay-with-Flints' Deposit In Northern Ireland: Reassessment Of The Evidence For An Early Paleocene Ignimbrite. *Geological Magazine* 155(8): 1811-1820.

Cormack, J. 2014. Bipolar Percussion. YouTube. https://www.youtube.com/watch?v=UkfSJoXNOQo. Accessed 12/01/19.

Costa, L-J., Sternke, F. 2007. La Transformation Des Industries Durant Le Mésolithique En Irlande: Une Mutation Économique, Sociale Ou Idéologique? *L'anthropologie* 111: 1-9.

Costa, L-J., Sternke, F., Woodman, P.C. 2005. Microlith To Macrolith: The Reasons Behind The Transformation Of Production In The Irish Mesolithic. *Antiquity* 79: 19-33.

--- 2001. The Analysis Of A Lithic Assemblage From Eleven Ballyboes, County Donegal. *Ulster Journal Of Archaeology* 60: 1-8.

Cotterell, B., Kamminga, J. 1987. The Formation Of Flakes. *American Antiquity* 52(4): 675-708.

Crandell, O., Ionescu, C., Mirea, P. 2016. Neolithic And Chalcolithic Stone Tools Used In Ceramics Production: Examples From The South Of Romania. *Journal Of Lithic Studies* 3(1): 241-258.

Culleton, E.B. 1978. Characterisation Of Glacial Deposits In South Wexford. *Proceedings Of The Royal Irish Academy Section B: Biological, Geological, And Chemical Science* 78: 293-308.

Davies, O., Evans, E.E., Whelan, C.B. 1940. Conditions Of Life In Prehistoric Ireland. *Ulster Journal Of Archaeology* 3: 5-16.

Deacon, J. 1984. *The Later Stone Age Of Southernmost Africa*. BAR: S213.

Delaney, S. 2009. *M1 Western Dundalk Bypass Site 124: Carn More 1*. IAC: unpublished excavation report.

Devriendt, I. 2008. Becoming Neolithic. The Mesolithic-Neolithic Transition And Its Impact On The Flint And Stone Industry At Swifterbant (The Netherlands). *Documenta Praehistorica* 35: 131-141.

Diamond, J., Sills, P. 2011. *Soils Of County Waterford*. An Foras Taluntais: Soil Survey Bulletin No. 44.

Diez-Martín, F., Sánchez Yustos, P., Domínguez-Rodrigo, M., Prendergast, M.E. 2011. An Experimental Study Of Bipolar And Freehand Knapping Of Naibor Soit Quartz From Olduvai Gorge (Tanzania). *Antiquity* 76: 690-708.

Doody, M. 2000. Bronze Age Houses In Ireland. In Desmond, A., Johnson, G., McCarthy, M., Sheehan, J., Shee-Twohig, E. (eds) *New Agendas In Irish Prehistory: Papers In Commemoration Of Liz Anderson*: 135-159. Bray: Wordwell.

Drift, J.W.P. van der. 2012a. *Partitioning The Palaeolithic: Introducing The Bipolar Toolkit Concept*. Groningen: Aktieve Praktijk Archeologie Nederland.

--- 2012b. Oblique Bipolar Flaking - The New Interpretation Of Mode-I. *Notae Praehistoricae* 32: 159-164.

--- 2010. Comparing Bipolar Artefacts With Pseudo-Artefacts And Industrial Waste: An Overview Based On Experimentation. *Notae Praehistoricae* 30: 95-100.

--- 2009. *Bipolar Techniques In The Old-Palaeolithic*. http://www.apanarcheo.nl/bipolair%20apanarcheo.pdf.

Driscoll, K. 2016. The Role Of Quartz In Neolithic Lithic Traditions: A Case Study From The Thornhill Early Neolithic Palisaded Enclosure, Co. Londonderry, Northern Ireland. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 116C: 3-29.

--- 2013. Coastal Communities In Earlier Prehistoric Ireland: Ploughzone Survey And The Tawin/Maree Stone Axes, Galway Bay. *Proceedings Of The Royal Irish Academy* 113C: 29-65.

--- 2010. *Understanding Quartz Technology In Early Prehistoric Ireland*. University College Dublin: unpublished PhD thesis.

--- 2009. 'They Wrought Almost Any Material That Came In Their Way': Mesolithic Flint Alternatives In The West Of Ireland. *Internet Archaeology* 26.

Driscoll, K., Alcaina, J., Égüez, N., Mangado, X., Fullola, J-M., Tejero, J-M. 2015. Trampled Under Foot: A Quartz And Chert Human Trampling Experiment At The Cova Del Parco Rock Shelter, Spain. *Quaternary International* 424: 130-142.

Driscoll, K., Menuge, J., O'Keeffe, E. 2014. New Materials, Traditional Practices: A Mesolithic Silicified Dolomite Toolkit From Lough Allen, Ireland. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 114C: 1-34.

Driscoll, K., Warren, G. 2007. Dealing With The 'Quartz Problem' In Irish Lithics Research. *Lithics* 28: 4-14.

Dubreuil, L., Savage, D., Delgado-Raack, S., Plisson, H., Stephenson, B., Torre, I. de la. 2015. Chapter 7: Current Analytical Frameworks For Studies Of Use-Wear On Ground Stone Tools. In Marreiros, J.M., Gibaja Bao, J.F., Ferreira Bicho, N. (eds) *Use-Wear And Residue Analysis In Archaeology*: 105-158. Switzerland: Springer.

Duke, H., Pargeter, J. 2015. Weaving Simple Solutions To Complex Problems: An Experimental Study Of Skill In Bipolar Cobble Splitting. *Lithic Technology* 40: 349-365.

Edmonds, M. 1997. Taskscape, Technology And Tradition. *Analecta Praehistorica Leidensia 29*: 99-110.

--- 1995. *Stone Tools And Society: Working Stone In Neolithic And Bronze Age Britain*. London: Routledge.

Engl, R. 2004. Stone Tool Analysis. In Danaher, E., Cagney, L. *Report On The Archaeological Excavation Of A Multi-phased Site At Ballinaspig More 5, Ballincollig, Co. Cork*. ACS Ltd.: unpublished excavation report.

Eogan, G. 1981. The Gold Vessels Of The Bronze Age In Ireland And Beyond. *Proceedings Of The Royal Irish Academy Section C: Archaeology, Celtic Studies, History, Linguistics, Literature* 81C: 345-382.

--- 1974. Pins Of The Late Irish Bronze Age. *Journal Of The Royal Society Of Antiquaries Of Ireland* 104: 74-119.

--- 1964. The Later Bronze Age In Ireland In Light Of Recent Research. *Proceedings Of The Prehistoric Society* 30: 268-311.

--- 1962. Some Observations On The Middle Bronze Age In Ireland. *Journal Of The Royal Society Of Antiquaries Of Ireland* 92: 45-60.

Eren, M.I., Diez-Martín, F., Dominguez-Rodrigo, M. 2013. An Empirical Test Of The Relative Frequency Of Bipolar Reduction In Beds VI, V, and III At Mumba Rockshelter, Tanzania: Implications For The East African Middle To Late Stone Age Transition. *Journal Of Archaeological Science* 40: 248-256.

Eriksen, B.V. (ed) 2010. *Lithic Technology In Metal Using Societies: Proceedings Of A UISPP Workshop*. Højbjerg: Jutland Archaeological Society.

Evans, J. 1881. *The Ancient Bronze Implements, Weapons, And Ornaments Of Great Britain And Ireland*. London: Longmans, Green & Co..

Faivre, J.P., Geneste, J.M., Turq, A. 2010. La Fracturation En Split, Une Technique De Production Dans L'Industrie Lithique Des Tares (Sourzac, Dordogne). *PALEO* Numéro spécial: 123-132.

Finch, T.F. 1977. *Soils Of County Westmeath*. An Foras Taluntais: Soil Survey Bulletin No. 33.

Finch, T.F., Gardiner, M.J., Comey, A., Radford, T. 1983. *Soils Of County Meath*. An Foras Taluntais: Soil Survey Bulletin No. 37.

Finch, T.F., Ryan, P. 1966. *Soils Of County Limerick*. An Foras Taluntais: Soil Survey Bulletin No. 16.

Flenniken, J.J., White, J.P. 1985. Australian Flaked Stone Tools: A Technological Perspective. *Records Of The Australian Museum* 36(3): 131-151.

Flynn, C. 2011. *N7 Castletown To Nenagh Road Improvement Scheme Contract 2 (Derrinsallagh To Castleroan): Camlin 3*. VJK Ltd.: unpublished excavation report.

Fox, C. 1939. The Socketed Bronze Sickles Of The British Isles; With Special Reference To An Unpublished Specimen From Norwich. *Proceedings Of The Prehistoric Society* 5(2): 222-248.

Fredengren, C. 2002. *Crannogs: A Study Of Peoples Interaction With Lakes, With Particular Reference To Lough Gara In The North-west Of Ireland*. Cambridge: Cambridge University Press.

Fröhlich, F. 2020. The Opal-CT Nanostructure. *Journal Of Non-Crystalline Solids* 533.

Furestier, R. 2010. La Percussion Directe Dure Au Campaniforme: Modalités D'Application Et Difficultés D'Interprétation. *PALEO* Numéro special: 189-200.

Gibson, A. 2002. *Prehistoric Pottery In Britain And Ireland*. Gloucestershire: Tempus Publishing Ltd.

Gibson, D.B. 2016. Chalcolithic Beginnings And Ecological Change Spanning 1,000 Years As Glimpsed From A Doline In The Burren, Co. Clare. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 116C: 33-91.

--- 2012. *From Chiefdom To State In Early Ireland*. Cambridge: Cambridge University Press.

Gilabert, X.R., Mora, R., Martínez-Moreno, J. 2015 Identifying Bipolar Knapping In The Mesolithic Site Of Font Del Ros (Northeast Iberia). *Philosophical Transactions Of The Royal Society B* 370: 20140354.

Gilmore, S. 2009. The Excavation Of A Bronze Age Settlement At Lisnalinchy, County Antrim. *Ulster Journal Of Archaeology* 68: 47-63.

Gijn, A. van. 2010. Not At All Obsolete! The Use Of Flint In The Bronze Age Netherlands. In Eriksen, B.V. (ed) *Lithic Technology In Metal Using Societies: Proceedings Of A UISPP Workshop*: 45-60. Højbjerg: Jutland Archaeological Society.

Gijn, A. van, Niekus, M.J.L.T. 2001. Bronze Age Settlement Flint From The Netherlands: The Cinderella Of Lithic Research. In Metz, W.H., Beek, B.L. van, Steegstra, H. (eds) *Patina: Essays Presented To Jay Jordan Butler On The Occasion Of His 80th Birthday*: 305-320. Amsterdam: Groningen.

Ginn, V. 2016. *Mapping Society: Settlement Structure in Later Bronze Age Ireland*. Oxford: Archaeopress Archaeology.

--- 2011. The Fusion Of Settlement And Identity In Dispersed And Nucleated Settlements In Bronze Age Ireland. *Journal Of Irish Archaeology* 20: 27-44.

Ginn, V., Plunkett, G., 2020. Filling The Gaps: A Chronology Of Bronze Age Settlement In Ireland. *Journal Of Irish Archaeology* XXIX: 41-61.

Ginn, V., Rathbone, S. (eds) 2012. *Corrstown - A Coastal Community: Excavations Of A Bronze Age Village In Northern Ireland*. Oxford: Oxbow Books.

Goren-Inbar, N., Sharon, G., Alperson-Afil, N., Herzlinger, G. 2015. A New Type Of Anvil In The Acheulian Of Gesher Benot Ya'aqov, Israel. *Philosophical Transactions Of The Royal Society B* 370: 20140353.

Green, S. 1984. Flint Arrowhead: Typology And Interpretation. *Lithics* 5: 19-39.

Green, S., Zvelebil, M. 1990. The Mesolithic Colonisation And Agricultural Transition Of Southeast Ireland. *Proceedings Of The Prehistoric Society* 56: 57-88.

Gregory, J.W. 1921. The Irish Eskers. *Philosophical Transactions Of The Royal Society Of London Series B* 210: 115-151.

Grimaldi, S., Santaniello, F., Angelucci, D.E., Bruni, L., Parenti, F. 2020. A Techno-functional Interpretation Of The Lithic Assemblage From Fontana Ranuccio (Anagni, Central Italy): An Insight Into A MIS 11 Human Behaviour. *Journal Of Paleolithic Archaeology* 3: 944-966.

Grogan, E. 2017. The Bronze Age: A Surfeit Of Data? In Stanley, M., Swan, R., O'Sullivan, A. (eds) *Stories Of Ireland's Past: Knowledge Gained From NRA Roads Archaeology*: 57-84. Transport Infrastructure Ireland: Dublin.

--- 2012. Stone Artefacts. In Ginn, V., Rathbone, S. (eds) *Corrstown - A Coastal Community: Excavations Of A Bronze Age Village In Northern Ireland*: 186-195. Oxford: Oxbow Books.

Grogan, E., O'Donnell, L., Johnston, P. 2007. *The Bronze Age Landscapes Of The Pipeline To The West*. Bray: Wordwell Ltd.

Grogan, E., Roche, H. 2011. The Prehistoric Pottery: Rathmullan 10 (00E0813), Co. Meath. In Bolger, T. 2012. *M1 Northern Motorway: Rathmullan 10*. IAC: unpublished excavation report.

---, --- 2009. The Prehistoric Pottery From Newtownbalregan 2, Co. Louth (03E0113). In Bayley, D. *M1 Dundalk Western Bypass Site 112: Newtownbalregan 2*. IAC: unpublished excavation report.

Groman-Yaroslavski, I., Weiss, E., Nadel, D. 2016. Composite Sickles And Cereal Harvesting Methods At 23,000-Years-Old Ohalo II, Israel. *PLoS ONE* 11(1).

GSI 2020. *Geological Survey Ireland Spatial Resources Viewer*. Available at: https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228. Accessed: 27/07/2020.

Gurova, M. 2014. Some Examples Of Technological Change In Prehistoric Bulgaria. In Gijn, A. van, Whittaker, J.C., Anderson, P.C. (eds) *Exploring And Explaining Diversity In Agricultural Technology*: 342-365. Oxford: Oxbow Books.

Gurova, M., Bonsall, C. 2017. Experimental Replication Of Stone, Bone And Shell Beads From Early Neolithic Sites In Southeast Europe. In Bar-Yosef Mayer, D.E., Bonsall, C., Choyke, A.M. (eds) *Not Just For Show: The Archaeology Of Beads, Beadwork, And Personal Ornaments*: 159-167. Oxford: Oxbow Books.

Harbison, P. 1973. The Earlier Bronze Age In Ireland Late 3rd Millennium – *c*. 1200 B.C. *Journal of the Royal Society of Antiquaries of Ireland* 103: 93-152.

--- 1969. The Relative Chronology Of Irish Early Bronze Age Pottery. *Journal Of The Royal Society Of Antiquaries Of Ireland* 99(1): 63-82.

Hayden, B. 1980. Confusion In The Bipolar World: Bashed Pebbles And Splintered Pieces. *Lithic Technology* 9: 2-7.

Hintzman, M.W., Garfinkel, A. 2011. Behavioural Snapshots: Single-reduction Loci Patterning In The Mojave Desert. *SCA Proceedings* 25.

Hiscock, P. 2015a. Making It Small In The Palaeolithic: Bipolar Stone-working, Miniature Artefacts And Models Of Core Recycling. *World Archaeology* 47: 158-169.

--- 2015b. Dynamics Of Knapping With Bipolar Techniques: Modelling Transitions And The Implications Of Variability. *Lithic Technology* 40(4): 342-348.

--- 2002. Quantifying The Size Of Artefact Assemblages. *Journal Of Archaeological Science* 29: 251-258.

Hodges, H.W.M. 1954. Studies In The Late Bronze Age In Ireland: 1. Stone And Clay Moulds, And Wooden Models For Bronze Implements. *Ulster Journal Of Archaeology* 17: 62-80.

Howland, M.D., Keuster, F., Levy, T.E. 2014. Photogrammetry In The Field: Documenting, Recording, And Presenting Archaeology. *Mediterranean Archaeology And Archaeometry* 14(4): 101-108.

Humphrey, J. 2004. *Iron Age Flint Utilisation In Central And Southern Britain: The Last "Stone Age?" An Integrated Theoretical And Empirical Study*. University of Leicester: unpublished PhD thesis.

Inizan, M.L., Reduron-Ballinger, M., Roche, H., Tixier, J. 1999. *Technology And Terminology Of Knapped Stone*. France: Cercle de Recherches et d'Etudes Préhistoriques.

Jeske, R.J. 1992. Energetic Efficiency And Lithic Technology: An Upper Mississippian Example. *American Antiquity* 57: 467-481.

Jeske, R.J., Sterner-Miller, K.M. 2015. Microwear Analysis Of Bipolar Tools From The Crescent Bay Hunt Club Site (47JE904). *Lithic Technology* 40: 366-376.

Kavanagh, R.M. 1991. A Reconsideration Of Razors In The Irish Earlier Bronze Age. *Journal Of The Royal Society Of Antiquaries Of Ireland* 121: 77-104.

--- 1976. Collared And Cordoned Cinerary Urns In Ireland. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 76: 293-403.

Keene, J.B. 1975. Cherts And Porcellanites From The North Pacific, DSDP Leg 32. In Moberly, R., Gardner, J.V., Larson, R.L. (eds) *Initial Reports Of The Deep Sea Drilling Project Volume XXXII*, 429-507. Washington: US Government Printing Office.

Kelly, A. 2010. *E3123: Grange 3 – Final Report*. IAC: unpublished excavation report.

Kelly, B., Doherty, B., Johnston, P., Doolan, A. 2007. *Archaeological Excavation Report For IDA Arklow Business & Technology Park, Ballynattin, Co. Wicklow*. Eachtra Journal 14.

Khalaily, M., Kaminsky, E. 2002. The Use Of Sickle Blades For Decorating Pottery In The Wadi Rabah Culture: The Case Of Tel Dover. In Brink, E.C.M. van den, Yannai, E. (eds) *In Quest Of Ancient Settlement Sites And Landscapes: Archaeological Studies In Honour Of Ram Gophna*: 57-64. Tel Aviv: Ramot Publishing.

Kiely, J., Teirney, J., Chrobak, E. 2011. *Archaeological Excavation Report For Drumbaun, Co. Tipperary*. Eachtra Journal 11.

Knight, J. 1991. Technological Analysis Of The Anvil (Bipolar) Technique. *Lithics* 12: 57-87.

Knowles, W.J. 1903. Irish Flint Arrow- And Spear-Heads. *Journal Of The Anthropological Institute Of Great Britain And Ireland* 33: 44-56.

Knutsson, K. 1988. *Making And Using Stone Tools: The Analysis Of The Lithic Assemblages From Middle Neolithic Sites With Flint In Västerbotten, Northern Sweden*. Uppsala: Societas Archaeologica Upsaliensis.

Kobayashi, H. 1975. The Experimental Study of Bipolar Flakes. In Swanson, E. (ed) *Lithic Technology: Making And Using Stone Tools*: 115-127. The Hague: Mouton.

Kononenko, N. 2009. Stone Working Methods 1: Anvil Technique. In Stone Working Methods. YouTube. https://www.youtube.com/watch?v=wfKn4xgQPIg. Accessed 12/01/19.

Kooyman, B.P. 2000. *Understanding Stone Tools And Archaeological Sites*. Canada: University of Calgary Press.

Kosolapoff, G.M. 1945. Basis For Scientific Terminology And Classification. *Science* 101(2613): 89-90.

Kostov, R.I. 2010. Review Of The Mineralogical Systematics Of Jasper And Related Rocks. *Archeometriai Mühely* 3: 209-213.

Kuijt, I., Prentiss, W.C., Pokotylo, D.L. 1995. Bipolar Reduction: An Experimental Study Of Debitage Variability. *Lithic Technology* 20(2): 116-127.

Larson, T.S. 2009. *Experiments Concerning The Mold Materials Used In The Production Of The Copper Ingots From The Late Bronze Age Shipwreck Excavated At Uluburun, Turkey*. Texas A&M University: unpublished MA thesis.

Leaf, G.R. 1979. Variation In The Form Of Bipolar Cores. *Plains Anthropologist* 24(83): 39-50.

Leonard, K. 2014*. Ritual in Late Bronze Age Ireland - Material Culture, Practices, Landscape Setting and Social Context*. National University of Ireland Galway: unpublished PhD thesis.

Lineen, J. 2017. *Spearheads In The Landscape: A Contextual Analysis*. University College Cork: unpublished MPhil thesis.

Little, A. 2005. Lithic Report. In Molloy, B. *Final Report, Charlesland Residential Development, Charlesland, Co. Wicklow, Site D*. Margaret Gowan & Co. Ltd.: unpublished excavation report.

Lovering, T.G. 1972. *Jasperoid In The United States – Its Characteristics, Origin, And Economic Significance*. U.S. Geological Survey: Geological Survey Professional Paper 710.

--- 1962. The Origin Of Jasperoid In Limestone. *Economic Geology* 57(6): 861-889.

Low, B.D. 1997. *Bipolar Technology And Pebble Stone Artifacts: Experimentation In Stone Tool Manufacture*. University of Saskatchewan: unpublished MA thesis.

Luik, H., Ots, M., Maldre, L. 2011. From The Neolithic To The Bronze Age: Continuity And Changes In Bone Artefacts In Saameraa, Estonia. In Baron, J., Kufel-Diakowska, B. (eds) *Written In Bones:*

Studies On Technological And Social Contexts Of Past Faunal Skeletal Remains: 243-261. Wrocław: Uniwersytet Wrocławski.

Lynch, P. 2011. *E3158: Cakestown Glebe 2*. IAC: unpublished excavation report.

Lynch, R. 2012. *00E0822: Platin/Lagavooren 1*. IAC: unpublished excavation report.

Lyne, E. 2010. *E3130: Phoenixtown 3*. IAC: unpublished excavation report.

--- 2009. *Excavations At Creggan Lower 1, Co. Westmeath*. IAC: unpublished excavation report.

MacDonald, P., Carver, N., Yates, M. 2005. Excavations At McIlwhans Hill, Ballyutoag, County Antrim. *Ulster Journal Of Archaeology* 64: 43-61.

Maeda, O., Lucas, L., Silva, F., Tanno, K-I., Fuller, D.Q. 2016. Narrowing The Harvest: Increasing Sickle Investment And The Rise Of Domesticated Cereal Agriculture In The Fertile Crescent. *Quaternary Science Reviews* 145: 226-237.

Maffezzoli, D., Massussi, M., Castangia, G. 2015. Some Experiments On Bipolar Knapping. *Traces In Time* 5.

Mallory, J.P., Brown, D.M., Baillie, M.G.L. 1999. Dating Navan Fort. *Antiquity* 73: 427-431.

Marín-Buzón, C., Pérez-Romero, A., López-Castro, J.L., Ben Jerbania, I., Manzano-Agugliaro, F. 2021. Photogrammetry As A New Scientific Tool In Archaeology: Worldwide Research Trends. *Sustainability* 13(5319).

Maryon, H. 1938. The Technical Methods Of The Irish Smiths In The Bronze And Early Iron Ages. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 44C: 181-228.

Matilla, K. 2010. La Chaise-de-Vouthon (Charente), Fouilles P. David (1936-1961) Et Fouilles A. Debénath (1967-1983): Un Exemple De Débitage Bipolaire Sur Enclume. *PALEO* Numéro special: 63-74.

Mazzucco, N., Guilbeau, D., Petrinelli-Pannocchia, C., Gassin, B., Ibáñez, J.J., Gibaja, J.F. 2017. Harvest Time: Crop-reaping Technologies And The Neolithisation Of The Central Mediterranean. *Antiquity* 91: 1-5.

Milliken, S. 2002. Lithics Report. In Sherlock, R. 2005. *Archaeological Excavation Of A Bronze Age House And A Number Of Bronze Age Grain-storage Pits At Killydonoghoe, Co. Cork*. Sheila Land & Associates: unpublished excavation report.

Molloy, B. 2005. *Final Report Charlesland Residential Development, Charlesland, Co. Wicklow – Site D*. Margaret Gowen & Co. Ltd.: unpublished excavation report.

Moloney, A., Jennings, D., Keane, M., MacDermott, C. 1993. *Excavations At Clonfinlough, Co. Offaly*. Dublin: Irish Archaeological Wetland Unit Transactions 2.

Moore, D.G. 2011. Lithic Assemblage. In Hardy, C. & Stevens, P. *N7 Castletown to Nenagh: Camlin-Derrymore 1*. VJK Ltd.: unpublished excavation report.

--- 2009a. Lithics Report. In Johnston, A. *Archaeological Excavation Final Report: Laughanstown, Co. Dublin*. CRDS: unpublished excavation report.

--- 2009b. Lithics Report. In McGowan, L. *Report On Archaeological Excavation Of Site 2, Cherryhound, County Dublin*. CRDS: unpublished excavation report.

--- 2008. Appendix 9: Report On The Lithic Assemblage From Demesne/Mearsparkfarm 2. In McDermott, C., O'Connor, D.J. *N6 Kinnegad To Athlone Dual Carriageway, Advance Archaeological Investigation, Contract 2: Tyrrellspass To Kilbeggan, Final Report*: 155-159. CRDS: unpublished excavation report.

Mora, R., Torre, I. de la. 2005. Percussion Tools In Olduvai Beds I And II (Tanzania): Implications For Early Human Activities. *Journal Of Anthropological Archaeology* 24: 179-192.

Morgan, B.M., Eren, M.I., Khreisheh, N., Hill, G., Bradley, B.A. 2015. Clovis Bipolar Lithic Reduction at Paleo Crossing, Ohio: A Reinterpretation Based on the Examination of Experimental Replications. In Smallwood, A. M., Jennings, T. A. (eds) *Clovis - On The Edge Of A New Understanding*: 121-143. Texas: Texas A&M University Press.

Mount, C. 2013. Thoughts On Razors And Male Grooming In Earlier Bronze Age Ireland. *Charles Mount's Blog* 20 November 2013. http://charles-mount.ie/wp/index.php/thoughts-on-razors-and-male-grooming-in-earlier-bronze-age-ireland/. Accessed: 05/10/2020.

--- 1997. Early Bronze Age Burial In South-East Ireland In Light Of Recent Research. *Proceedings Of The Royal Irish Academy* 97C(3): 101-193.

Mount, C., Buckley, L. 1997. Adolf Mahr's Excavations Of An Early Bronze Age Cemetery At Keenoge, County Meath. *Proceedings Of The Royal Irish Academy* 97C(1): 1-59, 61-68.

Mount, C., Hartnett, P.J., Buckley, L. 1993. Early Bronze Cemetery At Edmondstown, County Dublin. *Proceedings Of The Royal Irish Academy* 93C(2): 21-79.

Mulligan, G. 2012. Settling Down Or Moving On? The Settlement Of The Irish Neolithic Landscape. *New Hibernia Review* 16(1): 94-112.

MacAlister, R.A.S. 1949. *The Archaeology Of Ireland*. London: Meuthen & Co. Ltd.

MacKenzie, D., Wajcman, J. 1999. Introductory Essay: The Social Shaping Of Technology. In MacKenzie, D., Wajcman, J. (eds.) *The Social Shaping Of Technology*: 1-49. Buckingham: Open University Press.

McCall, G.S. 2019. "The Place Is Full Of Cabbages": An Analysis Of The Irish Late Mesolithic Stone Tool Technology From Kenure, Co. Dublin. *Journal Of Archaeological Science: Reports* 23: 203-215.

McClatchie, M., Bogaard, A., College, S., Whitehouse, N.J., Schulting, R.J., Barratt, P., McLaughlin, T.R. 2016. Farming And Foraging In Neolithic Ireland: An Archaeobotanical Perspective. *Antiquity* 90: 302-318.

McConway, C., Sheehan, G. 2011. *Final Report On Excavations At Benedin, N7 Nenagh Bypass, Co. Tipperary*. ADS Ltd.: unpublished excavation report.

McGee, W.J. 1902. Germe D'industrie De La Pierre En Amérique. *Journal Of American Folklore* 15(58): 182.

McLaughlin, T.R., Whitehouse, N.J., Schulting, R.J., McClatchie, M., Barratt, P., Bogaard, A. 2016. The Changing Face Of Neolithic And Bronze Age Ireland: A Big Data Approach To The Settlement And Burial Records. *Journal Of World Prehistory* 29: 117-153.

McLoughlin, G. 2012. *Archaeological Excavation At Haynestown-Haggardstown, Dundalk, Co. Louth: Site 1: Haynestown*. IAC: unpublished excavation report.

--- 2010. *M3 Clonee-North Of Kells Motorway Scheme: Cookstown Great 3*. IAC: unpublished excavation report.

McQuade, M. 2007. *Final Report At Ballylegan, N8 Cashel To Mitchelstown Road Improvement Scheme*. Margaret Gowen & Co. Ltd.: unpublished excavation report.

Nelis, D. 2012. *00E0811: Sheephouse 3*. IAC: unpublished excavation report.

Nelis, E. 2010a. The Lithics: Grange 3. In Kelly, A. *E3123: Grange 3*. IAC: unpublished excavation report.

--- 2010b. The Lithics: Phoenixtown 3. In Lyne, E. *E3130: Phoenixtown 3*. IAC: unpublished excavation report.

--- 2010c. The Lithics: Gardenrath 2. In Bayley, D. *M3 Clonee-North Of Kells Motorway Scheme: Gardenrath 2*. IAC: unpublished excavation report.

--- 2010d. The Lithics: Kilmainham 1C. In Walsh, F. 2011. *M3 Clonee-North Of Kells Motorway Scheme: Kilmainham 1C*. IAC: unpublished excavation report.

--- 2010e. The Lithics: Cookstown Great 3. In McLoughlin, G. *M3 Clonee-North Of Kells Motorway Scheme: Cookstown Great 3*. IAC: unpublished excavation report.

--- 2010f. The Lithics: Cakestown Glebe 2. In Lynch, P. 2011. *E3158: Cakestown Glebe 2*. IAC: unpublished excavation report.

--- 2010g. Appendix 2.2: The Lithics. In Coughlan, T. *E3126: Phoenixtown 5*. IAC: unpublished excavation report.

--- 2009a. Appendix 2.5 Chipped Stone And Worked Stone Assemblage Analysis Reports And Catalogues. In Ó Donnchadha, B. *M1 Dundalk Western Bypass, Site 108: Donaghmore 1, Final Report*. IAC: unpublished excavation report.

--- 2009b. Chipped Stone And Worked Stone Assemblage Analysis, Reports And Catalogue For Newtownbalregan 5. In Bayley, D. 2009. *M1 Dundalk Western Bypass Site 113: Newtownbalregan 5*. IAC: unpublished excavation report.

--- 2007. Appendix 5 Lithic Report: Chipped And Worked Stone Assemblage Analysis, Catalogues And Reports. In Elder, S. 2009. *E3044: Knocks 1*. ACS Ltd.: unpublished excavation report.

--- 2006a. Lithics Report For Carn More 1, Co. Louth. In Delaney, S. 2009. *M1 Dundalk Western Bypass Site 124: Carn More 1*. IAC: unpublished excavation report.

--- 2006b. Chipped Stone Assemblage Catalogue, Analysis And Report For Newtownbalregan 2. In Bayley, D. 2009. *M1 Dundalk Western Bypass Site 112: Newtownbalregan 2*. IAC: unpublished excavation report.

--- 2004. Neolithic Flint-work From The North Of Ireland: Some Thoughts On Prominent Tool Types And Their Production. In Gibson, A., Sheridan, A. (eds) *From Sickles To Circles: Britain And Ireland At The Time Of Stonehenge*: 155-217. Gloucestershire: Tempus Publishing.

Nicolas, C. 2020. Bracer Ornaments! An Investigation Of Bell Beaker Stone 'Wrist-guards' From Central Europe. *Journal Of Neolithic Archaeology* 22: 15-108.

--- 2019. The Production And Use Of Archery-related Items As A Reflection Of Social Changes During The Late Neolithic And The Early Bronze Age In Europe. In Kadrow, S., Müller, J. (eds) *Habitus? The Social Dimension Of Technology And Transformation*: 115-139. Leiden: Sidestone Press.

Norman, J. 2013. *Make Do And Mend: Keeping Family And Home Afloat On War Rations*. London: Michael O'Mara Books Limited.

Osipowicz, G., Kuriga, J., Piličiauskas, G. 2016. Polished Flint 'Scrapers' From Nida Neolithic Settlement – Were They Tools? Clues From Experimental Studies And A Use-wear Analysis. *Lietuvos Archeologija* 42: 127-149.

O'Brien, W. 2017. The Development Of The Hillfort In Prehistoric Ireland. *Proceedings Of The Royal Irish Academy* 117C: 1-59.

--- 2012. The Chalcolithic in Ireland: A Chronological and Cultural Framework. In Allen, J.M., Gardiner, J., Sheridan, A. (eds) *Is There A British Chalcolithic?: People, Place And Polity In The later Third Millennium*: 211-225. Oxford: Oxbow Books.

--- 2010. Copper Axes, Stone Axes: Production And Exchange Systems In The Chalcolithic Of Britain And Ireland. In Anreiter, P., Goldenberg, G., Hanke, L., Krause, R., Leitner, W., Mathis, F., Nicolussi, K., Oeggl, K., Pernicka, E., Prast, M., Schibler, J., Schneider, I., Stadler, H., Stöllner, T., Tomedi, G., Tropper, P. (eds) *Mining In European History And Its Impact On Environment And Human Societies – Proceedings For The 1st Mining In European History – Conference Of The SFB-HIMAT, 12–15 November 2009, Innsbruck*: 255-260. Innsbruck: Innsbruck University Press.

--- 2007. Miners And Farmers: Local Settlement Contexts For Bronze Age Mining. In Burgess, C., Topping, P., Lynch, F. (eds) *Beyond Stonehenge: Essays On The Bronze Age In Honour Of Colin Burgess*: 20-30. Oxford: Oxbow Books.

--- 2005. (Con)Fusion Of Tradition? The Circle Henge In Ireland. In Gibson, A., Sheridan, A. (eds) *From Sickles To Circles: Britain And Ireland At The Time Of Stonehenge*: 323-338. Stroud: Tempus Publishing.

--- 2004. *Ross Island: Mining, Metal And Society In Early Ireland*. Galway: NUIG.

--- 1999. *Sacred Ground: Megalithic Tombs In South-west Ireland*. National University Of Ireland Galway: Bronze Age Studies 4.

--- 1995. Ross Island and the Origins of Irish-British Metallurgy. In Waddell, J., Shee-Twohig, E. (eds) *Ireland In The Bronze Age: Proceedings Of The Dublin Conference, April 1995*: 38-48. Belfast: Shanway Press.

O'Brien, W., O'Driscoll, J. 2017. *Hillforts, Warfare And Society In Bronze Age Ireland*. Oxford: Archaeopress Publishing Ltd.

O’Connor, B. 2009. Re-collected Objects: Carved, Worked And Unworked Stone In Bronze Age Funerary Monuments. In O’Connor, B., Cooney, G., Chapman, J. (eds) *Materialitas – Working Stone, Carving Identity*: 147-160. Prehistoric Society Research Paper 3.

O’Driscoll, J. 2016. *The Baltinglass Landscape And The Hillforts Of Bronze Age Ireland*. University College Cork: unpublished PhD thesis.

O’Driscoll, J, Gleeson, P., Noble, G. 2020. Re-imagining Navan Fort: New Light On The Evolution Of A Major Ceremonial Centre In Northern Europe. *Oxford Journal Of Archaeology* 39(3): 247-273.

O’Flaherty, R. 2002. *A Consideration Of The Early Bronze Age Halberd In Ireland: Function And Context*. University College Dublin: unpublished PhD thesis.

--- 1995. An Analysis Of Irish Early Bronze Age Hoards Containing Copper Or Bronze Objects. *Journal Of The Royal Society Of Antiquaries Of Ireland* 125: 10-45.

O’Hara, B., McCormack, L. 2017. *2017:712 – Ardloy 1 And 2 / Springfield 4, Sligo*. Available at: https://excavations.ie/report/2017/Sligo/0029056/. Accessed: 14/08/2020.

O'Hare, M.B. 2013. *The Everyday Chipped Stone Technologies Of The Irish Bronze Age: A Broader Regional Perspective*. Unpublished proof.

--- 2012. Lithics. In Ginn, V., Rathbone, S. (eds) *Corrstown - A Coastal Community: Excavations Of A Bronze Age Village In Northern Ireland*: 156-167. Oxford: Oxbow Books.

--- 2009. Appendix 8: Analysis Of The Lithic Collection From Parknahown 5, Co. Laois. In O'Neill, T. *M7 Portlaoise-Castletown / M8 Portlaoise-Cullahill Motorway Scheme: Final Report*: 265-278. ACS Ltd.: unpublished excavation report

--- 2005. *The Bronze Age Lithics Of Ireland*. Queen's University Belfast: unpublished PhD thesis.

O’Neill, N. 2020. Continuity And Change: The Early Bronze Age And The Mid-Barrow Region. *Carloviana* 68: 37-42.

O’Neill, N., Kearney, D. 2014. *Ballon Hill Archaeology Project Phase 1 Report*.

O’Sullivan, A. 2007. Exploring Past People’s Interactions With Wetland Environments In Ireland. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 107C: 147-203.

Ó Baoill, R. 2016. Archaeological Excavations At Squire’s Hill, Belfast, County Antrim. *Ulster Journal Of Archaeology* 73: 59-67.

Ó Faoláin, S. 2004. *Bronze Artefact Production In Late Bronze Age Ireland: A Survey*. Oxford: Archaeopress.

--- 1997. *A Survey Of Bronze Artefact Production In Late Bronze Age Ireland*. National University of Ireland Galway: unpublished MA thesis.

Ó Faoláin, S., Northover, J.P. 1998. The Technology Of Late Bronze Age Sword Production In Ireland. *Journal Of Irish Archaeology* 9: 69-88.

Ó Maoldúin, R. 2014. *Exchange in Chalcolithic and Early Bronze Age Ireland: Connecting People, Objects And Ideas*. National University of Ireland Galway: unpublished PhD thesis.

--- 2008. *Kildare Town Bypass: Archaeological Excavation Of Early Bronze Age Structure And Associated Features, Final Report 02E0541, Site 11, French Furze, Tully East Townland, Co. Kildare*. VJK Ltd.: unpublished excavation report.

Ó Néill, J. 2009. *Inventory Of Bronze Age Structures*. Heritage Council: unpublished report.

--- 2004. Chapter 13: Worked Wood. In Gowen, M., Phillips, M., Ó Néill, J. (eds) *The Lisheen Mine Archaeological Project 1966-98*: 329-340. Bray: Wordwell Ltd.

Ó Nualláin, S. 1978. Boulder-burials. *Proceedings of the Royal Irish Academy C: Archaeology, Celtic Studies, History, Linguistics, Literature* 78: 75-114.

Ó Ríordán, S.P. 1954. Lough Gur Excavations: Neolithic And Bronze Age Houses On Knockadoon. *Proceedings Of The Royal Irish Academy Section C: Archaeology, Celtic Studies, History, Linguistics, Literature* 56: 297-459.

--- 1952. Lough Gur Excavations: The Great Stone Circle (B) In Grange Townland. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 54: 37-74.

Ó Ríordán, B., Waddell, J. 1993. *The Funerary Bowls And Vases Of The Irish Bronze Age*. Galway: Galway University Press.

Pargeter, J., Duke, H. (eds). 2015. *Lithic Technology 40(4) – Exploring Variability In Bipolar Technology*.

Pargeter, J., Eren, M.I. 2017. Quantifying And Comparing Bipolar Versus Freehand Flake Morphologies, Production Currencies, And Reduction Energetics During Lithic Miniaturization. *Lithic Technology* 42: 90-108.[17]

Pelegrin, J. 2006. Long Blade Technology In The Old World: An Experimental Approach And Some Archaeological Results. In Apel, J., Knutsson, K. (eds) *Skilled Production And Social Reproduction*: 37-68. Uppsala: SAU Stone Studies 2.

Peña, P. de la. 2015a. The Interpretation Of Bipolar Knapping In African Stone Age Studies. *Current Anthropology* 56(6): 911-923.

--- 2015b. A Qualitative Guide To Recognize Bipolar Knapping For Flint and Quartz. *Lithic Technology* 40: 316-331.

--- 2011. Sobre La Identificación Macroscópica De Las Piezas Astilladas: Propuesta Experimental. *Trabajos De Prehistoria* 68(1): 79-98.

Peña, P. de la, Wadley, L. 2014. Quartz Knapping Strategies In The Howiesons Poort At Sibudu (KwaZulu-Natal, South Africa). *PLoS ONE* 9(7): e101534. DOI: 10.1371/journal.pone.0101534.

Percival, S. 2016. *An Introduction To Neolithic To Mid Bronze Age Prehistoric Pottery of Cambridgeshire*. Jigsaw Cambridgeshire.

[17] Article was downloaded as a PDF. Page numbers in document do not match those in journal.

Pershits, A. 1979. On Scientific Communication And Scientific Terminology. *Current Anthropology* 20(1): 148-150.

Peterson, J. 1990. From Foraging To Food Production In Southeast Ireland: Some Lithic Evidence. *Proceedings Of The Prehistoric Society* 56: 89-99.

Piličiauskas, G., Osipowicz, G. The Processing And Use Of Flint In The Metal Ages: A Few Cases From The Kernavė And Naudvaris Sites In Lithuania. *Archaeologia Baltica* 13: 110-125.

Pisciotto, K.A. 1980. Chert And Porcellanite From Deep Sea Drilling Project Site 436, Northwest Pacific. In Lee, M., Stout, L.N. (eds) *Initial Reports Of The Deep Sea Drilling Project Volume LVI, LVII, Part 1*: 1133-1142. Washington: US Government Printing Office.

Prendergast, E. 1962. Urn Burial At Maganey Lower, Co. Kildare. *Journal Of The Royal Society Of Antiquaries Of Ireland* 92: 169-173.

Prous, A., Alonso, M., Neves de Souza, G., Pessoa Lima, A., Amoreli, F. 2010. La Place Et Les Caractéristiques Du Débitage Sur Enclume (Bipolaire) Dans Les Industries Brésiliennes. *PALEO* Numéro spécial: 201-220.

Randall, D., Welser, C. 2018. *The Irreproducibility Crisis Of Modern Science: Causes, Consequences, And The Road To Reform*. National Association of Scholars.

Rathbone, S. 2013. A Consideration Of Villages In Neolithic And Bronze Age Britain And Ireland. *Proceedings Of The Prehistoric Society* 79: 39-60.

--- 2010. *Investigations At Slievemore, Roundhouse 2*. Achill Field School: unpublished excavation report.

Roberts, B.W. 2013. Britain And Ireland In The Bronze Age: Farmers In The Landscape Or Heroes On The High Seas?. In Fokkens, H., Harding, A. (eds) *The Oxford Handbook Of The European Bronze Age*: 531-549. Oxford: Oxford University Press.

Robertson, A., Lochrie, J., Timpany, S. 2010. Neolithic Tool Manufacture On The Antrim Coast: Excavations At West Division, Greenisland. *Ulster Journal Of Archaeology* 69: 27-45.

Roche, H., Grogan, E. 2012. Pottery. In Ginn, V., Rathbone, S. (eds) *Corrstown - A Coastal Community: Excavations Of A Bronze Age Village In Northern Ireland*: 167-186. Oxford: Oxbow Books.

Roe, F., Woodward, A. 2009. Bits And Pieces: Early Bronze Age Stone Bracers From Ireland. *Internet Archaeology* 26.

Runnels, C. 1985. Lithic Studies: Some Theoretical Considerations. *Lithic Technology* 14(3): 100-106.

Scannell, M. 1992. *The Effect Of Resource Availability On The Neolithic/Bronze Age Traditions In Cork, Kerry And Limerick*. University College Cork: unpublished MA thesis.

Sheridan, A., Cooney, G., Grogan, E. 1992. Stone Axe Studies In Ireland. *Proceedings Of The Prehistoric Society* 58: 389-416.

Sheridan, A., Davis, M. 2002. Investigating Jet And Jet-like Artefacts From Prehistoric Scotland: The National Museums Of Scotland Project. *Antiquity* 76: 812-825.

Simpson, D. 1990a. The Stone Battle Axes Of Ireland. *Journal Of The Royal Society Of Antiquaries Of Ireland* 120: 5-40.

--- 1990b. Irish Axe Hammers. *Ulster Journal Of Archaeology* 53: 50-56.

--- 1989. The Stone Maceheads Of Ireland: Part II. *Journal Of The Royal Society Of Antiquaries Of Ireland* 119: 113-126.

--- 1988. The Stone Maceheads Of Ireland. *Journal Of The Royal Society Of Antiquaries Of Ireland* 118: 27-52.

Sloan, B. 2016. Appendix: The Lithics From Squires Hill. In Ó Baoill, R. Archaeological Excavations At Squire's Hill, Belfast, County Antrim. *Ulster Journal Of Archaeology* 73: 59-67.

Slisko, J., Dykstra, D.I. 1997. The Role Of Scientific Terminology In Research And Teaching: Is Something Important Missing?. *Journal Of Research In Science Teaching* 34(6): 655-660.

Smyth, J. 2013. Tides Of Change? The House Through The Irish Neolithic. In Hofmann, D., Smyth, J. (eds) *Tracking The Neolithic House In Europe: Sedentism, Architecture And Practice*: 301-327. Switzerland: Springer.

--- 2012. Breaking Ground: An Overview Of Pits And Pit-digging In Neolithic Ireland. In Anderson-Whymark, H., Thomas, J. (eds) *Regional Perspectives On Neolithic Pit Deposition: Beyond The Mundane*: 13-29. Oxford: Oxbow Books.

--- 2011. The House And Group Identity In The Irish Neolithic. *Proceedings Of The Royal Irish Academy: Archaeology, Culture, History, Literature* 111C: 1-31.

Sollberger, J.B., Patterson, L.W. 1977. Reply By Sollberger And Patterson To Comments By Haynes And White On Bipolar Flaking. *Lithic Technology* 6(3): 26-28.

Soriano, S., Robert, A., Huysecom, É. 2010. Percussion Bipolaire Sur Enclume: Choix Ou Contrainte? L'Exemple Du Paléolithique D'Ounjougou (Pays Dogon, Mali). *PALEO* Numéro special: 123-132.

Sproule, A.M.N. 1968. *Flint Artifacts From Bronze Age Contexts In Ireland*. University College Dublin: unpublished MA thesis.

Stafford, E. 2011. *01E0399: Donore 2, Co. Meath – Final Report*. IAC: unpublished excavation report.

Sternke, F. 2015. 9.2 Lithic Finds Report For 12E0147, Bray, Valentia Island, Co. Kerry. In Harte, A. *Report On The Archaeological Excavations Undertaken At Bray, Valentia Island, Co. Kerry*: 36-39. Munster Archaeology: unpublished excavation report.

--- 2012a. Lithics. In McNamara, M. *Final Excavation Report For Cooleen Site 1, Co. Tipperary*. TVAS Ireland Ltd.: unpublished excavation report.

--- 2012b. The Lithics: Haynestown Site 1 (08E0476), Co. Louth. In McLoughlin, G. *Archaeological Excavation At Haynestown-Haggardstown, Dundalk, Co. Louth*. IAC: unpublished excavation report.

--- 2011a. Stuck Between A Rock And Hard Place: Skill Transmission And Differential Raw Material Use In Mesolithic Ireland. *Lithic Technology* 36(2): 221-236.

--- 2011b. Appendix 2.3: Lithic Analysis Report. In Bolger, T. *Final Report On Excavations At Rathmullan 6, Co. Meath, M1 Northern Motorway Gormanstown - Monasterboice (Drogheda Bypass)*: lxv-lxxiv. IAC: unpublished excavation report.

--- 2011c. Appendix VII: Lithics Finds Report For 98E0444 Benedin, Co. Tipperary N7 Nenagh To Limerick HQDC Road Scheme. In McConway, C., Sheehan, G. *Final Report On Excavations At Benedin, N7 Nenagh Bypass, Co. Tipperary*: 87-94. ADS Ltd.: unpublished excavation report.

--- 2011d. Lithic Artefacts Report. In Kiely, J., Teirney, J., Chrobak, E. *Archaeological Excavation Report For Drumbaun, Co. Tipperary*. Eachtra Journal 11.

--- 2011e. Lithic Finds Report. In Bower, N., Hegarty, L., Lugowski, S., Miciak, M. *Archaeological Excavation Report Neolithic House Caherdrinny 3, Co. Cork*. Eachtra Journal 10.

--- 2011f. Appendix IV: Lithics Finds Report For 98E0474 Lahesseragh Site C, Co. Tipperary, N7 Nenagh To Limerick HQDC Road Scheme. In Leahy, D. *Final Report On Excavations At Lahesseragh Site C, N7 Nenagh Bypass, Co. Tipperary*: 31-33. ADS Ltd.: unpublished excavation report.

--- 2011g. Lithic Finds Report. In Kiely, J., Tierney, J., Chrobak, E. *Archaeological Excavation Report: E3909 Castleroan, Co. Offaly*. Eachtra Journal 11.

--- 2010a. The Lithics: Rathmullan 10 (00E0813), Co. Meath. In Bolger, T. 2012. *M1 Northern Motorway: Rathmullan 10*. IAC: unpublished excavation report.

--- 2010b. Appendix 2.3: Lithics Analysis Report. In Stafford, E. 2012. *00E0914: Lagavooren 7, Co. Meath – Final Report*: cxli-cc. IAC: unpublished excavation report.

--- 2010c. The Lithics: Donore 2 (01E0399), Co. Meath. In Stafford, E. 2011. *M1 Northern Motorway: Donore 2*. IAC: unpublished excavation report.

--- 2010d. The Lithics: Platin Lagavooren 1 (00E0822), Co. Meath. In Lynch, R. 2012. *M1 Northern Motorway: Platin/Lagavooren 1*. IAC: unpublished excavation report.

--- 2010e. The Lithics: Sheephouse 3 (00E0811), Co. Meath. In Nelis, D. *00E0811: Sheephouse 3, Co. Meath - Final Report*: lxxi-xci. IAC: unpublished excavation report.

--- 2009a. From Boy To Man: 'Rights' Of Passage And The Lithic Assemblage From A Neolithic Mound In Tullahedy, Co. Tipperary. In Stanley, M., Danaher, E. & Eogan, J. (eds) *Creative Minds: Production, Manufacturing And Invention In Ancient Ireland*: 1-14. NRA Monograph 7.

--- 2009b. Appendix 11: Lithics Report. In Clarke, L. *M3 Clonee-North Of Kells Contract 3 Navan Bypass: Report On The Archaeological Excavation Of Boyerstown 3, Co. Meath*. ACS Ltd.: unpublished excavation report.

--- 2009c. Lithic Finds Report For E2589 Tinryland, Co. Carlow. In O'Connell, T.J. *Final Report On Archaeological Investigations At Site E2589, In The Townland Of Tinryland, Co. Carlow*. Headland Archaeology Ltd.: unpublished excavation report.

--- 2009d. Lithic Finds Report For A016/030 Creggan Lower 1. In Lyne, E. *Excavations At Creggan Lower 1, Co. Westmeath*. IAC: unpublished excavation report.

--- 2007. Lithic Finds Report For 03E1692 And 04E0712, Ballynattin, Co. Wicklow. In Kelly, B., Doherty, B., Johnston, P., Doolan, A. *Archaeological Excavation Report: 04E0712 & 03E1692 IDA Arklow Business & Technology Park, Ballynattin, Co. Wicklow*. Eachtra Journal 14.

Stevens, P. 2011a. *N11 Gorey To Arklow Link: Archaeological Resolution – Site 42-44, Ask Townland, Co. Wexford*. VJK Ltd.: unpublished excavation report.

--- 2011b. *Final Report: Rathnaveoge Lower 4, Co. Tipperary*. VJK Ltd.: unpublished excavation report.

--- 2010. *Site AR 31 Borris & Blackcastle, Co. Tipperary: M8/N8 Cullahill To Cashel Road Improvement Scheme: Archaeological Resolution Final Report*. VJK Ltd.: unpublished excavation report.

Straus, L.G. 2007. Even The Notion Of A "Transitional Industry" Is A Suspect Typological Construct. In Riel-Salvatore, J., Clark, G.A. (eds) *New Approaches To The Study Of Early Upper Palaeolithic 'Transitional' Industries In Western Eurasia: Transitions Great And Small*: 11-18. BAR: S1620.

Suddaby, I., Armit, I., Church, M., Cressey, M., Gormley, S., Nelis, E.L., Dunne, C.M., Murphy, E.M. 2003. The Excavation Of Two Late Bronze Age Roundhouses At Ballypriorbeg, Island Magee, County Antrim. *Ulster Journal Of Archaeology* 62: 45-91.

Tierney, M., Jonhston, P. 2009. No Corners! Prehistoric Roundhouses On The N8 And N7 In Counties Cork, Tipperary and Offaly. In Stanley, M., Danaher, E., Eogan, J. (eds) *Dining And Dwelling*: 99-108. National Roads Authority Monograph 6.

Tierney, M., Leininger, H., O Dowd, J. 2011. *Archaeological Excavation of AR022 Kealgorm Final Report*. The Archaeology Company: unpublished excavation report.

Torre, I. de la, Benito-Calvo, A., Arroyo, A., Zupancich, A., Proffitt, T. 2013. Experimental Protocols For The Study Of Battered Stone Anvils From Olduvai Gorge (Tanzania). *Journal Of Archaeological Science* 40: 313-332.

Turek, J. 2015. Bell Beaker Stone Wrist-guards As Symbolic Male Ornament. The Significance Of Ceremonial Warfare In 3rd Millennium BC Central Europe. In Martínez, M.P.P., Salanova, L. (eds) *The Bell Beaker Transition In Europe – Mobility And Local Evolution During The 3rd Millennium BC*: 28-40. Oxford: Oxbow Books.

Vergès, J.M.Í., Ollé, A. 2011. Technical Microwear And Residues In Identifying Bipolar Knapping On An Anvil: Experimental Data. *Journal Of Archaeological Science* 38: 1016-1025.

Waddell, J. 2010. *The Prehistoric Archaeology Of Ireland*. Bray: Wordwell.

--- 2000. *The Prehistoric Archaeology Of Ireland*. Bray: Wordwell.

--- 1990. *The Bronze Age Burials Of Ireland*. Galway: Galway University Press.

Walker, J. 2010. *Early Bronze Age Stone Metalworking Tools In The United Kingdom And Ireland*. Queens University Belfast: unpublished BA thesis.

Walsh, F. 2011. *Final Report E3140: Kilmainham 1C (Vols. 1-2)*. IAC: unpublished excavation report.

--- 2009. *N6 Kinnegad-Athlone Scheme Phase 2: Tober 1*. IAC: unpublished excavation report.

Walsh. P. 1993. In Circle And Row: Bronze Age Ceremonial Monuments. In Shee-Twohig, E., Ronayne, M. (eds) *Past Perceptions: The Prehistoric Archaeology Of Southwest Ireland*: 101-113. Cork: Cork University Press.

Warren, G., Little, A. 2017. Stone Tool Assemblage From Knowth. In Eogan, G., Cleary, K. (eds) *Excavations At Knowth 6: The Passage Tomb Archaeology Of The Great Mound At Knowth*: 471-485. Dublin: Royal Irish Academy.

Warren, G., Little, A., Stanley, M., McDermott, C., O'Keeffe, E. 2009. A Late Mesolithic Scatter From Corralanna, Co. Westmeath, And Its Place In The Mesolithic Landscape Of The Irish Midlands. *Proceeding of the Royal Irish Academy: Archaeology, Culture, History, Literature* 190C: 1-35.

Westman, A. (ed) 1994. *Museum Of London Archaeology Service: Archaeological Site Manual*. Hampshire: RAS Printers Ltd.

Whitehouse, N.J., Schulting, R.J., McClatchie, M., Barratt, P., McLaughlin, T.R., Bogaard, A., College, S., Marchant, R., Gaffrey, J., Bunting, M.J. 2014. Neolithic Agriculture On The European Western Frontier: The Boom And Bust Of Early Farming In Ireland. *Journal Of Archaeological Science* 51: 181-205.

Woodman, P. 2016. Mesolithic, Neolithic And Bronze Age Lithics From Caves. In Dowd, M. (ed) *Underground Archaeology: Studies On Human Bones And Artefacts From Ireland's Caves*: 55-78. Oxford: Oxbow Books.

--- 2005. It's Too Light To Be Right. In Milner, N., Woodman, P. (eds) *Mesolithic Studies At the Beginning Of The 21st Century*: 126-143. Oxford: Oxbow Books.

--- 1994. Towards A Definition Of Irish Early Neolithic Lithic Assemblages. In Ashton, N., David, A. (eds) *Stories In Stone*: 213-218. Lithic Studies Society: Occasional Paper 4.

--- 1984. The Early Prehistory Of Munster. *Journal Of The Cork Historical And Archaeological Society* 89: 1-11.

--- 1978. *The Mesolithic In Ireland*. BAR: B58.

Woodman, P. Anderson, E., Finlay. N. 1999. *Excavations At Ferriter's Cove, 1983-85: Last Foragers, First Farmers In The Dingle Peninsula*. Bray: Wordwell.

Woodman, P., Finlay, N., Anderson, E. 2006. *The Archaeology Of A Collection: The Keiller-Knowles Collection Of The National Museum Of Ireland*. National Museum of Ireland Monograph Series 2.

Woodman, P., Scannell, M. 1993. A Context For The Lough Gur Lithics. In Shee-Twohig, E., Ronayne, M. (eds) *Past Perceptions: The Prehistoric Archaeology Of Southwest Ireland*: 53-62. Cork: Cork University Press.

Woodward, A., Hunter, J., Ixer, R., Roe, F., Potts, P.J., Webb, P.C., Watson, J.S., Jones, M.C. 2006. Beaker Age Bracers In England: Sources, Function And Use. *Antiquity* 80: 530-543.

Wright, K.I., Critchley, P., Garrard, A., Baird, D., Bains, R., Groom, S. 2008. Stone Bead Technologies And Early Craft Specialization: Insights From Two Neolithic Sites In Eastern Jordan. *Levant* 40(2): 131-165.

Yang, SX. Hou, YM., Jian-Ping, Y., Petraglia, M.D., Deng, CL., Zhu, RX. 2016. The Lithic Assemblages Of Xiaochangliang, Nihewan Basin: Implications For Early Pleistocene Hominin Behaviour In North China. *PLos ONE* 11(5): e0155793. DOI: 10.1371/journal. pone.0155793.

Zaidner, Y. 2013. Adaptive Flexibility of Oldowan Hominins: Secondary Use Of Flakes At Bizat Ruhama, Israel. *PLoS ONE* 8(6): e66851. DOI: 10.1371/ journal.pone.0066851.

Zvelebil, M., Moore, J., Green, S., Henson, D. 1987. Regional Survey And The Analysis Of Lithic Scatters: A Case Study From Southeast Ireland. In Rowley-Conwy, P., Zvelebil, M., Blankholm, H.P. (eds) *Mesolithic Northwest Europe: Recent Trends*: 9-32. Sheffield: University of Sheffield.

Appendices

Appendix 1 – List of Case Studies

Notes:

(green shading)	=	Site analysed
*	=	Selected assemblage not fully analysed
CL	=	Chalcolithic
EBA	=	Early Bronze Age
MBA	=	Middle Bronze Age
LBA	=	Late Bronze Age
IA	=	Iron Age
M-P	=	Multi-period

Period	ID	Excavation Number	Site Name	County	ITM E	ITM N
CL	1	01E0294	Rathmullan 6	Meath	707057	773327
CL	26	02E1330	Donaghmore 1	Louth	701897	807181
CL	27	03E0113	Newtownbalregan 2	Louth	701922	808387
EBA	2	01E0399	Donore 2	Meath	706258	774172
EBA	3	02E0541	French Furze 11	Kildare	674014	711809
EBA	4	02E0700*	Carrickmines Great 63M	Dublin	722122	723854
EBA	5	E3139	Cookstown Great 3	Meath	675415	773684
MBA	6	03E0146	Charlesland D	Wicklow	729136	710277
MBA	28	03E0867	Carn More 1	Louth	704285	810855
MBA	7	E2374	Borris and Blackcastle AR31	Tipperary	619069	719414
MBA	29	E2589	Tinryland	Carlow	675103	672367
MBA	8	E3107	Boyerstown 3	Meath	683251	766242
MBA	9	E3123	Grange 3	Meath	680633	769998
MBA	10	E3130	Phoenixtown 3B	Meath	678968	771348
MBA	11	E3580	Camlin 3	Tipperary	613745	685763
MBA	12	E3912	Drumbaun 2	Tipperary	604171	681784
LBA	30	06E0944	Laughanstown	Dublin	723230	723767
LBA	13	E2658	Creggan Lower 1	Westmeath	607273	740616
LBA	31	E2677	Tober 1	Offaly	622169	737513
LBA	14	E3623	Rathnaveoge Lower 4	Tipperary	608598	684277
LBA	15	98E0444	Benedin	Tipperary	586303	677249
IA	16	00E0822	Platin-Lagavooren 1	Meath	707477	772792
M-P	32	00E0696	Ballynamuddagh	Wicklow	727823	716230
M-P	17	00E0811	Sheephouse 3	Meath	706088	774417
M-P	18	00E0813	Rathmullan 10	Meath	707017	773407
M-P	33	00E0914	Lagavooren 7	Meath	707247	773167
M-P	34	01E0495	Killydonoghue AR7	Cork	573345	578432
M-P	35	02E1033	Ballinaspig More 5	Cork	562818	569212
M-P	36	03E0114	Newtownbalregan 5	Louth	702044	808839
M-P	37	03E1058	Ballybrowney Lower 1	Cork	579100	590703
M-P	38	03E1360	Cherryhound 2	Dublin	711634	742239
M-P	19	04E0712	Ballynattin	Wicklow	723243	671179
M-P	20	08E0476	Haynestown 1	Louth	705448	802286
M-P	39	E2170	Parknahown 5	Laois	634168	674222
M-P	21	E2265	Ballylegan 207.2	Tipperary	608138	625820
M-P	22	E2422	Caherdrinny 3	Cork	580314	608211
M-P	40	E2792	Demesne/Mearsparkfarm 2	Westmeath	634213	734346
M-P	23	E3140	Kilmainham 1C	Meath	675634	774117
M-P	24	E3145	Gardenrath 2	Meath	675004	774207
M-P	25	E3158	Cakestown Glebe 2	Meath	674394	777367
M-P	41	E3370	Cooleen 1	Tipperary	571046	666481
M-P	42	E3744	Camlin-Derrymore 1	Tipperary	613697	686133
M-P	43	E3804	Aghnaskeagh Site 120	Louth	707212	812217
M-P	44	E3909	Castleroan 1	Offaly	606273	683006
M-P	45	97E0075	Rathdown Upper	Wicklow	728443	713590

Appendix 2 – Case Study Reports

Notes:

Artefacts are identified as [context.number:artefact.number]. The excavation number is listed at the top of the site entry, and is not repeated throughout the text.

Ground/coarse lithic material is not discussed in the Technology section.

Pieces catalogued under [UNCLASSIFIED] and [NATURAL] are not discussed.

Radiocarbon dates are presented as ####-#### cal BC. This is followed by the BP date, sigma designation, and lab code – [####±##, #σ – LAB ####]. Where this information was not available, it is presented as [N/A].

Chalcolithic

Site: Rathmullan 6 \ Excavation Number: 01E0294

Introduction

The site at Rathmullan 6 (Bolger 2011) consisted of a series of pits, two linear slot trenches, and a metalled surface. No clear structure was identified, though the slot trenches and metalled surface were seen as indicative of habitation. The site was dated through pottery sherds, accounting for 26 Beaker vessels, and two radiocarbon dates, which came back at 2470-2280 cal BC [3890±30 BP, 2σ – SUERC 31907] and 2470-2200 cal BC [3855±35 BP, 2σ – SUERC 31908]. Residual activity was evidenced by a Grooved Ware vessel.

A total of 92 lithic artefacts were recovered. 81 (88% of total) were selected. 77 of these were chipped lithic material; and 4 were ground/coarse lithic.

Only 65 of the chipped lithic artefacts were analysed, and none of ground/coarse pieces were examined.

The chipped lithic material was catalogued in the database tables: 10 – [CORE]; 49 – [LITHIC]; 5 – [UNCLASSIFIED]; 1 – [NATURAL].

Raw material

All material was of flint.

The assemblage contained pieces at all reduction stages: primary = 17%; secondary = 39%; tertiary = 44%.

Assemblage

Debitage products included: 16 regular flakes, 18 irregular flakes, 4 blades, 4 chunks, 1 microblade, 5 pieces of an indeterminate nature, and 1 other. The debitage cores included: 5 bipolar forms, 2 platform cores, 1 possible split pebble, and 2 of an indeterminate nature.

Condition

Abrasion was clearly seen on 10% of the material – 3 flakes, 2 blades, 1 chunk. 97% of pieces had confirmed edge-damage. Patination appeared to varying extents on 75% of pieces. 83% pieces had no evidence of burning. The remaining 17% had been burnt to various degrees.

Technology

From the debitage products, bipolar reduction was confirmed on 8% and possible on 19%. Freehand reduction was seen on 14% and possibly on 15%.

The debitage cores displayed freehand reduction on 3%, with bipolar reduction on 10%.

The reduction method was indeterminate for 31% of the assemblage.

The dimensions of material are displayed in **Fig. A3.1**.

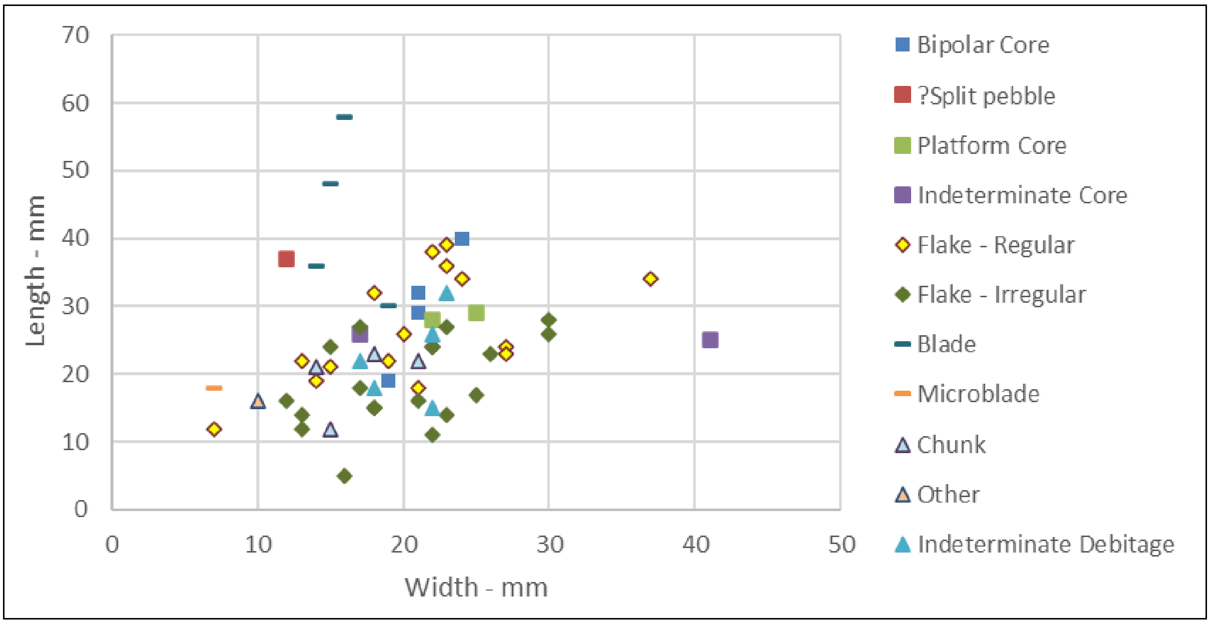


Fig. A3.1: Dimensions of lithic products and cores from Rathmullan 6.

Typology

Secondary working was recorded on 27% of the assemblage. Scrapers constituted the most frequent type: convex = 14%; hollow = 2%.

5% of pieces, 2 blades and 1 regular flake, displayed retouch, with no particular form.

Two pieces, 3%, were recorded as a piercer and an awl/borer.

1 piece was identified as a possible wedge.

Early Bronze Age

Site: Donore 2 \ Excavation Number: 01E0399

Introduction

The site at Donore 2 (Stafford 2011) consisted of a series of pits. One pit, C26, was dated to the Early Bronze Age, 2210-2030 BC [3730±30 BP, 2σ – SUERC 31895].

A total of 22 lithic artefacts were recovered. 2 (9% of total) artefacts were selected, from contexts associated with the Early Bronze Age activity. They were 2 chipped lithic pieces.

The chipped lithic material was catalogued in the database tables: 2 – [LITHIC].

Raw Material

Both pieces were of flint.

Assemblage

Debitage products included: 1 regular flake, and 1 piece of indeterminate form.

Condition

Neither piece displayed any patination or signs of heat exposure. The flake had an abraded feel and a rolled appearance. Both pieces displayed edge-damage.

Technology

The indeterminate piece, [3:2], was at a primary stage of reduction. The regular flake was at a secondary stage.

The regular flake had been reduced by freehand technique. The other piece was indeterminate in the reduction technique.

The flake measured 34mm L by 33mm W. The indeterminate piece measured 7mm L by 11mm W.

Typology

The flake showed secondary working and was classed as a hollow scraper.

Site: French Furze \ Excavation Number: 02E0541

Introduction

The site at French Furze (Ó Maoldúin 2008) consisted of five areas of activity. A circular structure was uncovered, evidenced by a concentration of post-holes. Additional evidence of activity took the form of hearths, stake-holes, and pits. The site was dated to the Early Bronze Age by a radiocarbon date of 2060-1880 cal BC [3625±40 BP, 2σ – SUERC 6760], and pottery sherds from a tripartite vessel.

A total of 47 lithic artefacts were recovered. 12 (26% of total) were selected. All pieces were chipped lithic material.

10 of the chipped lithic artefacts were analysed – 2 items were not in the storage boxes.

The chipped lithic material was catalogued in the database tables: 9 – [LITHIC]; 1 – [NATURAL].

Raw Material

All pieces were of flint.

22% were at a secondary stage. And 1 piece was at primary stage.

Assemblage

Debitage products included: 1 blade; 3 regular flakes; 2 irregular flakes; 1 fragment; 2 pieces of indeterminate form.

Condition

All pieces displayed edge-damage. All pieces bar one displayed patination. None displayed evidence of heat exposure. 2 pieces displayed abrasion, with 1 of these also being rolled.

Technology

Most pieces, 67%, were worked to a tertiary stage.

The majority of pieces displayed evidence of freehand reduction, 56%. Only 1 piece was worked by bipolar reduction.

The reduction technique for 3 pieces was indeterminate.

The dimensions of material are displayed in **Fig. A3.2**.

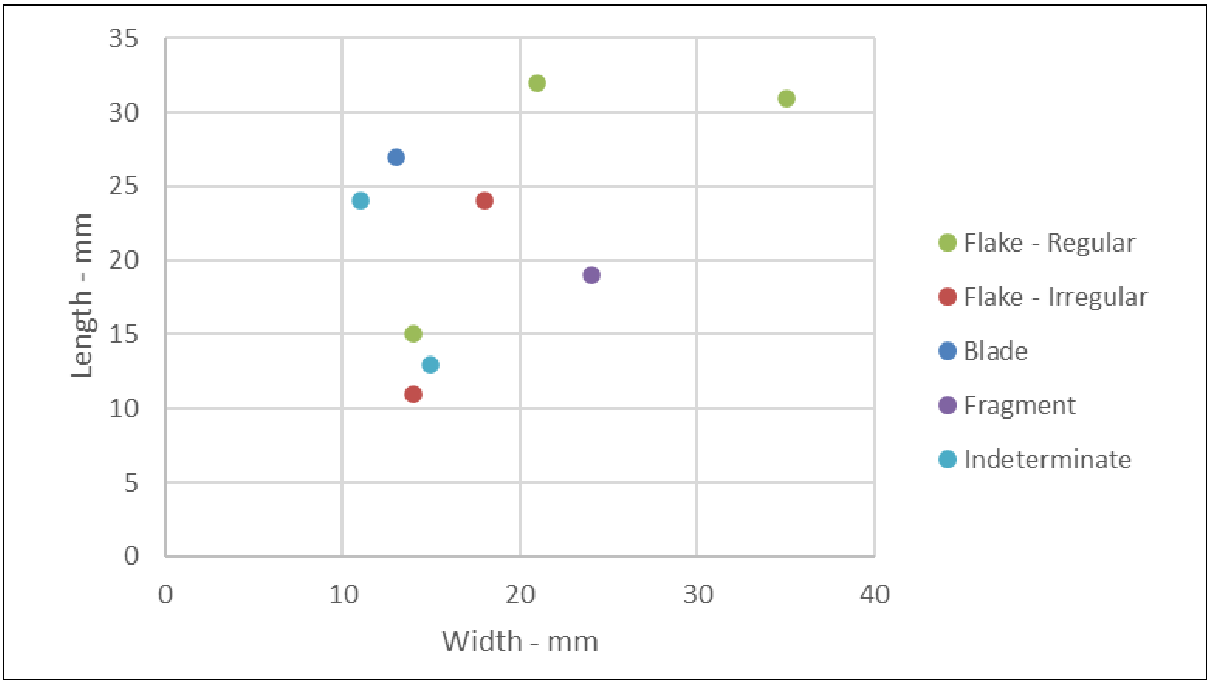


Fig. A3.2: Dimensions of lithic products from French Furze.

Typology

No pieces displayed secondary working. 1 piece whose form was indeterminate, [366:60], was identified as a wedge. This was due to opposing edges which showed crushing. One edge, possible cutting edge, had a uniform appearance, with small *écaillé* retouch. The other edge, likely the hammer edge, had larger *écaillé* scars and more irregular appearance.

<u>Site: Cookstown Great 3 \ Excavation Number: E3139</u>

Introduction

The site at Cookstown Great 3 (McLoughlin 2010) consisted of two small structures dated to separate phases in the Early Bronze Age. There was preceding activity in the Early Neolithic. Both structures were circular or D-shaped. The earlier one was post-built, and the later one defined by stake-holes. Pits were also associated with this activity. A series of radiocarbon dates indicated Early Bronze Age activity: Structure C = 2023-1886 cal BC [3590±26 BP, 2σ – UBA 11093], 2109-1892 cal BC [3614±28 BP, 2σ – UBA 11094]; Structure D = 1948-1776 cal BC [3544±21 BP, 2σ – UBA 11095], 1923-1756 cal BC [3521±27 BP, 2σ – UBA 11096]; Burnt Mound B = 1912-1742 cal BC [3500±32 BP, 2σ – UBA 11097]. Sherds of urn pottery also indicated activity during this period.

A total of 6 lithic artefacts were recovered. Only 1 was selected. This represents 17% of the whole assemblage. The piece was chipped lithic material.

The chipped lithic material was catalogued in the database tables: 1 – [LITHIC].

Raw Material

The piece was of chert.

Assemblage

The debitage product included: 1 irregular flake.

Condition

The piece was in good condition. It had some edge-damage.

Technology

The piece was at a secondary stage.

The piece had been worked by bipolar reduction.

The piece measured 24mm L by 27mm W.

Typology

The piece did not display secondary working.

<u>Site: Carrickmines Great 63M \ Excavation Number: 02E0700</u>

Introduction

The site at Carrickmines Great 63M (Conboy 2006) consisted of a specialised work area. This was defined by post-holes, stake-holes, pits and a hearth. The site was interpreted as a designated location for knapping and grain processing. Pottery and lithic analysis suggested a date of Early Bronze Age. This may be a mis-classification – the pottery report identified sherds as Beaker pottery, though was inconclusive, and suggested it was "early bronze age pottery of some form" (Brindley 2002, 13).

A total of 1,390 lithic artefacts were recovered. Due to a lack of detailed context and find registers, and a lithic catalogue, it could not be established how many came from secure contexts. 612 lithic artefacts, 44%, were analysed from the excavated assemblage. However, there were more artefacts from secure contexts which were not recorded. Sufficient time was not available to complete the analysis. 611 of these pieces were chipped lithic material, and 1 was ground/coarse lithic.

The chipped lithic material was catalogued in the database tables: 74 – [CORE]; 488 – [LITHIC]; 15 – [UNCLASSIFIED]; 34 – [NATURAL].

The ground/coarse lithic material was catalogued in the database table: 1 – [PERCUSSOR].

Raw Material

Flint dominated the assemblage, accounting for 94%. Quartz represented 4%, and chert only <1%.

The ground/coarse lithic artefact was of indeterminate geology, <1%.

Assemblage

Debitage products included: 41 blades, 81 chips, 48 chunks, 84 irregular flakes, 40 regular flakes, 159 fragments, 6 pieces of indeterminate nature, and 29 other. The debitage cores included: 63 bipolar forms, 4 tested pebbles, 1 freehand form, and 6 pieces of indeterminate nature.

The percussors included: 1 active item.

Condition

The assemblage is in fresh condition in general.

There are few pieces with patination, 10%, or showing signs of abrasion, 3%, or rolling, 0.5%.

Edge-damage is prevalent amongst the pieces, appearing on 59% of material. Heat exposure is evidenced to some degree on 52% of pieces. There is a discrepancy in the ratio of burnt to unburnt pieces between the debitage products and debitage cores. Roughly 70% of cores are unburnt, compared to approximately 35% of the debitage products. Of the burnt debitage products, 230 pieces showed high levels of burning, with a further 60 showing moderate levels. This indicates a variation in the treatment of cores and products.

Technology

The majority of pieces, 53%, were reduced to a secondary stage. A quarter, 26%, were tertiary. The primary stage was evident on 21%.

From the debitage products, bipolar reduction was confirmed on 25% and possible on 16%. Freehand reduction was seen on 1%.

The debitage cores displayed bipolar reduction on 10%. Only 1 piece was identified as a platform core, indicating freehand reduction. 4 tested pebbles were identified, 0.5% of the assemblage. 2 had signs of opposed crushing, which would indicate bipolar attempts to open them. The other 2 had crushing opposite the removals proximal end. In these cases, it is likely it indicates bipolar blows, though not as definite.

The reduction method was indeterminate for 39% of the assemblage.

The dimensions of material are displayed in **Figs. A3.3**, **A3.4** and **A3.5**.

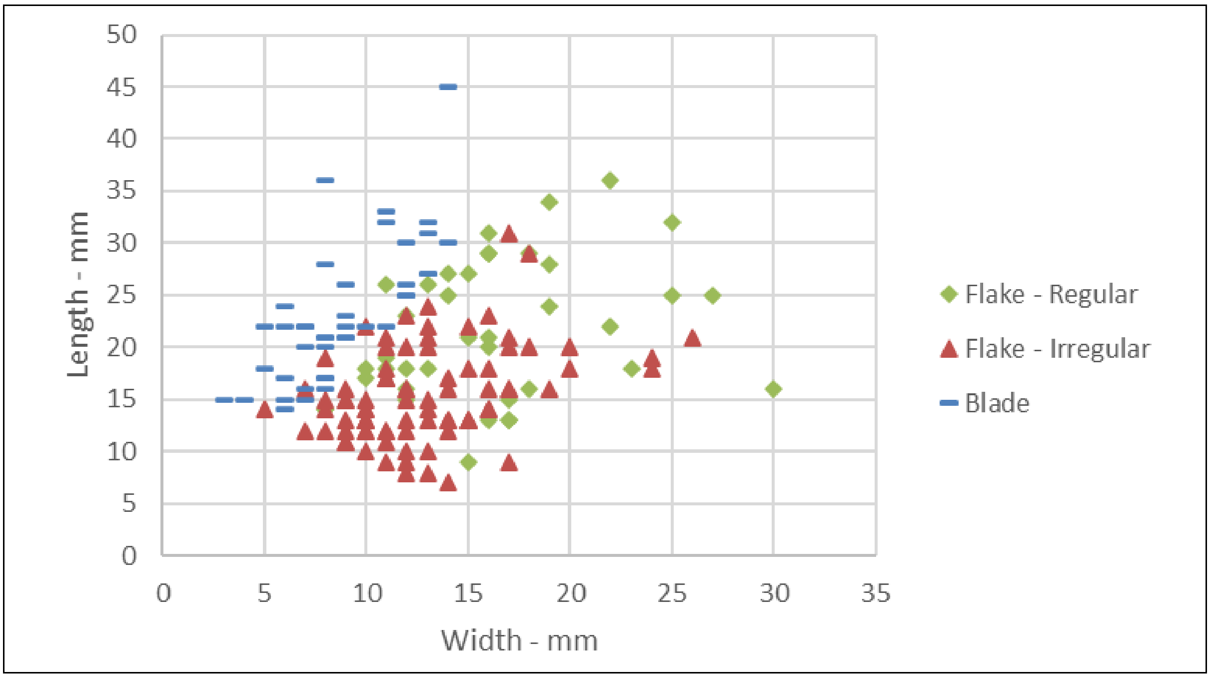


Fig. A3.3: Dimensions of lithic products from Carrickmines Great 63M.

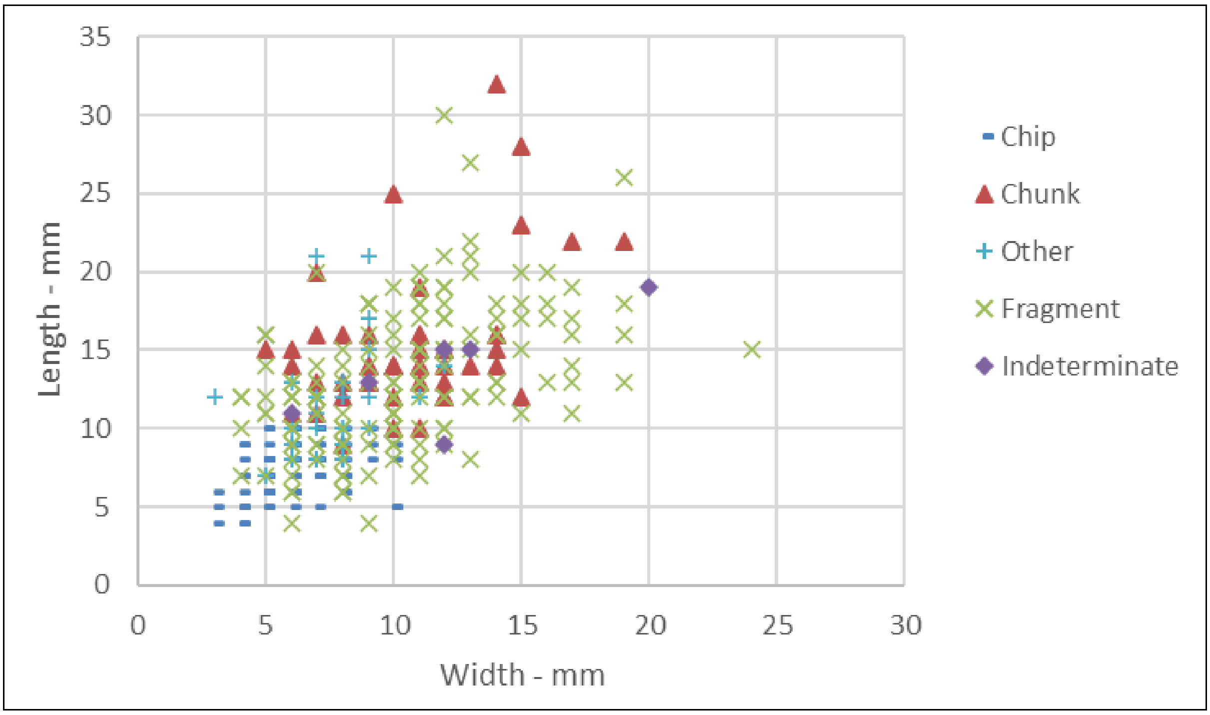


Fig. A3.4: Dimensions of lithic products from Carrickmines Great 63M.

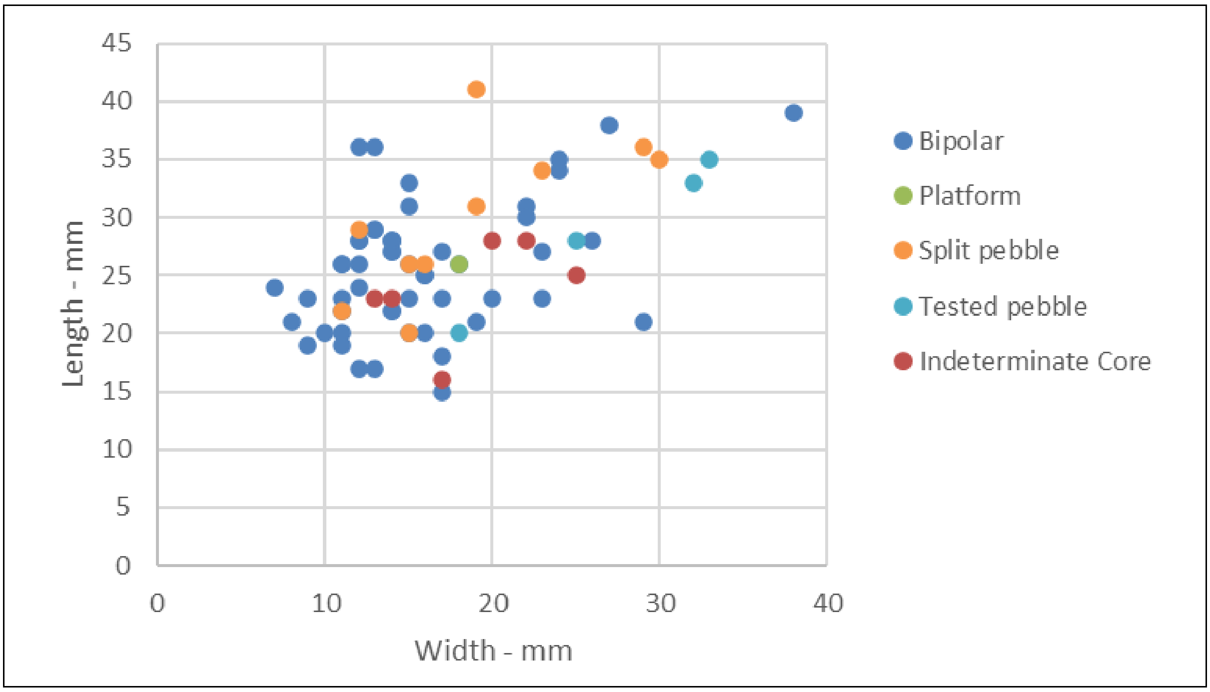


Fig. A3.5: Dimensions of lithic cores from Carrickmines Great 63M.

Typology

Only 3 chipped lithic items displaying secondary modification were recorded. 1 piece, [10:955], appeared to be an awl/borer. The third piece, [15:1001], had retouch along the left lateral. These 2 items were of flint. 1 was possibly a convex scraper, [6:678], and was on quartz.

The ground/coarse stone item, [14:933], had polished surfaces. It could have been used for a polishing or grinding activity.

Middle Bronze Age

Site: Charlesland D \ Excavation Number: 03E0146

Introduction

The site at Charlesland D (Molloy 2005) consisted of two structures, with associated activity. Both structures were circular and consisted of post-holes. Additional activity was indicated by pits, spreads and metalled surfaces. Activity was dated by a radiocarbon date: Structure 1 = 1429-1265 cal BC [N/A]. Pottery also indicated Middle to Late Bronze Age activity.

A total of 209 lithic artefacts were recovered. 207 lithic artefacts, 99% of the whole assemblage, were selected. 201 pieces were chipped lithic material, and 6 were ground/coarse lithic material. 6 pieces of chipped lithic material and 5 of ground/coarse were not recorded.

The chipped lithic material was catalogued in the database tables: 53 – [CORE]; 116 – [LITHIC]; 14 – [UNCLASSIFIED]; 15 – [NATURAL].

The ground/coarse lithic material was catalogued in the database table: 1 – [PERCUSSOR].

Raw Material

All the chipped lithic material was of flint.

The geology of the ground/coarse lithic artefact was undetermined.

Assemblage

Debitage products included: 33 regular flakes; 43 irregular flakes; 23 blades; 3 chips; 2 chunks; 1 other; 9 fragments; and 2 pieces of indeterminate nature. The debitage cores included: 47 bipolar forms; 2 split pebbles; 2 tested pebbles; and 2 cores of an indeterminate nature.

The percussor material included: 1 passive item.

Condition

Edge-damage was present on 85% of pieces. The majority of the pieces were unburnt, 86%. Extreme levels of burning were seen on 8% of the material, with weak to moderate heat-exposure on 5%. Patination was seen on 28% of the material. It was only present on debitage products; none of the cores displayed any patination. Few pieces showed signs of abrasion, 14%, or rolling, 5%.

The ground/coarse lithic item was noted as being in good condition.

Technology

The largest portion of material was worked at a primary stage, 45%. This was closely followed by secondary-stage pieces, 39%. Tertiary pieces accounted for 16%.

Bipolar reduction dominates the assemblage. Confirmed material accounts for 49%, with possible material for a further 28%. Freehand reduction was evident on 4%.

One of the tested pebbles, [385:1], was thought to have been struck using the bipolar technique. The other may, [441:2], have been struck using direct percussion.

The reduction technique was undetermined for 18%.

The dimensions of material are displayed in **Figs. A3.6** and **A3.7**.

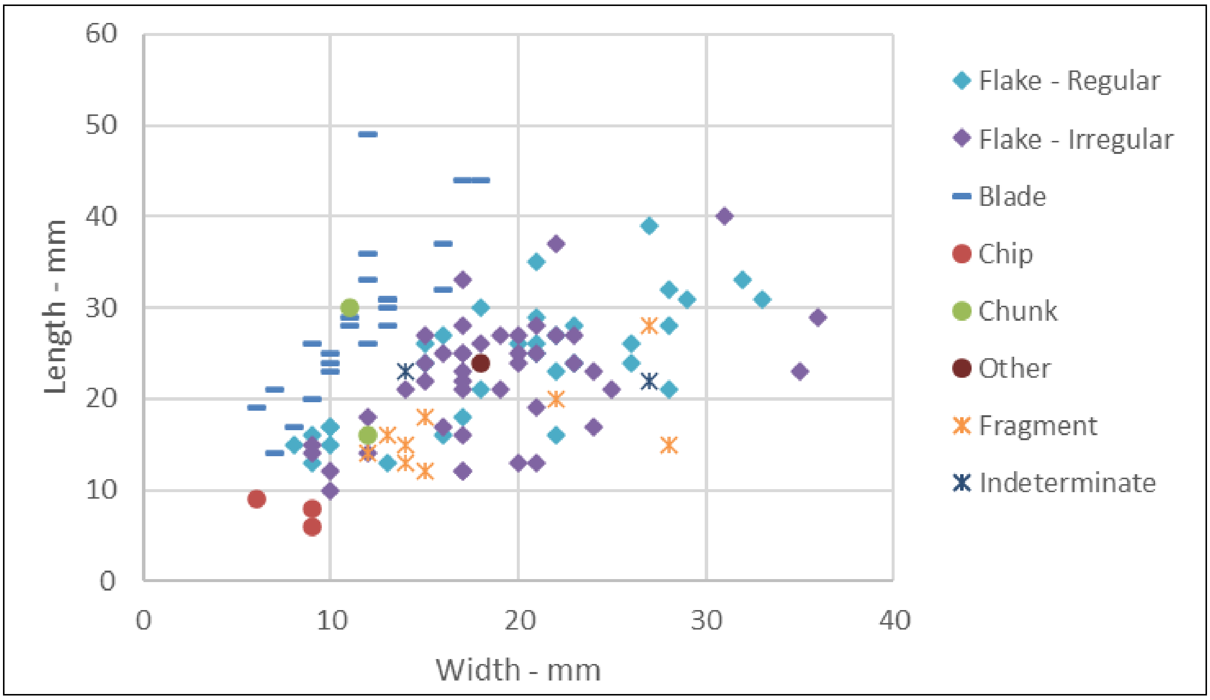


Fig. A3.6: Dimensions of lithic products from Charlesland D.

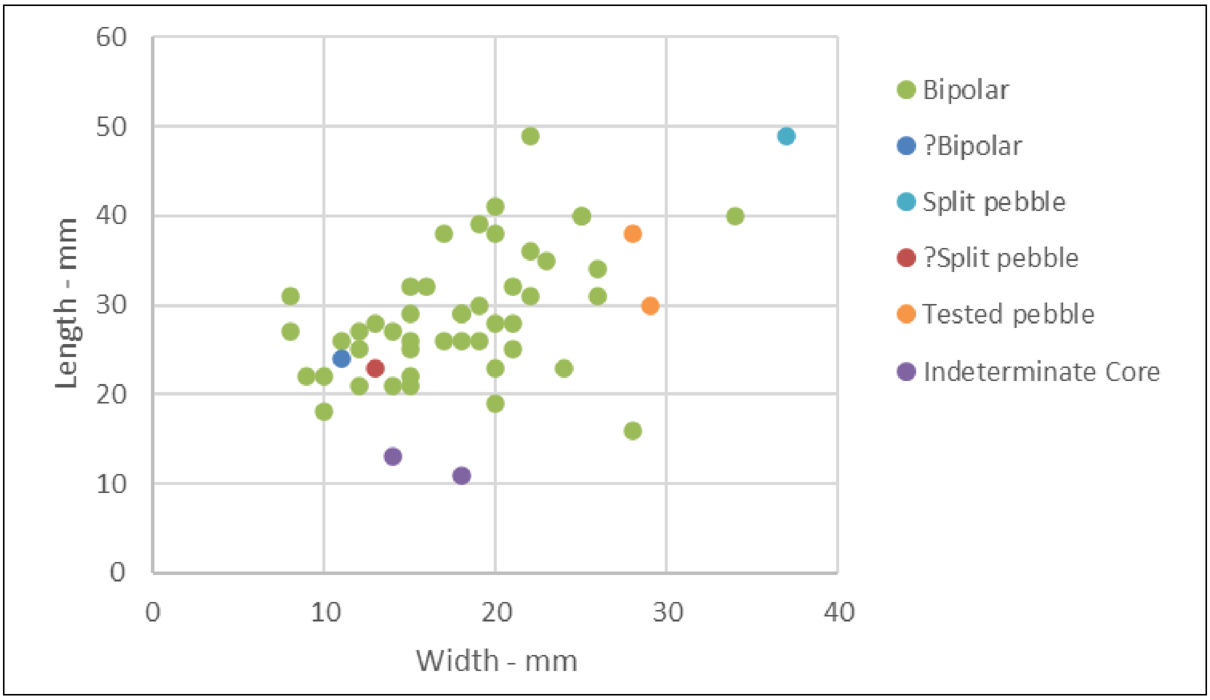


Fig. A3.7: Dimensions of lithic cores from Charlesland D.

Typology

A small portion of the assemblage, 6%, showed secondary modification. 6 pieces displayed areas of retouch. 4 convex scrapers were identified. A possible wedge was recorded. The passive percussor was interpreted as being a sharpening stone.

Site: Borris and Blackcastle AR31 \ Excavation Number: E2374

Introduction

The site at Borris and Blackcastle AR31 (Stevens 2010) consisted of a circular structure, with a porch. This was evidenced by a curvilinear wall slot, with post-holes. Internal activity was evidenced by stake-holes. Radiocarbon dates indicating activity in the Bronze Age and Medieval periods were obtained. The Middle Bronze Age was indicated by 2 dates from a roundhouse: 1607-1451 cal BC [N/A]; 1651-1456 cal BC [N/A]. The Late Bronze Age was dated by an isolated cremation pit: 1265-1060 cal BC [N/A].

A total of 97 lithic artefacts were recovered. 28 lithic artefacts, 29% of the whole assemblage, were selected. 22 of these were chipped lithic pieces, and 6 were ground/coarse lithic material. 7 chipped lithic artefacts and 1 ground/coarse lithic artefact were not analysed.

The chipped lithic material was catalogued in the database tables: 6 – [LITHIC]; 1 – [UNCLASSIFIED]; 8 – [NATURAL].

The ground/coarse lithic material was catalogued in the database tables: 2 – [PERCUSSOR]; 3 – [UNCLASSIFIED].

Raw Material

The chipped lithic material included 3 pieces of flint, 2 pieces of chert, and 1 piece of limestone.

The ground/coarse lithic material consisted of a quartz and a quartzite piece.

Assemblage

Debitage products included: 2 irregular flakes; 1 chunk; 2 fragments; and 1 piece of indeterminate nature.

The percussor material included: 1 active/passive item, and 1 indeterminate piece.

Condition

One piece of flint was heavily burnt. None of the other pieces displayed signs of heat-exposure. They displayed edge-damage. Two of these were patinated. Four pieces were abraded, and none were rolled.

Both of the ground/coarse lithic items were noted as being in good condition.

Technology

One piece of flint was worked at the primary stage. Three pieces were worked at a secondary stage. Two pieces were worked at the tertiary stage.

2 flint pieces, [4:1] and [4:607], were possibly worked using bipolar reduction.

The technique of reduction was indeterminate for 4 pieces.

The dimensions of material are displayed in **Fig. A3.8**.

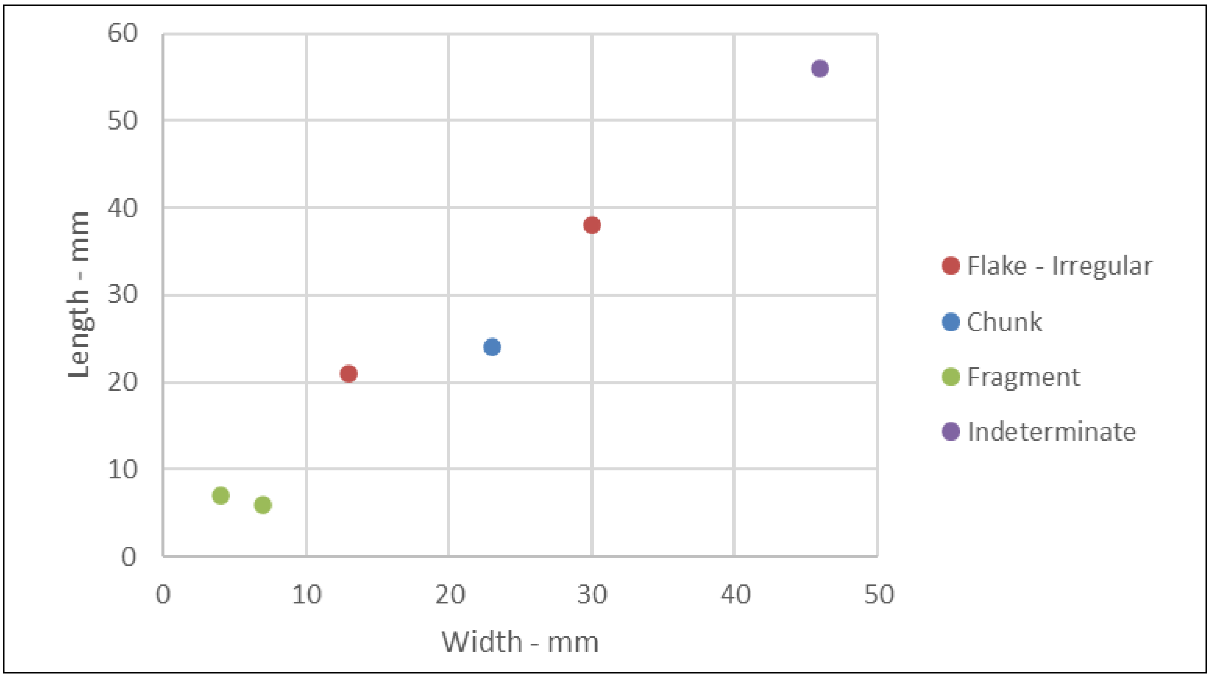


Fig. A3.8: Dimensions of lithic products from Borris and Blackcastle AR31.

Typology

3 chipped lithic pieces displayed signs of secondary working. Artefact [4:1] was interpreted as a wedge. Artefacts [929:449] and [4:600] were interpreted as retouched pieces.

The active/passive percussor was interpreted as an anvilstone or pounder. The other item, [4:603], was interpreted as a gaming piece.

Site: Boyerstown 3 \ Excavation Number: E3107

Introduction

The site at Boyerstown 3 (Clarke 2009) consisted of circular structure with an enclosing palisade. The structure was defined by a penannular slot trench with in-cut post-holes, and an inner ring of post-holes. Internal activity came in the form of stake-holes. Additional activity came in the form of pits and a palisade. Sherds of Bronze Age pottery were recovered in association with the structural remains. A radiocarbon date from the adjacent palisade came back as Middle Bronze Age: 1734-1515 cal BC [3330±40 BP, 2σ – BETA 247110].

A total of 208 lithic artefacts were recovered. Two pieces, <1% of the whole assemblage, were selected for analysis.

The chipped lithic material was catalogued in the database tables: 1 – [CORE]; 1 – [LITHIC].

Raw Material

Both pieces were of flint.

Assemblage

The debitage product included: 1 chip. The debitage core included: 1 bipolar core.

Condition

Neither piece was burnt or rolled. Both displayed edge-damage, and had an abraded appearance. Both pieces had some patination.

Technology

Both pieces were worked at a tertiary stage.

The core was worked using bipolar reduction. The chip was indeterminate.

The dimensions of the core were 19mm L by 24mm W. The chip measured 9mm L by 4mm W.

Typology

There were no pieces with secondary modification.

<u>Site: Grange 3 \ Excavation Number: E3123</u>

Introduction

The site at Grange 3 (Kelly 2010) consisted of various activities over a period of time. Middle Bronze Age activity included two circular structures, with associated pits and metalled areas. A series of radiocarbon dates from contexts associated with the structures placed them in the Middle Bronze Age: Structue 1 = 1520-1310 cal BC [3155±40 BP, 2σ – SUERC 29331], 1499-1415 cal BC [3128±25 BP, 2σ – UB 12937]; Structure 2 = 1540-1390 cal BC [3190±40 BP, 2σ – SUERC 29332], 1408-1269 cal BC [3065±24 BP, 2σ – UB 12058]. Pottery also dated the structures to the Middle and Late Bronze Age. Activity – a figure-of-eight shaped kiln, burnt spread and pit - was dated to the Chalcolithic, 2460-2210 cal BC [3858±24 BP, 2σ – UB 12059], but no material from this was analysed. Burial activity in the form of cremation pits was dated to the Middle and Late Bronze Age: = 1420-1294 cal BC [3083±24 BP, 2σ – UB 12942]; = 971-807 cal BC [2726±24 BP, 2σ – UB 15475]. No material from these was analysed. Middle and Late Bronze Age dates were also returned from a ring-ditch and linear feature: ring-ditch = 1372-1131 cal BC [3001±22 BP, 2σ – UB 12054], 974-828 cal BC [2753±26 BP, 2σ – UB 12053]; linear ditch = 1090-840 cal BC [2810±40 BP, 2σ – SUERC 29329].

A total of 380 lithic artefacts were recovered. 343 lithic artefacts, 90% of the whole assemblage, was selected. 332 pieces were chipped lithic material, and 11 pieces were ground/coarse lithic material.

Only 119 pieces were analysed: 116 chipped lithic pieces and 3 ground/coarse lithic pieces.

The chipped lithic material was catalogued in the database tables: 79 – [LITHIC]; 14 – [UNCLASSIFIED]; 23 – [NATURAL].

The ground/coarse lithic material was catalogued in the database tables: 3 – [PERCUSSOR].

Raw Material

Flint was the predominant material, at 56%. Chert was present in the assemblage, at 39%. 1 piece was quartz crystal.

The geology of the ground/coarse material was undetermined.

Assemblage

Debitage products included: 12 regular flakes; 20 irregular flakes; 2 blades; 7 chips; 5 chunks; 28 fragments; 1 other; 4 pieces of indeterminate nature.

The percussor items included: 1 active, 1 passive, 1 active/passive.

Condition

The majority of pieces, 90%, displayed edge-damage. 15 flint pieces, 18%, displayed patination. 5 pieces of flint were burnt, with 3 of these extremely so. 29% of pieces were abraded, with 2 pieces also being rolled.

The condition of the ground/coarse lithic material was noted as good.

Technology

The majority of the assemblage was worked to a tertiary stage, 70%. Secondary pieces were present at 22%, and primary at 5%.

Freehand-reduced material was more evident in the assemblage – confirmed 22%, possible 10%. Bipolar reduction played a significant role as well – both confirmed and possible at 13%. The reduction technique could not be identified for 38% of material.

The dimensions of material are displayed in **Fig. A3.9**.

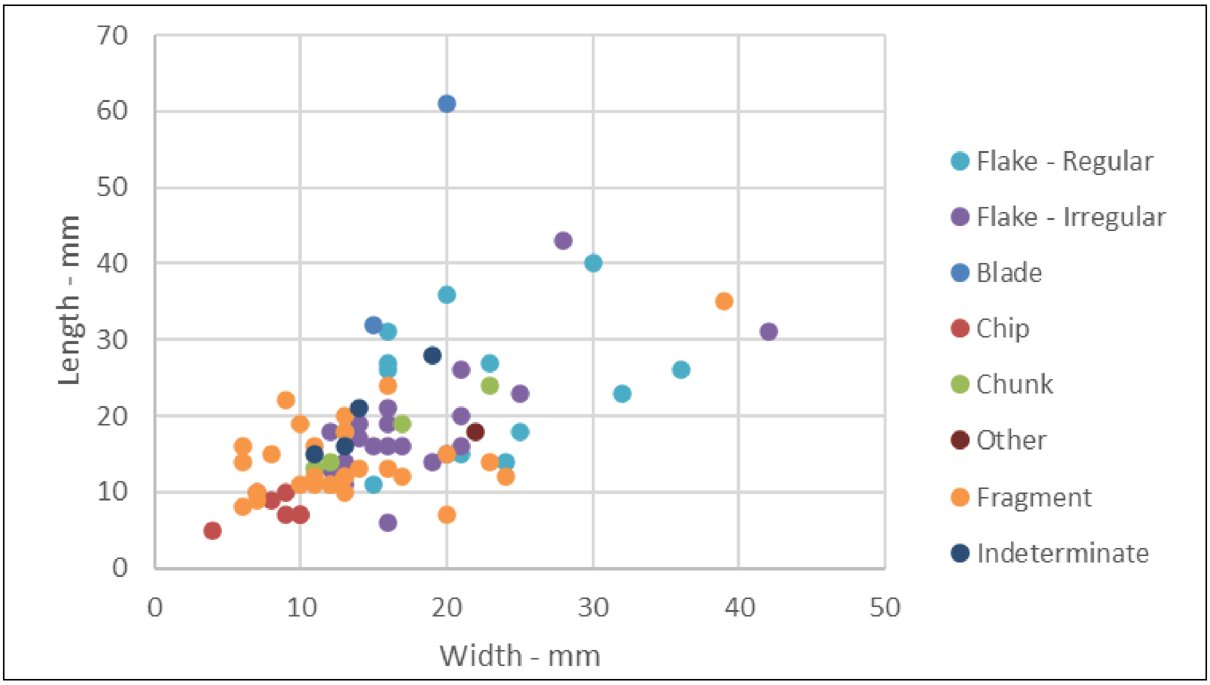


Fig. A3.9: Dimensions of lithic products from Grange 3.

Typology

34 pieces, 41%, displayed secondary modification. The majority, 34%, of these were scrapers: convex, 32%; concave, 1%; general, 1%. Retouched pieces accounted for 5%. The remainder were a: wedge, fabricator/rod, and PTD.

The passive ground/coarse lithic item was identified as a mortar. The active/passive item was recorded as an anvilstone or pounder. The active item was an axehead, that had been re-utilised.

Site: Phoenixtown 3B \ Excavation Number: E3130

Introduction

The site at Phoenixtown 3B (Lyne 2010) consisted of a well-defined Middle Bronze Age structure, with associated activity. The structure was formed by a circle of post-holes with adjacent curvilinear gullies. Additional activity occurred in the form of stake-holes and a linear feature. A series of radiocarbon dates from structural and adjacent features dated the activity to the Middle Bronze Age: 1494-1392 cal BC [3152±24 BP, 2σ – UB 11111], 1436-1316 cal BC [3113±22 BP, 2σ – UB 11113], 1503-1415 cal BC [3188±26 BP, 2σ – UB 11112], 1435-1303 cal BC [3102±29 BP, 2σ – UB 11114], 1515-1428 cal BC [3203±24 BP, 2σ – UB 12111], 1607-1451 cal BC [3247±22 BP, 2σ – UB 12941].

A total of 54 lithic artefacts were recovered. 39 lithic artefacts, 72% of the whole assemblage, were selected. 37 pieces were chipped lithic material, and 2 pieces were ground/coarse lithic material.

The chipped lithic material was catalogued in the database tables: 32 – [LITHIC]; 4 – [UNCLASSIFIED]; 1 – [NATURAL].

The ground/coarse lithic material was catalogued in the database tables: 2 – [PERCUSSOR].

Raw Material

All the chipped lithic material was of flint.

The ground/coarse lithic material included a granite piece, [1001:225], and a sandstone, or similar type of geology, piece, [1048:1].

Assemblage

Debitage products included: 1 blade; 6 regular flakes; 9 irregular flakes; 4 chips; and 12 fragments.

The ground/coarse items included: 1 active object, and 1 passive object.

Condition

All chipped lithic pieces, except for 2, displayed edge-damage. Most pieces, 88%, displayed no sign of abrasion (present on 4 pieces) or rolling (present on 1 piece). Only 1 piece displayed very slight signs of heat-exposure. 82% of pieces displayed patination to some degree. 4 pieces without patination came from context [1115] with 23 other pieces, all of which had patination.

The ground/coarse lithic pieces were in good condition.

Technology

The majority of pieces were worked to the tertiary stage, 53%. Secondary-stage pieces accounted for 35%, and primary for 6%.

Freehand reduction was more evident in the assemblage. Confirmed pieces accounted for 21%, and possible for 15%. Bipolar reduction still played a large role within the knapping tradition. Confirmed pieces accounted for 9%, and possible for 18%.

The reduction technique was indeterminate for 32% of pieces.

The dimensions of material are displayed in **Fig. A3.10**.

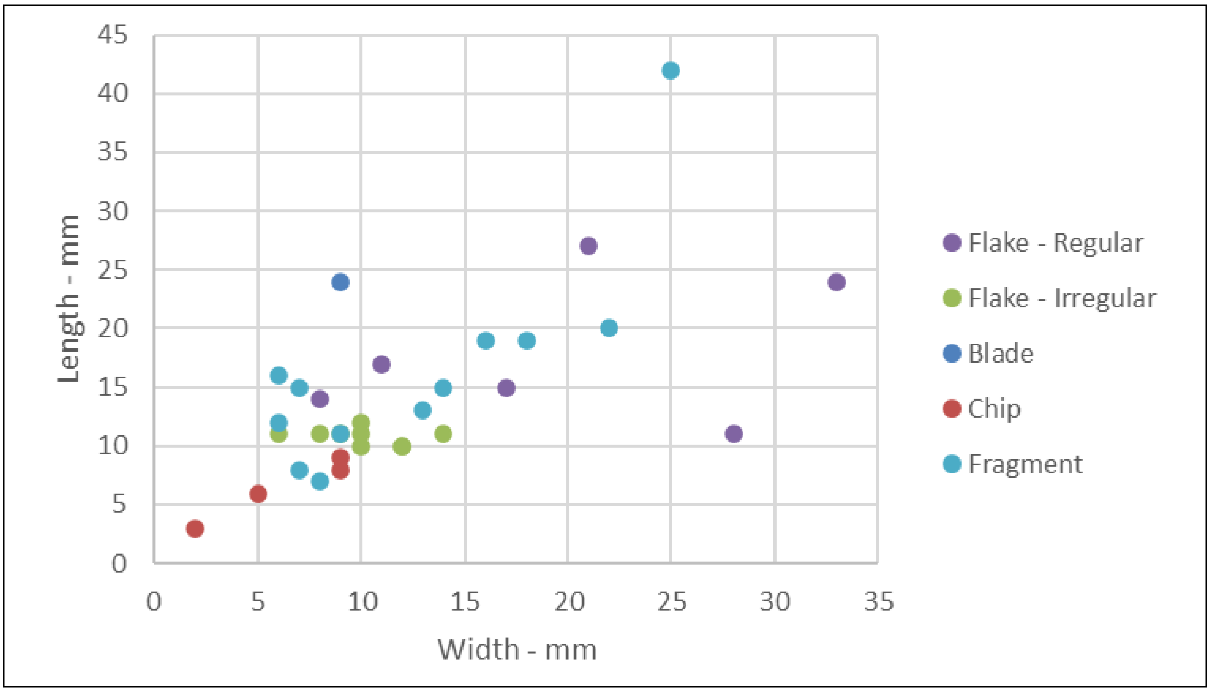


Fig. A3.10: Dimensions of lithic products from Phoenixtown 3B.

Typology

The ground/coarse lithic material included one mortar and one rubbing/hammer stone.

No modified types were identified amongst the chipped lithic material.

<u>Site: Camlin 3 \ Excavation Number: E3580</u>

Introduction

The site at Camlin 3 (Flynn 2011) consisted of an extensive multi-period archaeological complex. Bronze Age activity was evidenced by burnt mounds, two unenclosed rectangular structures, and an enclosure with central oval structure. Middle Bronze Age activity was indicated by several radiocarbon dates: Building Q = 1630-1490 cal BC [3270±30 BP, 2σ – SUERC 31065], linear channel = 1620-1450 cal BC [3265±30 BP, 2σ – SUERC 31064], well = 1320-1120 cal BC [2995±30 BP, 2σ – SUERC 31067], Enclosure 2 = 1630-1490 cal BC [3280±30 BP, 2σ – SUERC 31074], Building O = 1530-1410 cal BC [3205±30 BP, 2σ – SUERC 31075]. Other activity on the site was dated to preceding and succeeding periods. A burnt mound was dated to Chalcolithic: 2500-2340 cal BC [3955±30 BP, 2σ – SUERC 31076], a second to the Early Bronze Age: 1910-1740 cal BC [3500±30 BP, 2σ – SUERC 31066], and a third one to the Middle Bronze Age: 1320-1120 cal BC [2995±30 BP, 2σ – SUERC 31067]. A structure was dated to the Neolithic by pottery and a radiocarbon date: 3770-3640 cal BC [4910±30 BP, 2σ – SUERC 31057]. A kiln or hearth was dated to the Late Bronze Age: 510-360 cal BC [2335±30 BP, 2σ – SUERC 31077]. An enclosure ditch was dated to the Iron Age: 50-80 cal BC-AD [1990±30 BP, 2σ – SUERC 31056].

A total of 127 lithic artefacts were recovered. 12 lithic artefacts, 9% of the whole assemblage, were selected. All these pieces were chipped lithic material.

The chipped lithic material was catalogued in the database tables: 10 – [LITHIC]; 2 – [NATURAL].

Raw Material

The assemblage was predominantly flint, 70%, with chert accounting for the remaining 30%.

Assemblage

Debitage products included: 2 irregular flakes; 2 chips; 1 other; and 5 fragments.

Condition

All pieces except one displayed edge-damage. Three of the flint artefacts had a degree of patination. 50% of pieces were abraded, and one flint piece appeared rolled. None of the artefacts were burnt.

Technology

80% pf pieces were reduced to a tertiary stage. There was 1 flint piece at the secondary stage and 1 at the primary stage.

For most pieces, 60%, the reduction technique was indeterminate. 2 chert pieces may have been worked by bipolar reduction. 1 flint piece was the product of freehand reduction, while another was possibly so.

The dimensions of material are displayed in **Fig. A3.11**.

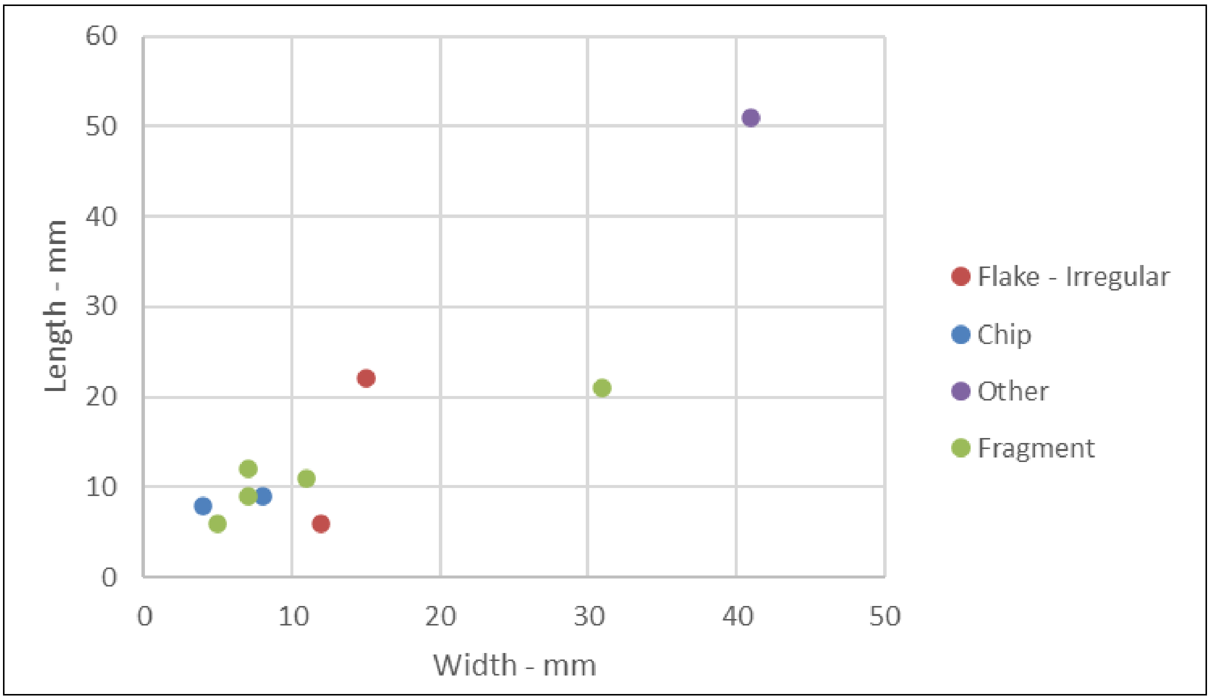


Fig. A3.11: Dimensions of lithic products from Camlin 3.

Typology

4 artefacts displayed secondary working. 3 of these were convex scrapers. The fourth was interpreted as a fragment of a wedge.

Site: Drumbaun 2 \ Excavation Number: E3912

Introduction

The site at Drumbaun 2 (Kiely *et al*. 2011) consisted of a post-holes, slot trenches, pits, hearths and ditches. Two structures, one defined by post-holes and slot trenches, the other by post-holes, were dated to the Middle Bronze Age. Associated activity took the form of stake-holes, pits and a hearth. Activity was dated by radiocarbon dates: Structure A = 1436-1316 cal BC [3113±21 BP, 2σ – UB 15082]; Structure B = 1520-1442 cal BC [3221±18 BP, 2σ – UB 15083]. Preceding activity during the Chalcolithic was indicated by a radiocarbon date: 2466-2291 cal BC [3886±28 BP, 2σ – UB 15041]; and in the Neolithic due to the presence of pottery in a pit.

A total of 27 lithic artefacts were recovered. 18 lithic artefacts, 67%, were selected for analysis. 8 of these pieces were chipped lithic material, and 10 were ground/coarse lithic. 5 of the chipped lithic artefacts were not in the storage box.

The chipped lithic material was catalogued in the database tables: 2 – [LITHIC]; 1 – [UNCLASSIFIED].

The ground/coarse lithic material was catalogued in the database tables: 7 – [PERCUSSOR]; 2 – [UNCLASSIFIED]; 1 – [NATURAL].

Raw Material

The regular flake, [158:1], was chert. Chip [11:1] was flint.

The ground/coarse lithic material included several materials: 2 pieces of sandstone, 1 piece of rhyolite, and 1 piece of quartzite. The geology of 3 items was undetermined.

Assemblage

Debitage products included: 1 regular flake, and 1 chip.

The percussors included: 3 active items, 2 passive items, and 2 of an indeterminate nature.

Condition

Both pieces of the chipped lithic material displayed edge-damage, and the flint chip [11:1] also appeared abraded. Neither piece displayed signs of patination, rolling or heat-exposure.

All ground/coarse lithic material was determined to be in good condition, except for 1 piece which was fair. 1 piece was broken.

Technology

The chert flake, [158:1], was reduced to a secondary stage. The flint chip, [11:1], was reduced to tertiary.

From the debitage products, the chert flake indicated possible bipolar reduction. The chip was interpreted as freehand reduced.

The dimensions of the flake were 33mm L by 31mm W. The chip measured 7mm L by 9mm W.

Typology

Chip [11:1] was interpreted as a resharpening flake. Percussor [110:1] was a polished axehead. Active item [52:6] was interpreted as a D-shaped rubbing stone. Active item [134:1] was interpreted as a possible hammerstone. The 2 other ground/coarse lithic pieces were recorded as polished stones. These may be the result of natural process; or could have been shaped to function as gaming pieces. The 2 passive items, [254:1] and [110:2], were interpreted as rubbing/grinding platforms.

Late Bronze Age

Site: Rathnaveoge Lower 4 \ Excavation Number: E3623

Introduction

The site at Rathnaveoge Lower 4 (Stevens 2011b) consisted of a series of postholes, stakeholes, and a cluster of pits and spreads. Activity was dated to the Late Bronze Age by pottery, and by a cremation pit: 1130-920 cal BC [2865±30 BP, 2σ – SUERC 31472]. Middle Bronze Age activity was evidenced by a radiocarbon date from a pit: 1400-1190 cal BC [3030±30 BP, 2σ – SUERC 31027].

A total of 36 lithic artefacts were recovered. All were from secure contexts associated with Bronze Age activity. 32 of these were chipped lithic material; and 4 were ground/coarse lithic.

Only 2 of the ground/coarse lithic artefacts were analysed.

The chipped lithic material was catalogued in the database tables: 6 – [CORE]; 17 – [LITHIC]; 4 – [UNCLASSIFIED]; 5 – [NATURAL].

The ground/coarse lithic material was catalogued in the database tables: 2 – [PERCUSSOR].

Raw Material

Chert was the main material reduced, with 60%. Quartz was the next most utilised, at 20%. Flint was present at 12%.

The ground/coarse lithic material consisted of 1 sandstone piece, and 1 quartzite.

Assemblage

Debitage products included: 2 regular flakes, 6 irregular flakes, 1 chip, 7 fragments, and 1 other. The debitage cores included: 4 bipolar forms, and 2 tested pieces.

The percussors included: 1 active item, and 1 active/passive item.

Condition

Abrasion was clearly seen on 32% of the material – 2 flakes, 1 fragment, 1 other, and 4 cores. 76% of pieces had confirmed edge-damage. Most pieces were not patinated, though some did appear on 8%. 88% pieces had no evidence of burning. The remaining 12% had been burnt to various degrees.

The ground/coarse lithic material was noted as ‘good’ in condition.

Technology

The majority of pieces, 52%, were reduced to a tertiary stage. A quarter, 24%, were secondary. The primary stage was evident on 16%.

From the debitage products, bipolar reduction was confirmed on 16% and possible on 24%. Freehand reduction was seen on 8%.

The debitage cores displayed bipolar reduction on 25%. One of these pieces was a tested pebble, which had crushing opposite to the proximal end of the removal scar.

The reduction method was indeterminate for 24% of the assemblage.

The dimensions of material are displayed in **Fig. A3.12**.

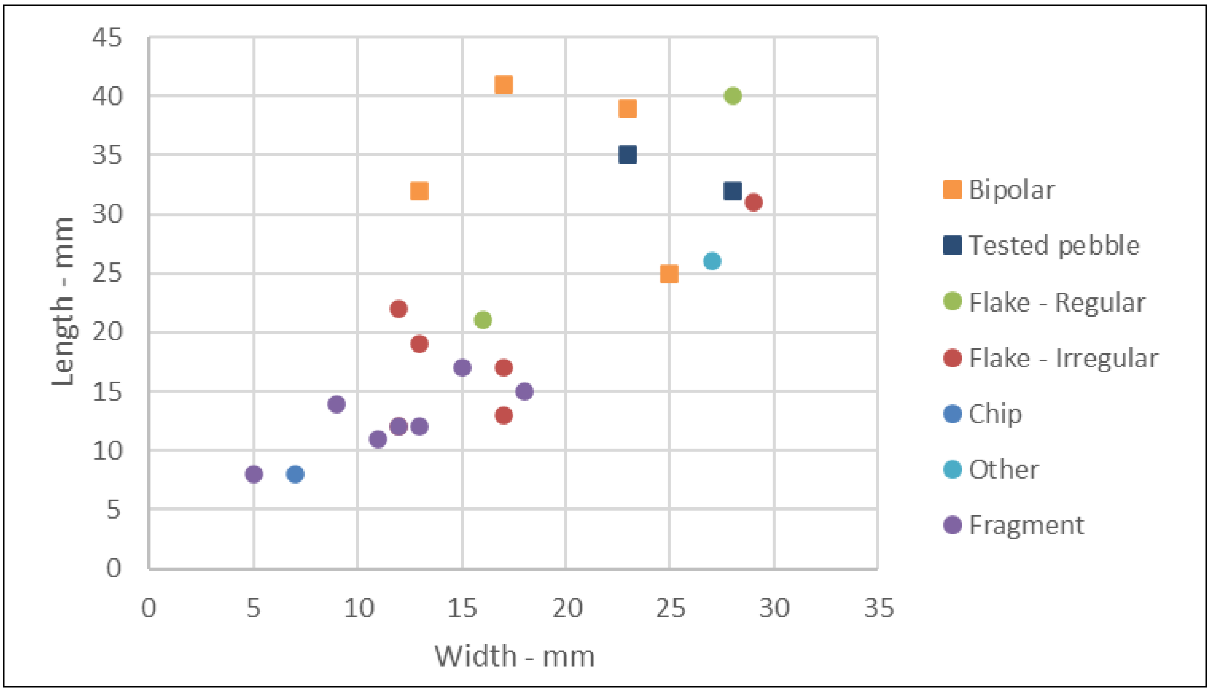


Fig. A3.12: Dimensions of lithic products and cores from Rathnaveoge Lower 4.

Typology

2 chipped lithic pieces had retouch. Both of these were reworked into convex scrapers.

1 ground/coarse lithic object was identified as a hammerstone. The other was noted as either a grinding stone or grinding platform.

Site: Creggan Lower 1 \ Excavation Number: E2658

Introduction

The site at Creggan Lower 1 (Lyne 2009) consisted of sub-rectangular post-built structure. Associated activity included a series of pits. Activity was dated to the Late Bronze Age based on pottery, and 2 radiocarbon dates: 1187-936 cal BC [2873±28 BP, 2σ – UBA 8584], 1004-846 cal BC [2783±25 BP, 2σ – UBA 8583]. An earlier date to the Middle Bronze Age: 1620-1440 cal BC [3260±40 BP, 2σ – BETA 249536] was considered erroneous due to old charcoal.

A total of 73 lithic artefacts were recovered. 56 were selected, from secure contexts associated with the Late Bronze Age activity. 53 of these were chipped lithic material; and 3 were ground/coarse lithic.

The chipped lithic material was catalogued in the database tables: 4 – [CORE]; 36 – [LITHIC]; 5 – [UNCLASSIFIED]; 8 – [NATURAL].

The ground/coarse lithic material was catalogued in the database table: 3 – [PERCUSSOR].

Raw Material

The chipped lithic material was dominated by chert, accounting for 84%. All cores were of chert. Flint accounted for 7% of the assemblage. There was 1 piece of quartz recorded.

The ground/coarse lithic material consisted of 2 sandstones pieces, and 1 of indeterminate geology.

Assemblage

Debitage products included: 21 regular flakes; 7 irregular flakes; 1 blade; 1 other; 5 fragments; 1 indeterminate form. The debitage cores included: 2 bipolar forms; and 2 freehand forms.

The percussors included: 1 active item; 1 passive item; and 1 of indeterminate use.

Condition

All the chipped lithic material, bar one piece, displayed edge-damage. 7 pieces showed signs of abrasion, and only one piece showed signs of being rolled. None of the chipped lithic material had been exposed to heat. There was no sign of patination on any piece.

2 of the ground/coarse lithic items were broken. 1 of the fragments was burnt. Apart from that, all pieces were noted as being in fair condition.

Technology

All three reduction stages were present: primary – 14%; secondary – 53%; tertiary – 26%.

Freehand reduction was more prominent within the assemblage, accounting for 51%. This includes two platform cores. Bipolar reduction was also evident, present on 23% of the material.

The method of reduction was indeterminate for 19% of pieces.

The dimensions of material are displayed in **Fig. A3.13**.

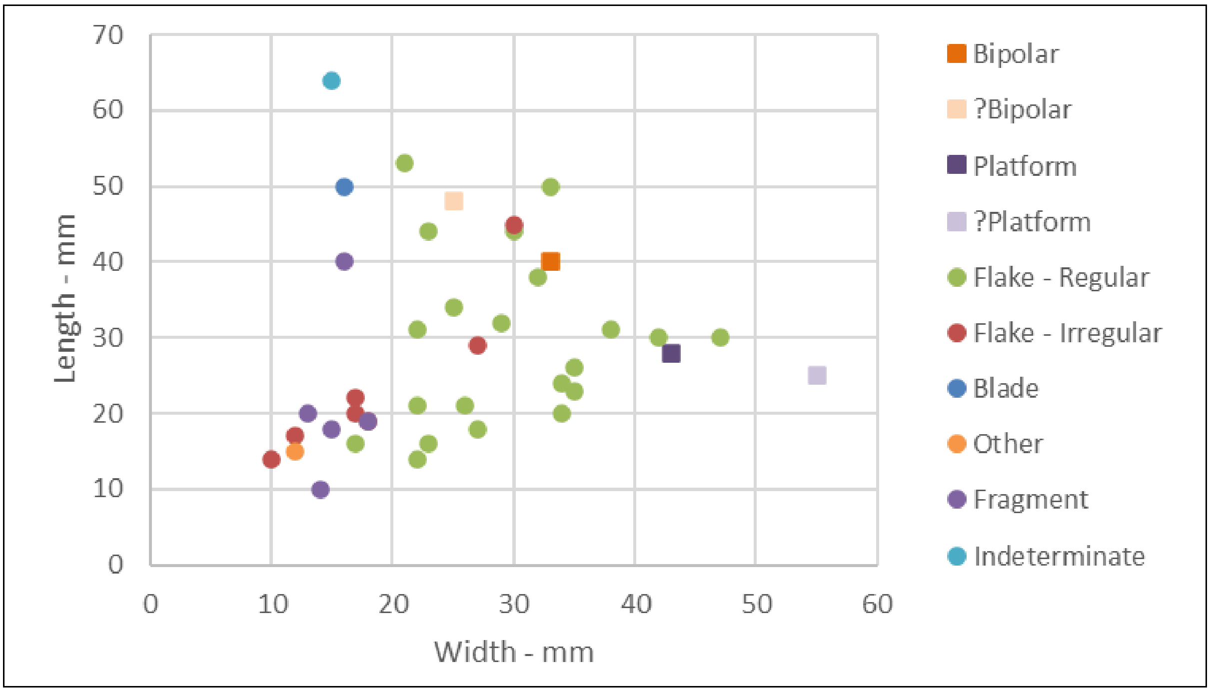


Fig. A3.13: Dimensions of lithic products and cores from Creggan Lower 1.

Typology

There were few items with secondary working. 3 of these displayed undiagnostic retouch. 1 piece was identified as a concave scraper. Another piece was recorded as a polished form.

The ground/coarse lithic item of indeterminate geology, [75:2], was interpreted as a hone stone.

Site: Benedin \ Excavation Number: 98E0444

Introduction

The site at Benedin (McConway, Sheehan 2011) consisted of 3 areas which contained pits, possible structures, and a ditch. Area B contained a post-hole structure, with associated pits, and stake-holes. A series of stake-holes may have formed a second ancillary structure. Activity in Area B was dated to the Late Bronze Age based on a sherd of pottery. Activity at Area C was dated to the Late Bronze Age: 1386-1134 cal BC [3019±25 BP, 2σ – UBA 15647].

A total of 73 lithic artefacts were recovered. 54 were selected, 74% of the whole assemblage, from secure contexts associated with the Late Bronze Age activity. 52 of these were chipped lithic material; and 2 were ground/coarse lithic.

The chipped lithic material was catalogued in the database tables: 2 – [CORE]; 7 – [LITHIC]; 7 – [UNCLASSIFIED]; 36 – [NATURAL].

1 chipped lithic artefact was not analysed. It had been cancelled prior to accession, and not held in storage.

Raw Material

The chipped lithic material was dominated by chert, accounting for 73%. There was 1 piece of quartz, core [110:1], recorded.

The 2 pieces of ground/coarse lithic material were sandstone.

Assemblage

Debitage products included: 2 regular flakes; 3 irregular flakes; 2 fragments. The debitage cores included: 1 bipolar form, and 1 tested form.

The percussors included: 2 active items.

Condition

All the chipped lithic material, bar one piece, displayed edge-damage. 4 pieces showed signs of abrasion, and only the 2 cores showed signs of being rolled. None of the chipped lithic material had been exposed to heat. There was no sign of patination on any piece.

The 2 ground/coarse lithic items were broken. Both were noted as being in poor condition, with artefact [160:2] also being burnt.

Technology

All debitage products were at the tertiary stage. However, given that they are all chert, this is unlikely to have the same significance as with flint. 1 debitage core, [237:2], was recorded as secondary. As it is chert, this means there was exterior surface or weather rind visible. The other core, [110:1], was noted as primary. As this was quartz, this was decided by the difference in lustre from the area with a removal to the rest of the surface. This likely represents a weathered surface, as opposed to true cortex.

The majority of the assemblage indicated bipolar reduction, at 55%. Freehand reduction was associated with 1 piece.

The reduction technology was unclear on 2 pieces.

The dimensions of material are displayed in **Fig. A3.14**.

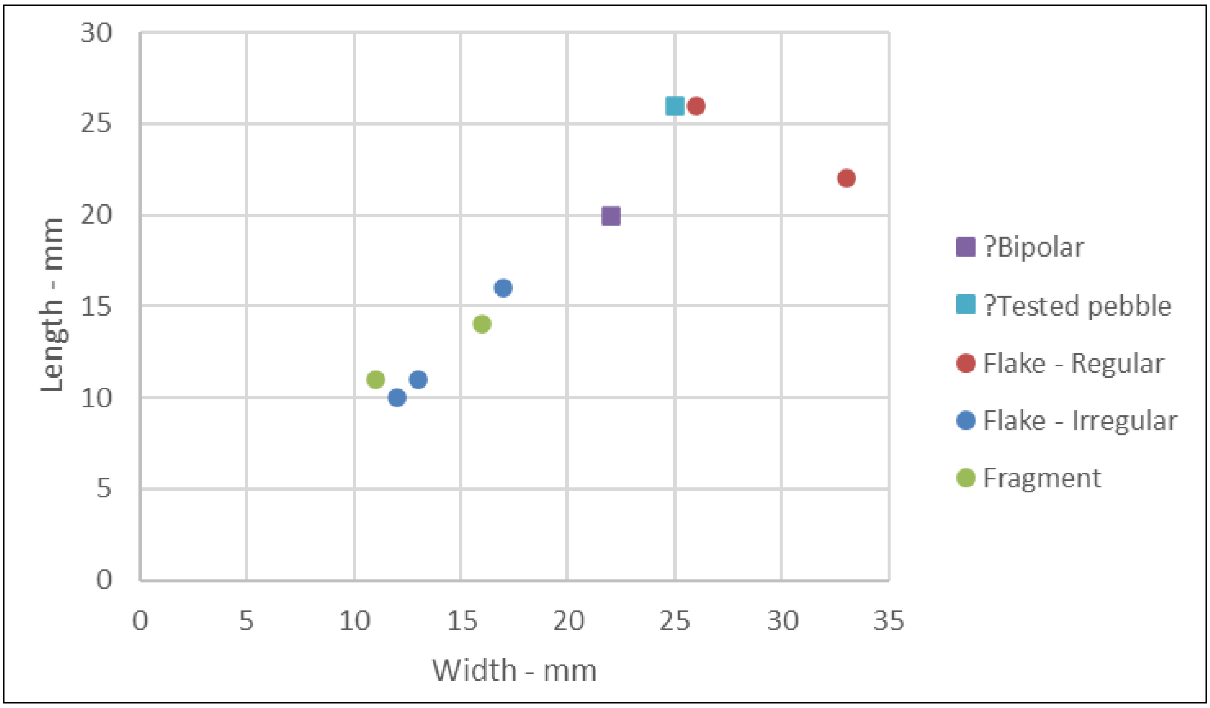


Fig. A3.14: Dimensions of lithic products and cores from Benedin.

Typology

None of the chipped lithic material displayed secondary working.

Both of the ground/coarse items displayed signs of use. [160:2] had abrasion present on its surfaces and edge, with impact scars also present on one edge. This may have been used as a percussor, i.e.: hammerstone, and or for polishing/grinding activities. [343:1] had abrasion present along its edges. It was possibly used for polishing/grinding.

Iron Age

Site: Platin-Lagavooren 1 \ Excavation Number: 00E0822

Introduction

The site at Platin-Lagavooren 1 (Lynch 2012) consisted of a well-defined circular structure, dated to the Middle or Developed Iron Age. Activity associated with this structure included pits and gullies. Metallurgical waste was noted in some gullies. The structure was radiocarbon dated to the Developed Iron Age: 160-60 cal BC-AD [2025±30 BP, 2σ – SUERC 31937]. The Developed Iron Age was dated by two other contexts: 170-20 cal BC-AD [2055±30 BP, 2σ – SUERC 31886], 160-60 cal BC-AD [2025±30 BP, 2σ – SUERC 31938]. Artefacts recovered included lithics, stone, pottery, burnt clay, glass, iron, bone. Earlier activity in the Late Bronze Age was indicate by a radiocarbon date from animal bone: 835-765 cal BC [2620±30 BP, 2σ – SUERC 31939].

A total of 184 lithic artefacts were recovered. 36 were selected, from contexts associated with structural activity. This represents 20% of the whole assemblage. 27 of these were chipped lithic material; and 9 were ground/coarse lithic.

Only 3 of the lithic artefacts were analysed. 24 pieces were not in the storage boxes. It is presumed they were removed from the catalogue before accession, as they were identified as 'natural chunks'.

The chipped lithic material was catalogued in the database table: 3 – [LITHIC].

The ground/coarse lithic material was catalogued in the database table: 9 – [PERCUSSOR].

Raw material

The chipped lithic consisted only of flint.

The ground/coarse lithic material consisted of 4 sandstone pieces, a flint piece, and 4 of indeterminate geology.

Assemblage

The chipped lithic debitage included: 1 irregular flake, [275:1]; and 2 proximal fragments, [21:1] and [334:1].

The percussors included: 4 passive, [297:1], [312:4.2], [314:4.2], [325:1]; and 5 active percussors, [254:1], [263:3], [264:1], [264:2], [264:3].

Condition

The ground/coarse lithic artefacts were in good to fair condition. 2 pieces, [312:4.2] and [325:1], were noted as being broken.

The chipped lithic pieces were in bad condition in general. Both fragments, [21:1] and [334:1], displayed edge-damage and fragment [21:1] was severely burnt. Flake [275:1] and fragment [21:1] were patinated and abraded. Flake [275:1] was rolled.

Technology

Flake [275:1] and fragment [334:1] were reduced to a secondary stage; while fragment [21:1] had no cortex.

All 3 pieces were identified as freehand reduced. The Waves of Percussion had a neutral extent, and the Platforms were extant. The termination on flake [275:1] was hinged.

The dimensions of the flake were 19mm L by 19mm W. The fragments measured 33mm L by 19mm W, and 10mm L by 15mm W.

Typology

There were no retouched chipped lithics.

The 4 passive percussors were interpreted as polishing platforms. 1 active percussor, [264:3], was interpreted as a plano-convex rubbing stone. [263:3] was identified as a possible burnisher.

Multi-period

Site: Sheephouse 3 \ Excavation Number: 00E0811

Introduction

The site at Sheephouse 3 (Nelis 2012) consisted of two phases of activity dated to the Bronze Age. Middle Bronze Age activity was indicated by a possible slot structure. Associated activity included post-holes, pits and cobbled surfaces. Middle Bronze Age activity was confirmed by radiocarbon dates: slot trench C111 = 1630-1450 cal BC [3270±30 BP, 2σ – SUERC 32068], pit = 1540-1410 cal BC [3215±30 BP, 2σ – SUERC 32064], pit C215 = 1500-1310 cal BC [3130±30 BP, 2σ – SUERC 35936], gully C6 = 1620-1450 cal BC [3260±30 BP, 2σ – SUERC 32063], pit C586 = 1420-1260 cal BC [3065±30 BP, 2σ – SUERC 32062], pit C9 = 1130-920 cal BC [2855±30 BP, 2σ – SUERC 32060]. Late Bronze Age activity was indicated by an enclosure and pits. Late Bronze Age activity was confirmed by domestic pottery and radiocarbon dates: 1120-910 cal BC [2835±30 BP, 2σ – SUERC 32059], 790-520 cal BC [2510±30 BP, 2σ – SUERC 32061]. Previous activity was represented by sherds of Grooved Ware pottery.

A total of 464 lithic artefacts were recovered. 93 lithic artefacts, 20% of the whole assemblage, were selected. 75 were chipped lithic material, and 18 were ground/coarse material.

8 of the chipped lithic pieces were not analysed as they were not in the storage boxes.

The chipped lithic material was catalogued in the database tables: 14 – [CORE]; 43 – [LITHIC]; 4 – [UNCLASSIFIED]; 6 – [NATURAL].

The ground/coarse lithic material was catalogued in the database tables: 16 – [PERCUSSOR]; 1 – [LITHIC]; 1 – [UNCLASSIFIED].

Raw Material

Flint was the dominant geology, accounting for 71%. Chert accounted for 7%. Sandstone and quartzite accounted for 4% and 3% respectively.

The geology of 15% was undetermined.

Assemblage

Debitage products included: 7 regular flakes; 11 irregular flakes; 1 blade; 2 chips; 4 chunks; and 18 fragments. The debitage cores included: 8 bipolar forms; 2 split pebbles; 2 tested pebbles; and 2 pieces of indeterminate form.

The percussor objects included: 12 active items, and 4 passive items. 1 ground/coarse lithic object was recorded as a fragment in the [LITHIC] table.

Technology

A small number of pieces at the primary stage were present, 12%. Both secondary and tertiary stage pieces appeared to the same extent, 32%.

Bipolar reduction was the most apparent technique – confirmed 30%, possible 18%. Freehand-reduced material only appeared on 9% of material, all debitage products. None of the cores indicated freehand reduction. This could indicate that cores were further reduced by bipolar reduction, once too small to be knapped in hand.

The reduction technique was indeterminate for 20% of material.

The dimensions of material are displayed in **Fig. A3.15**.

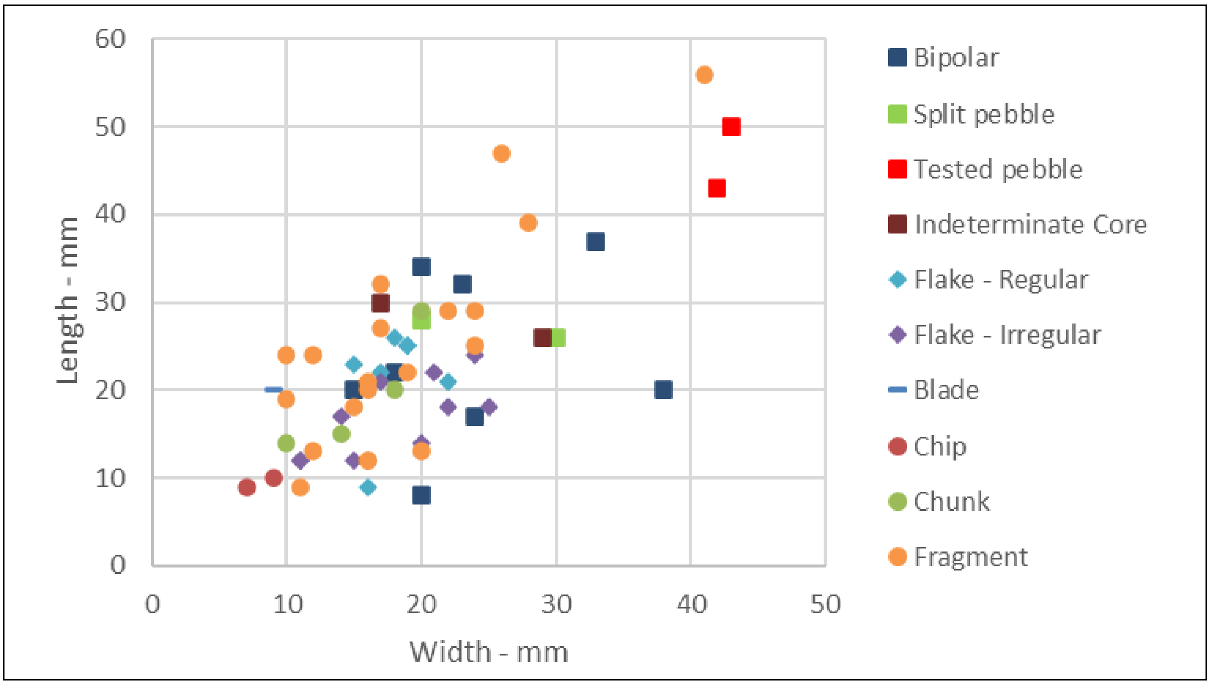


Fig. A3.15: Dimensions of lithic products and cores from Sheephouse 3.

Typology

19% of chipped lithic material displayed secondary modification. 11 pieces were worked into convex scrapers, with a further 3 pieces showing areas of retouch. The majority of these were on flint, with 1 retouched piece and 1 possible convex scraper on chert.

The ground/coarse material included: 6 rubbing stones; a pestle; a burnisher or polishing stone; 2 utilised stones; 2 possible hammerstones; a whet stone; an anvilstone; a grinding or polishing platform; and a possible bedstone.

<u>Site: Rathmullan 10 \ Excavation Number: 00E0813</u>

Introduction

The site at Rathmullan 10 (Bolger 2012) comprised an area of intense activity, with numerous features present. A circular slot and post-built structure, which produced dates for the Early Bronze Age and Middle Bronze Age, was attributed to the latter period by the excavator. Radiocarbon dates confirmed activity: post-hole C82 = 1770-1610 cal BC [3400±30 BP, 2σ – SUERC 31881], slot trench C292 = 1520-1400 cal BC [2180±30 BP, 2σ – SUERC 31918], stake-hole C240 = 1770-1610 cal BC [3395±30 BP, 2σ – SUERC 31917]. A series of pits, post-holes and spreads indicated a previous period of activity, dated to the Chalcolithic. This was confirmed by pottery sherds and radiocarbon dates: shallow cut C94 = 2460-220 cal BC [3850±30 BP, 2σ – SUERC 31920], pit C60 = 2460-2200 cal BC [3850±30 BP, 2σ – SUERC 31921], pit C18 = 2300-2050 cal BC [3780±30 BP, 2σ – SUERC 31925].

A total of 248 lithic artefacts were recovered. 107 lithic artefacts, 43% of the whole assemblage, were selected for analysis. 104 were chipped lithic material, and 1 was ground/coarse lithic material.

1 chipped lithic piece was not analysed.

The chipped lithic material was catalogued in the database tables: 16 – [CORE]; 88 – [LITHIC]; 1 – [NATURAL].

The ground/coarse lithic material was catalogued in the database tables: 1 – [PERCUSSOR].

Raw Material

The assemblage was dominated by flint, accounting for 97%. 2 pieces of debitage products were of chert.

The ground/coarse lithic object was of quartz.

Assemblage

Debitage products included: 18 regular flakes; 11 irregular flakes; 3 blades; 7 chips; 12 chunks; 33 fragments; 2 other; and 2 pieces of indeterminate form. The debitage cores included: 12 bipolar forms; 2 re-used forms; 1 split pebble; and 1 combination core.

The percussors included: 1 active/passive item.

Condition

The majority of the pieces displayed edge-damage, 77%. Patination appeared on 22% of the material, to varying extents. 17% of pieces were abraded, and 9% were rolled. Most pieces were not affected by heat exposure, 80%. The remainder were severely burnt.

The ground/coarse lithic item was noted as being in good condition.

Technology

The majority of material was worked to a secondary stage, 42%. Tertiary material was the next most apparent, with 34%. Primary material accounted for 23%.

Bipolar reduction was more evident. Confirmed pieces accounted for 26%, with possible pieces for another 18% of the assemblage. Confirmed freehand-reduced material came to 13%, with possible pieces adding 4%.

2 core pieces showed use of platform and bipolar reduction.

The reduction technique was indeterminate for 36%.

The dimensions of material are displayed in **Figs. A3.16** and **A3.17**.

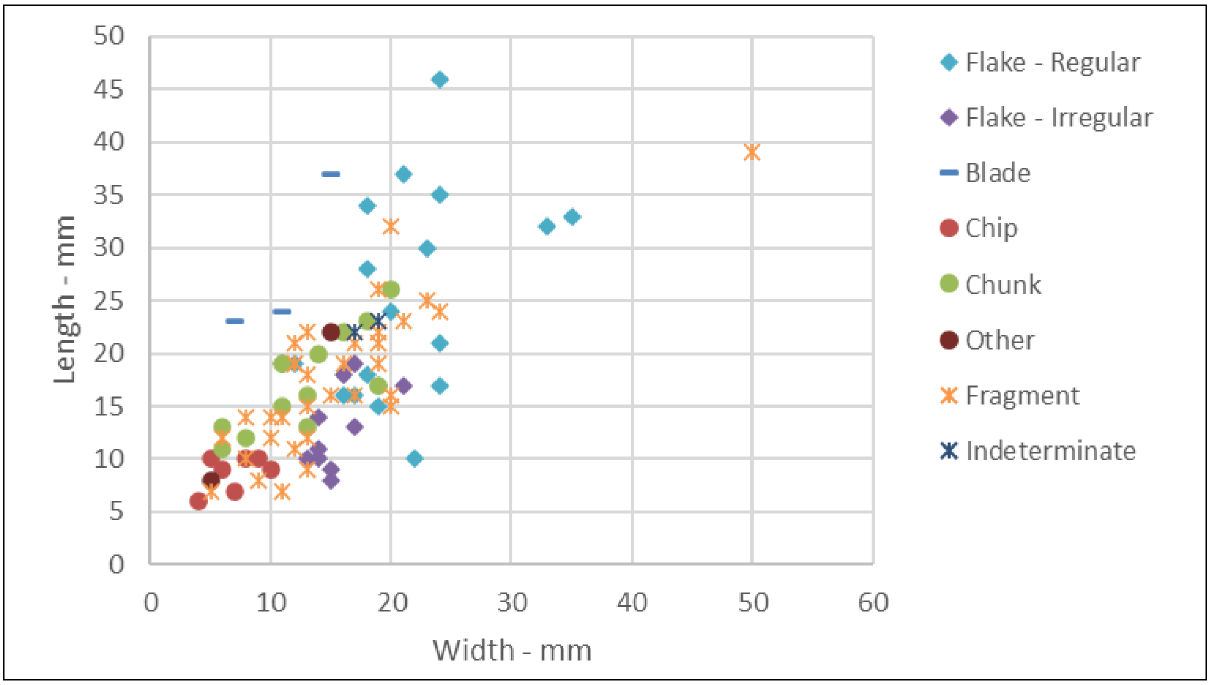


Fig. A3.16: Dimensions of lithic products from Rathmullan 10.

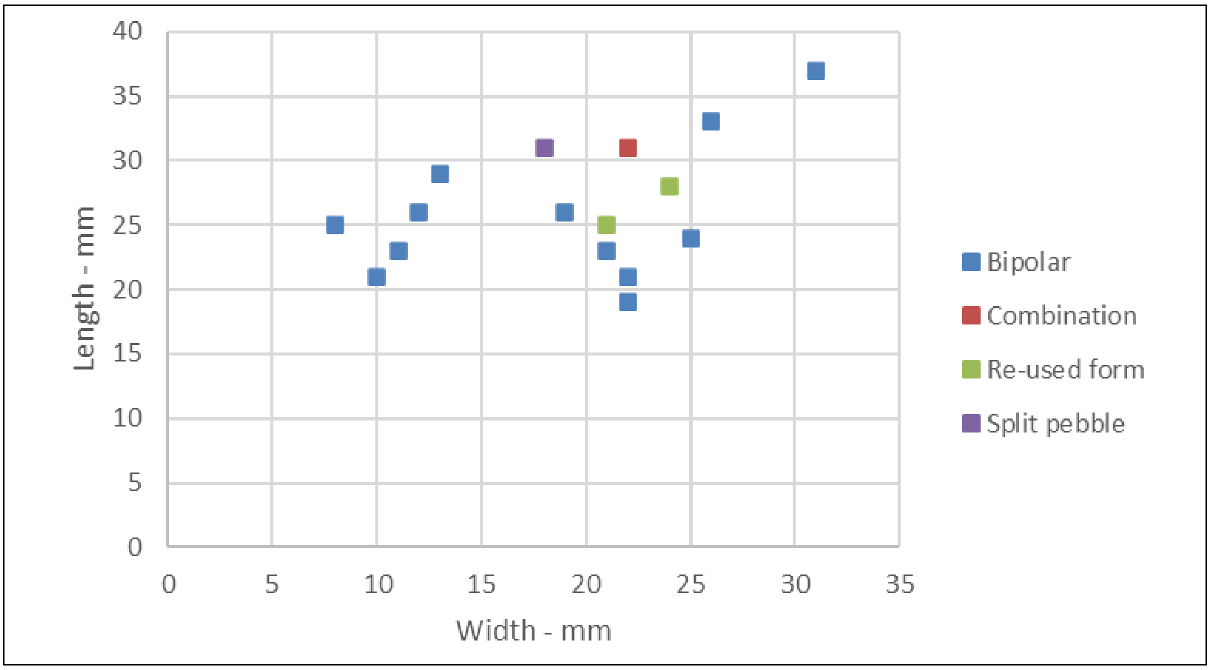


Fig. A3.17: Dimensions of lithic cores from Rathmullan 10.

Typology

Only 10 pieces, 10%, displayed secondary modification. Convex scrapers were 5 of the pieces. 1 piece was a concave scraper. 4 pieces displayed retouch, with no particular form developed.

Site: Ballynattin \ Excavation Number: 04E0712

Introduction

The site at Ballynattin (Kelly *et al*. 2007) consisted of several areas of activity, which represented a range of archaeological periods. A spread was dated to the Early Bronze Age: 1970-1820 cal BC [3845±37 BP, 2σ – UB 7199]. This may have been placed in a natural hollow and represented a dump. 2 structures were dated to the Middle Bronze Age by radiocarbon date: 1415-1267 cal BC [3074±31 BP, 2σ – UB 7197], 1445-1304 cal BC [3109±31 BP, 2σ – UB 7196]. Another structure was also identified, and dated to the Late Bronze Age by coarse ware pottery. The structure was defined by a curvilinear footing trench, a post-hole and a stake-hole. Late Bronze Age activity was also evidenced by radiocarbon date: 1130-980 cal BC [3004±35 BP, 2σ – UB 7198]. Earlier activity was noted by radiocarbon date: 3693-3524 cal BC [4825±35 BP, 2σ – UB 7195].

A total of 65 lithic artefacts were recovered. 27 lithic artefacts, 42% of the whole assemblage, were selected for analysis. All were chipped lithic material.

The chipped lithic material was catalogued in the database tables: 11 – [CORE]; 16 – [LITHIC].

Raw Material

All the material was of flint.

Assemblage

Debitage products included: 7 regular flakes; 4 irregular flakes; and 5 fragments. The debitage cores included: 5 bipolar forms; 2 split pebbles; 1 combination core; 1 tested pebble; 1 re-used form; and 1 piece of indeterminate nature.

Condition

Patination appeared to varying extents on one-third of the material. Signs of abrasion were noted on 26%, with rolling on 19%. 4 of the 5 pieces which displayed rolling were cores. Two-thirds of pieces displayed edge-damage. Most of the material had no signs of heat exposure. 2 pieces displayed a slight lustre.

Technology

The bulk of the material was worked at a primary stage, 70%. Secondary-stage pieces accounted for 26% of the material, and the remaining 4% for tertiary. Only 1 Core item was at a secondary stage, the other 10 were at the primary stage.

Bipolar reduction dominated the assemblage, accounting for 63%. 14 pieces showed confirmed bipolar reduction, with another 3 possible. Freehand reduction was seen on 22% of the material.

1 core was interpreted as showing a combination of reduction techniques, where opposed crushing and platform preparation appeared on the piece. The preparation of platforms, while associated with freehand reduction, does not necessarily discount bipolar.

The technique of reduction was unclear for 11% of pieces.

The dimensions of material are displayed in **Fig. A3.18**.

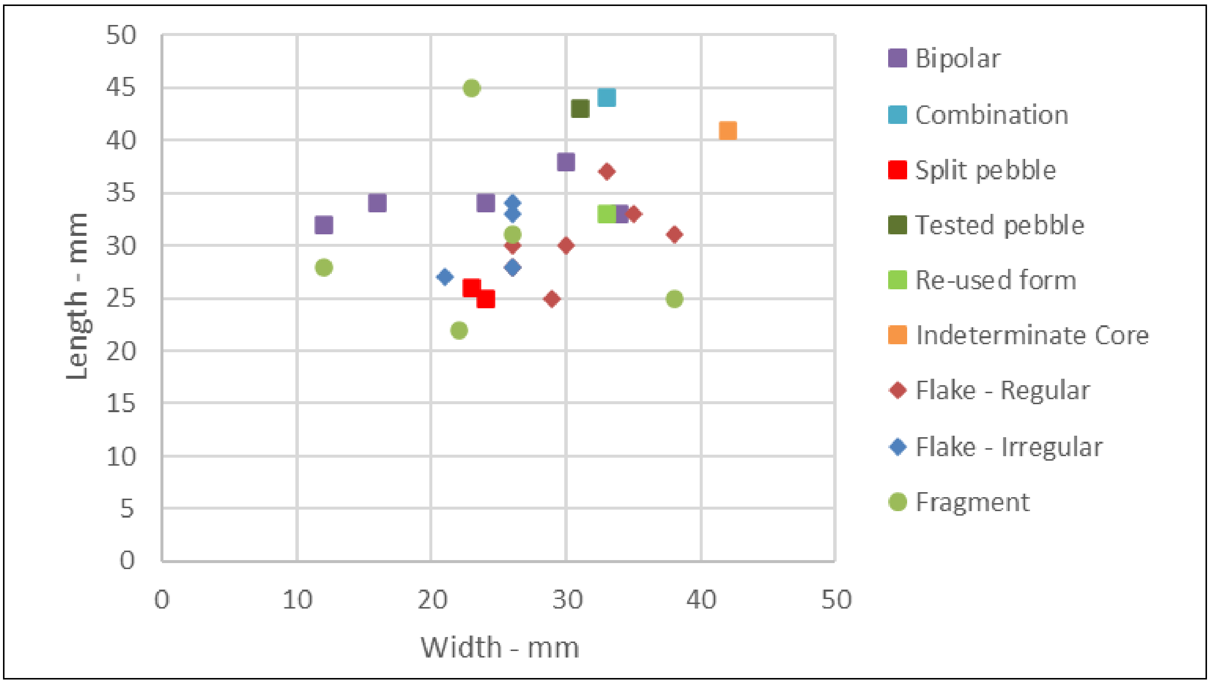


Fig. A3.18: Dimensions of lithic products and cores from Ballynattin.

Typology

There was secondary modification on 19% of the pieces. These included 2 convex scrapers, and 3 pieces with retouch.

<u>Site: Haynestown 1 \ Excavation Number: 08E0476</u>

Introduction

The site at Haynestown 1 (McLoughlin 2012) comprised a circular post-built structure. Internal features included two post-holes. Additional activity included a series of pits, or possibly post-holes at the entrance. Activity was dated by early Neolithic and Middle Bronze Age pottery. A Late Neolithic or early Chalcolithic date was returned from post-hole C58: 2576-2474 cal BC [4012±25 BP, 2σ – UBA 12168].

A total of 63 lithic artefacts were recovered. 59 lithic artefacts, 94% of the whole assemblage, were selected for analysis. 58 pieces were chipped lithic material, and 1 piece was ground/coarse lithic.

1 chipped lithic piece was not analysed.

The chipped lithic material was catalogued in the database tables: 13 – [CORE]; 44 – [LITHIC].

The ground/coarse lithic material was catalogued in the database table: 1 – [PERCUSSOR].

Raw Material

All the chipped lithic material was of flint.

The geology of the ground/coarse lithic item was indeterminate.

Assemblage

Debitage products included: 6 regular flakes; 7 irregular flakes; 1 blade; 4 chips; 1 other; and 25 fragments. The debitage cores included: 12 bipolar forms, and 1 core of indeterminate nature.

The percussor item was an active/passive piece.

Condition

Only 12% showed signs of abrasion, with none being rolled. Edge-damage appeared on 84% of pieces. Patination only occurred on 10%. The majority of pieces, 84%, displayed no sign of heat exposure, though 14% were moderately to severely burnt.

The percussor item was noted as being in fair condition.

Technology

A small majority of pieces were reduced to a tertiary stage, 40. Primary and secondary stage pieces both appeared at 29%.

The assemblage was dominated by bipolar reduction. 41% of material was confirmed bipolar, with further 16% possible. Freehand-reduced material was present to a minor degree, 5%.

The reduction technique for 36% was indeterminate.

The dimensions of material are displayed in **Fig. A3.19**.

Typology

1 piece displayed secondary modification. This was a retouched piece.

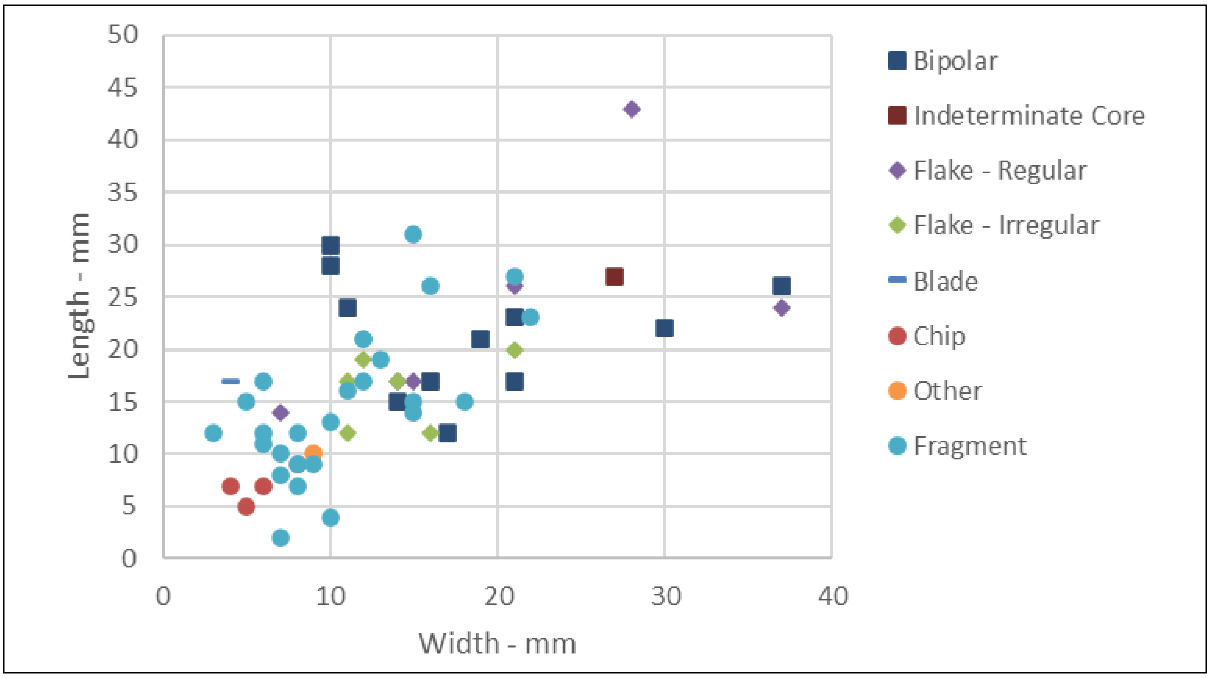


Fig. A3.19: Dimensions of lithic products and cores from Haynestown 1.

<u>Site: Ballylegan 207.2 \ Excavation Number: E2265</u>

Introduction

The site at Ballylegan (McQuade 2007) comprised four areas of archaeological activity. Site 207.2 evidenced several periods of activity. The Middle Bronze Age was represented by an unenclosed work area on the southern part of the site. A hearth was radiocarbon dated to: 1686-1519 cal BC [3318±33 BP, 2σ – UB 7217]. The Late Bronze Age displayed the most intense phase of activity. It was represented by the remains of two structures and a series of features representing domestic settlement and industrial activity. A post-hole from 1 of the structures was radiocarbon dated to: 1253-1007 cal BC [2910±32 BP, 2σ – UB 7216]. A second structure was identified as Late Bronze Age by pottery and radiocarbon dates: 1128-992 cal BC [2861±33 BP, 2σ – UB 7218], 1122-923 cal BC [2854±33 BP, 2σ – UB 7390]. A Late Iron Age structure and a series of associated domestic features were present on the northern end of the site. A radiocarbon date returned as: 402-539 cal AD [1603±30 BP, 2σ – UB 7215]. Chalcolithic activity was evidenced by sherds of Beaker pottery. Activity was dated to the Early Neolithic by pottery.

A total of 10 lithic artefacts were recovered. All 10 were selected for analysis. 5 pieces were chipped lithic material, and 5 pieces were ground/coarse lithic material.

The chipped lithic material was catalogued in the database tables: 4 – [LITHIC]; 1 – [UNCLASSIFIED].

The ground/coarse lithic material was catalogued in the database tables: 4 – [PERCUSSOR]; 1 – [NATURAL].

Raw Material

All chipped lithic material was of flint.

2 of the ground/coarse items were sandstone. The geology of the other 2 was indeterminate.

Assemblage

Debitage products included: 2 regular flakes; 2 irregular flakes.

The percussor items included 3 active pieces and 1 active/passive piece.

Condition

3 pieces displayed edge-damage. Patination appeared on 1 piece. Signs of abrasion appeared on 1 piece. None of the pieces appeared rolled or exposure to heat.

The condition of the ground/coarse lithic items was noted as good in 3 cases, and fair in 1.

Technology

2 chipped lithic pieces were worked at a primary stage, and the other 2 at a secondary stage.

2 pieces were confirmed bipolar reduction. The reduction technique was unclear on the other 2 – though 1 was possibly bipolar and the other possibly freehand.

The dimensions of material are displayed in **Fig. A3.20**.

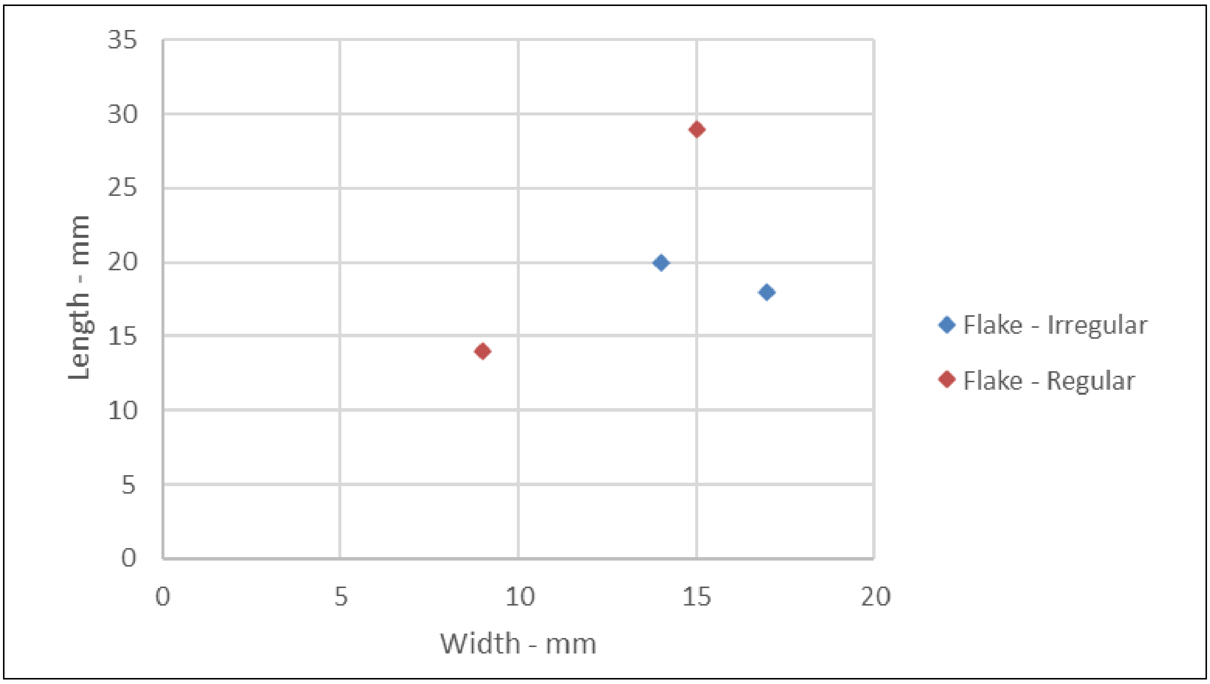


Fig. A3.20: Dimensions of lithic products from Ballylegan 207.2.

Typology

1 of the pieces displayed secondary modification. This was worked into a convex scraper.

Site: Caherdrinny 3 \ Excavation Number: E2422

Introduction

The site at Caherdrinny 3 (Bower *et al*. 2011) comprised activity from several archaeological periods. The Early Bronze Age was evidenced by an irregular structure, and supported by pottery and radiocarbon dates: 1736-1536 cal BC [3356±24 BP, 2σ – UBA 13293], 1871-1632 cal BC [3420±29 BP, 2σ – UBA 13291]. Other evidence for the Chalcolithic and Bronze Age came in the form of a number of pits and post-holes, and a corn-drying kiln. Middle Bronze Age activity was confirmed by domestic cordoned urn sherds and radiocarbon dates: 1634-1496 cal BC [3287±29 BP, 2σ – UB 13294], 1657-1498 cal BC [3291±29 BP, 2σ – UB 13231], 1606-1444 cal BC [3242±23 BP, 2σ – UB 13300]. Iron Age activity was confirmed with radiocarbon dates: 160-51 cal BC-AD [2027±25 BP, 2σ – UB 13290], 90-51 cal BC-AD [2020±22 BP, 2σ – UBA 13295], 107-48 cal BC-AD [2031±23 BP, 2σ – UBA 13302], 344-52 cal BC [2122±29 BP, 2σ – UB 13303], 175-48 cal BC [2092±22 BP, 2σ – UB 13299]. Preceding activity came in the form of a Neolithic house and other features, confirmed by pottery and radiocarbon dates: 3766-3650 cal BC [4926±26 BP, 2σ – UB 13286], 4144-3963 cal BC [5214±27 BP, 2σ – UBA 13292]; and the Mesolithic with a Moynagh point and radiocarbon dates: 4685-4498 cal BC [5734±32 BP, 2σ – UB 13287], 4144-3963 cal BC [5214±27 BP, 2σ – UB 13292].

A total of 223 lithic artefacts were recovered. 24 lithic artefacts, 11% of the whole assemblage, were selected for analysis. 18 of these were chipped lithic material, and 6 were coarse/ground lithic material.

4 chipped lithic pieces and 1 ground/coarse lithic piece were not analysed.

The chipped lithic material was catalogued in the database tables: 2 – [CORE]; 10 – [LITHIC]; 2 – [NATURAL].

The ground/coarse lithic material was catalogued in the database tables: 4 – [PERCUSSOR]; 1 – [NATURAL].

Raw Material

All chipped lithic material was of flint.

The ground/coarse lithic material included 2 sandstone pieces, 1 mudstone piece, and 1 piece of indeterminate geology.

Assemblage

Debitage products included: 1 regular flake; 1 irregular flake; 2 blades; 2 chunks; and 4 fragments. The debitage cores included: 1 bipolar form, and 1 core of indeterminate nature.

The percussor material included: 4 active items.

Condition

Edge-damage appeared with the greatest frequency, on 69%. Abrasion appeared on 25% of the material. Patination was noted on 6% of pieces. None of the pieces appeared rolled. Most pieces, 56%, displayed no signs of heat exposure. 19% were severely burnt.

The percussor items were noted as being in good condition in 2 cases, and fair condition in 2 cases.

Technology

38% of pieces were reduced to a tertiary stage. Pieces at the secondary stage represented 25%, and the primary stage 13%.

Bipolar reduction was slightly more apparent in the assemblage. Confirmed pieces accounted for 19%, and possible for 6%. Freehand reduction was visible on 13%, and possibly on a further 6%.

The reduction technique for 25% was indeterminate.

The dimensions of material are displayed in **Fig. A3.21**.

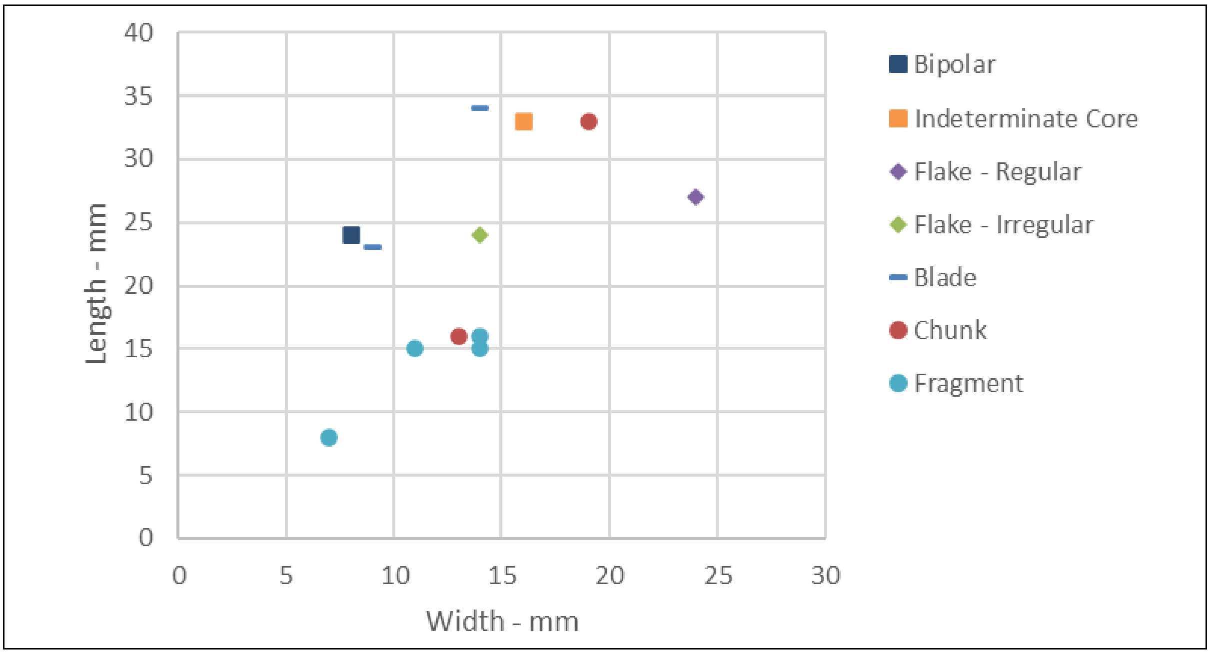


Fig. A3.21: Dimensions of lithic products and cores from Caherdrinny 3.

Typology

1 chipped lithic item displayed retouch, though it was not developed into a formal type.

Site: Kilmainham 1C \ Excavation Number: E3140

Introduction

The site at Kilmainham 1C (Walsh 2011) comprised ten phases of activity, ranging from the Neolithic to the post-Medieval. Chalcolithic and Bronze Age activity was evidenced by structures, formed by post-holes, stake-holes and a foundation trench; a stone platform; burnt mounds; pits. This was confirmed by Beaker pottery and radiocarbon dates: Chalcolithic = 2573-2472 cal BC [4003±23 BP, 2σ – UB 12925], 2569-2350 cal BC [3960±23 BP, 2σ – UB 12921], 2474-2309 cal BC [3918±23 BP, 2σ – UB 15480], 2433-2148 cal BC [3824±26 BP, 2σ – UB 12920], 2287-2061 cal BC [3770±26 BP, 2σ – UB 13021], 2287-2051 cal BC [3766±28 BP, 2σ – UB 14139]; Early Bronze Age = 2128-1926 cal BC [3639±25 BP, 2σ – UB 13020], 1953-1774 cal BC [3546±24 BP, 2σ – UB 12898], 2122-1831 cal BC [3601±37 BP, 2σ – UB 12918], 1896-1752 cal BC [3509±23 BP, 2σ – UB 12922], 1906-1683 cal BC [3467±44 BP, 2σ – UB 12923], 1885-1749 cal BC [3493±23 BP, 2σ – UB 12909], 1880-1530 cal BC [3400±40 BP, 2σ – SUERC 29342], 1616-1751 cal BC [3392±29 BP, 2σ – UB 12912]; Middle Bronze Age = 1440-1316 cal BC [3116±23 BP, 2σ – UB 12917], 1443-1293 cal BC [3103±33 BP, 2σ – UB 12905], 1299-1059 cal BC [2965±26 BP, 2σ – UB 15481]; Late Bronze Age = 1208-1007 cal BC [2903±26 BP, 2σ – UB 12924], 1128-977 cal BC [2878±22 BP, 2σ – UB 12916], 1119-932 cal BC [2857±26 BP, 2σ – UB 12914], 810-773 cal BC [2603±22 BP, 2σ – UB 12904]; Iron Age = 203-51 cal BC [2117±26 BP, 2σ – UB 12915], 27-127 cal AD [1924±20 BP, 2σ – UB 12927], 235-376 cal AD [1750±20 BP, 2σ – UB 12929], 269-432 cal AD [1654±21 BP, 2σ – UB 12926]. Neolithic activity was confirmed by pottery and radiocarbon date: 3086-2913 cal BC [4375±24 BP, 2σ – UB 12919]

A total of 232 lithic artefacts were recovered. 105 lithic artefacts, 45% of the whole assemblage, were selected for analysis. 103 of these were chipped lithic material, and 2 were ground/coarse lithic material.

The chipped lithic material was catalogued in the database tables: 13 – [CORE]; 74 – [LITHIC]; 4 – [UNCLASSIFIED]; 3 – [NATURAL].

The ground/coarse lithic material was catalogued in the database tables: 1 – [PERCUSSOR].

Raw Material

The assemblage was dominated by flint, accounting for 93% of the material. Chert was present to a minor degree, 6%.

The geology of the ground/coarse lithic item was indeterminate.

Assemblage

Debitage products included: 9 regular flakes; 11 irregular flakes; 7 blades; 17 chips; 6 chunks; 21 fragments; 2 other; and 1 piece of indeterminate form. The debitage cores included: 10 bipolar forms, 2 split pebbles, and 1 core of indeterminate nature.

The percussor entry was an active item.

Condition

Edge-damage appeared on 73% of the material. Patination was present to varying degrees on 17%. 32% of pieces were abraded, with 6% displaying signs of rolling. The majority of pieces, 85%, were not exposed to heat to any degree. 11% were extremely burnt. 2% displayed very light to moderate signs of heat exposure.

The ground/coarse lithic item was noted as being in good condition.

Technology

The majority of pieces, 72%, were reduced to a tertiary stage. Secondary-stage material was present to the degree of 22%, with primary pieces accounting for 6%.

Bipolar reduction was dominant within the assemblage. 23% of pieces were confirmed, with a further 11% possible. Freehand reduction was confirmed for 11%, and possible in another 2%.

The reduction technique for 51% of material was indeterminate.

The dimensions of material are displayed in **Figs. A3.22** and **A3.23**.

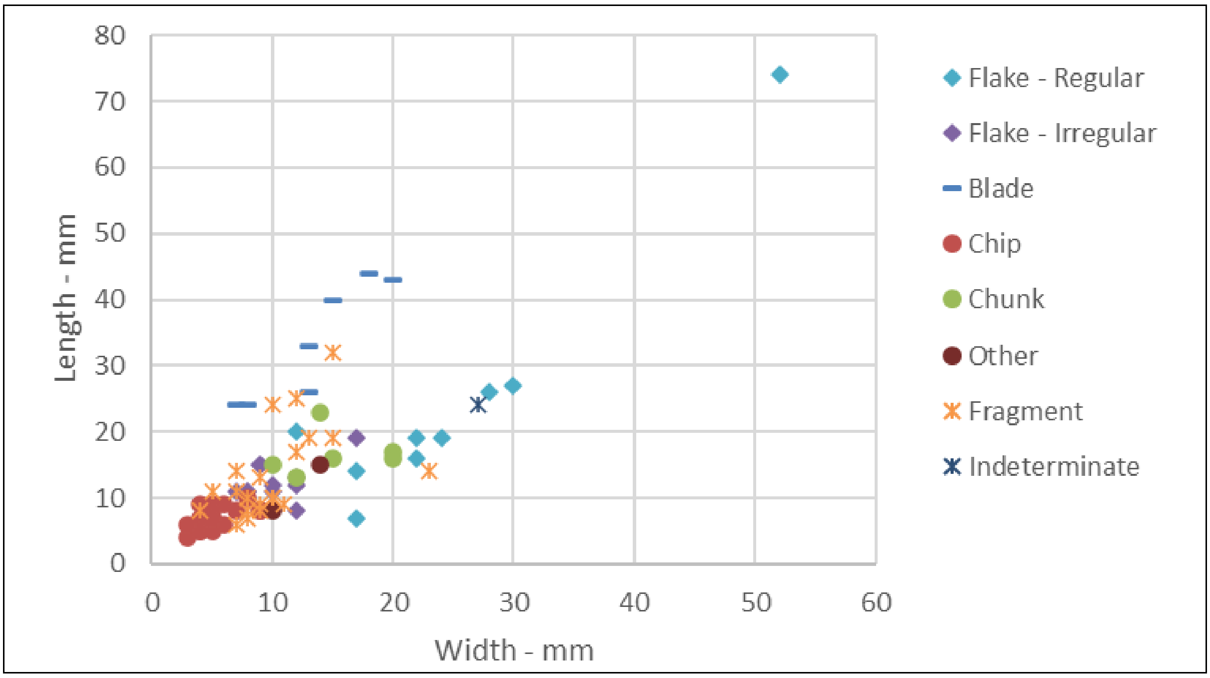


Fig. A3.22: Dimensions of lithic products from Kilmainham 1C.

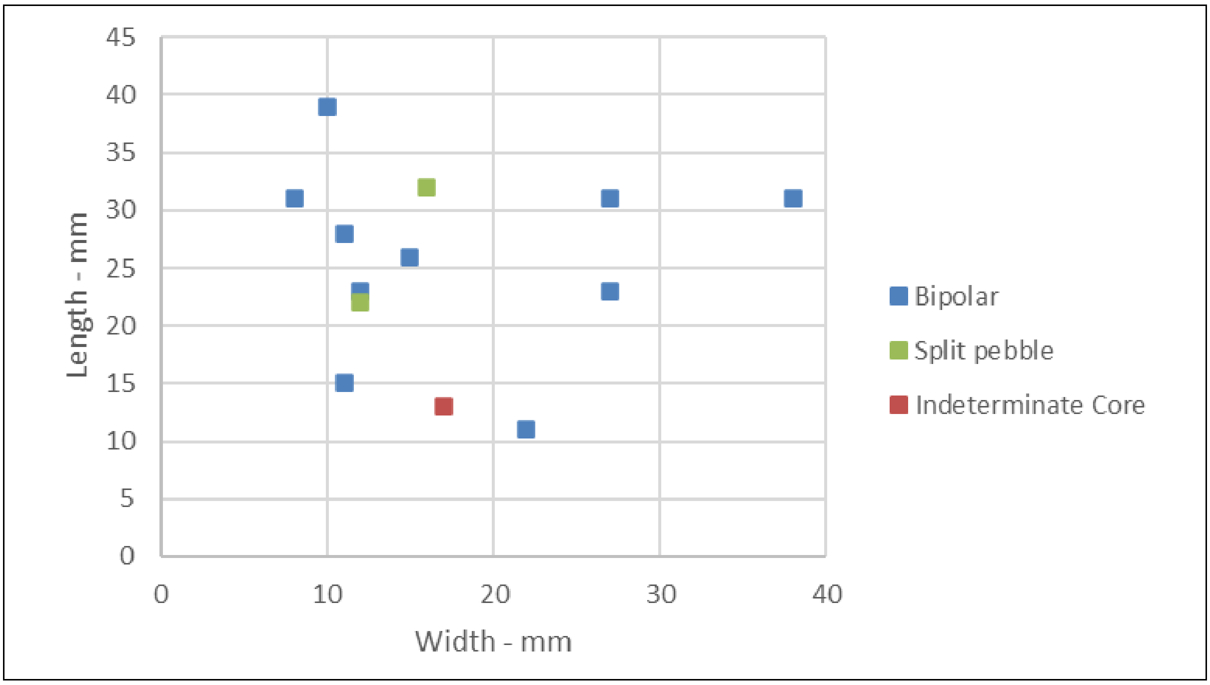


Fig. A3.23: Dimensions of lithic cores from Kilmainham 1C.

Typology

5 pieces, 6% of the assemblage, displayed secondary modification. 2 artefacts were convex scrapers. 1 item was a plano-convex form. 1 piece had an area of retouch. 1 piece was identified as wedge.

Site: Gardenrath 2 \ Excavation Number: E3145

Introduction

The site at Gardenrath 2 (Bayley 2010) comprised various pits and features. There was no clear habitation during the Bronze Age. Activity consisting of pits was identified, and confirmed by radiocarbon date: 1628-1496 cal BC (3282±28 BP, 2σ – UB 12044]. A spread containing a hearth and 2 pits was dated to the Chalcolithic: 2457-2202 cal BC [3838±25 BP, 2σ – UB 12936].

A total of 25 lithic artefacts were recovered. 9 lithic artefacts, 36% of the whole assemblage, were selected for analysis. 8 pieces were chipped lithic material, and 1 piece was ground/coarse lithic.

The chipped lithic material was catalogued in the database tables: 8 – [LITHIC].

The ground/coarse lithic material was catalogued in the database tables: 1 – [PERCUSSOR].

Raw Material

Flint was the predominant geology, accounting for 78%. Quartz crystal and sandstone accounted for 11% each.

Assemblage

Debitage products included: 3 fragments, 4 chips, and 1 chunk.

The percussor item was recorded as being indeterminate in category.

Condition

Abrasion and edge-damage appeared frequently, 67% and 56% respectively. 1 piece was patinated. None of the pieces displayed evidence of heat exposure or rolling.

The condition of the ground/coarse lithic item was noted as good.

Technology

The majority of pieces were reduced to a tertiary stage, 78%. 11% were at a secondary stage.

Neither reduction technique was confirmed within the assemblage. Possible freehand reduction was seen on 22%, and possible bipolar on 11%.

The reduction technique was indeterminate for 56% of pieces.

The dimensions of material are displayed in **Fig. A3.24**.

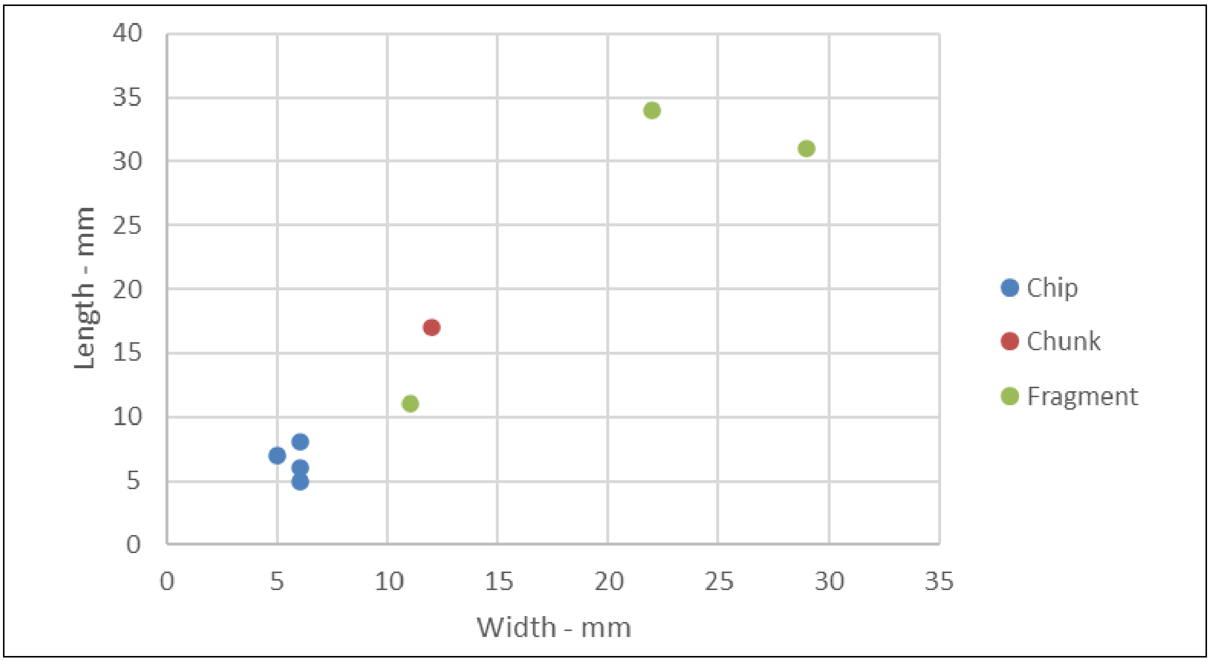


Fig. A3.24: Dimensions of lithic products from Gardenrath 2.

Typology

1 piece displayed secondary modification. This was a hollow scraper.

<u>Site: Cakestown Glebe 2 \ Excavation Number: E3158</u>

Introduction

The site at Cakestown Glebe 2 (Lynch 2011) comprised several structures from different archaeological periods. The Early Bronze Age was evidenced by a square, post-built structure, and a cremation pit. Radiocarbon dates confirmed activity: 2280-2020 cal BC [3730±40 BP, 2σ – SUERC 29338], 2141-1981 cal BC [3687±22 BP, 2σ – UB 12944]. Late Bronze Age activity included two structures. One structure was defined by post-holes, the second by stake-holes. Structure 1 was radiocarbon dated: 1122-939 cal BC [2864±24 BP, 2σ – UB 12071], 993-838 cal BC [2768±24 BP, 2σ – UB 12943]. Structure 2 was dated by pottery. A radiocarbon date returned as: 5220-4990 cal BC [6155±40 BP, 2σ – SUERC 29339] – which was interpreted as residual material. Associated with these structures were hearths and pits. In addition to Bronze Age activity, the Mesolithic and Iron Age were also represented. The Iron Age was radiocarbon dated: 380-110 cal BC [2175±40 BP, 2σ – SUERC 29337], 28-128 cal AD [1921±21 BP, 2σ – UB 12069].

A total of 41 lithic artefacts were recovered. 35 lithic artefacts, 85% of the whole assemblage, were selected for analysis. All were chipped lithic material.

1 lithic artefact was not analysed as it was not in the storage box.

The chipped lithic material was catalogued in the database tables: 2 – [CORE]; 32 – [LITHIC].

Raw Material

All pieces were of flint.

Assemblage

Debitage products included: 6 regular flakes; 6 irregular flakes; 4 blades; 1 chip; 6 chunks; and 9 fragments. The debitage cores included: 1 freehand core, and 1 combination core.

Condition

Edge-damage appeared on all pieces. Patination was present on 21% of material. 15% of pieces were abraded, with 3% of pieces also rolled. The majority of the pieces were unburnt, 74%, with the other 26% being extremely burnt.

Technology

A majority of pieces, 59%, were reduced to a tertiary stage. 35% were reduced to a secondary stage. Primary stage pieces accounted for only 6%.

Bipolar and freehand reduction appeared to the same degree in the assemblage, with a slight preference for freehand. Confirmed bipolar material accounted for 26%, with confirmed freehand material for 29%. For possible forms, bipolar came to 3% and freehand for 6%. 1 core, [286:1], displayed both reduction techniques.

The reduction technique was indeterminate for 32% of the assemblage.

The dimensions* of material are displayed in **Fig. A3.25**.

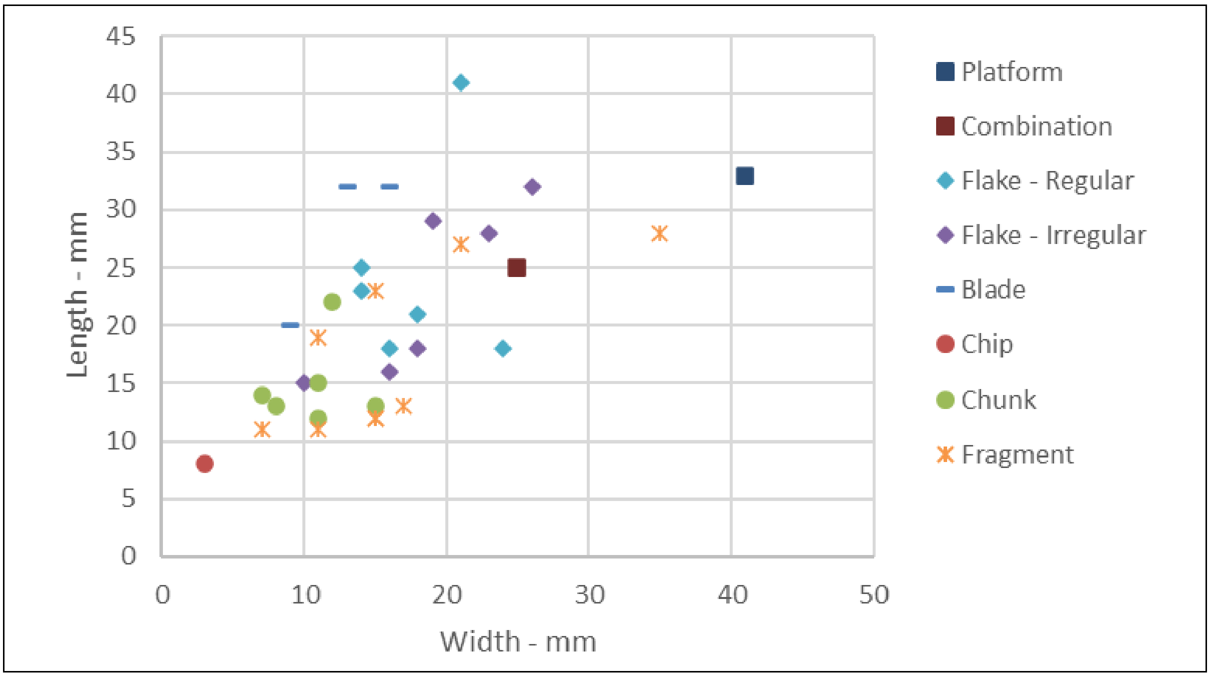


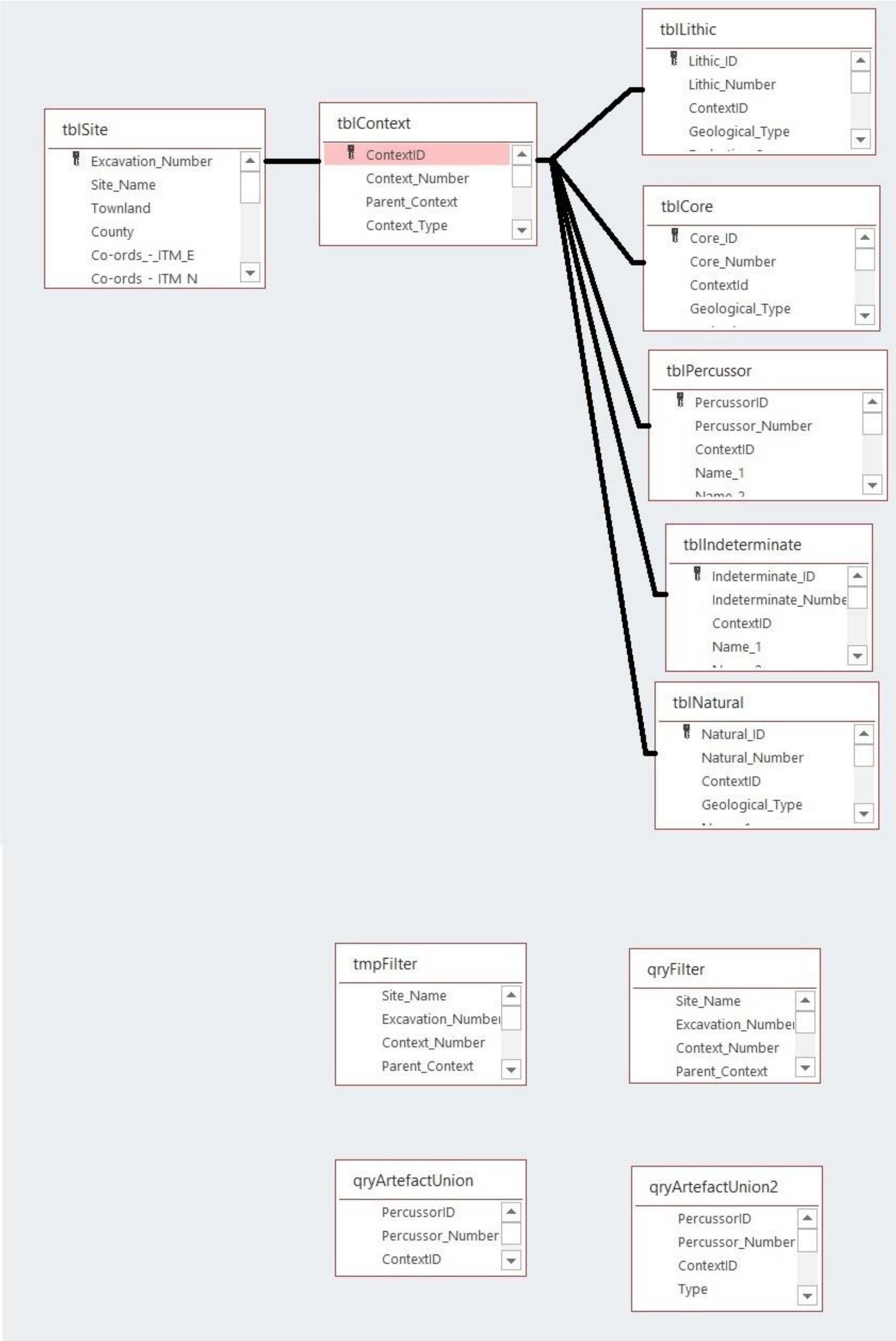
Fig. A3.25: Dimensions of lithic products and cores from Cakestown Glebe 2.
*the width of one blade was not recorded, so it is exempted from the above figure.

Typology

No pieces displayed secondary modification.

Appendix 3 – Database Structure and Fields

A) Database Structure



B) Database Fields

1. [SITE]

Field	Options	Definition	Reference
Excavation_Number^	Text	Primary key field	
Site_Name	Text		
Townland	Text		
County	Carlow Cavan Cork Dublin Kerry Kildare Kilkenny Laois Limerick Longford Louth Meath Offaly Tipperary Waterford Westmeath Wexford Wicklow	Restricted to counties set out in study parameters	
Co-ords_-_ITM_(E)	Text	Central Easting co-ordinate of excavation; defined in Irish Transverse Mercator	
Co-ords_-_ITM_(E)	Text	Central Northing co-ordinate of excavation; defined in Irish Transverse Mercator	
Period	Chalcolithic Early Bronze Age Middle Bronze Age Late Bronze Age Iron Age Multi-period	Restricted to periods set out in study parameters 'Multi-period' refers to sites with activity from various periods within the study parameters	
Radiocarbon_Date	Memo		
Site_Description	Memo		
Notes	Memo		
Void	Yes/No	Selected if entry is a mistake	

2. [CONTEXT]

Field	Options	Definition	Reference
ContextID^	Autonumber	Primary key field	
Context_Number	Text		
Parent_Context	Text	The cut which the deposit was contained within	
Context_Type	Text	General interpretation of the context where the artefact was recovered	
Context_Description	Memo		
Context_Dimensions	Memo		
Associated_Contexts	Memo	Other contexts that overlay; are overlaid; or border current context	
Associated_Artefacts	Memo	List of artefacts retrieved from current context	

Excavation_Number	Autonumber	Relation to Site table
Notes	Memo	
Void	Yes/No	Selected if entry is a mistake

3. **[PERCUSSORS]**

Field	Options	Definition	Reference
PercussorID^	Autonumber	Primary key field	
Percussor_Number	Text		
ContextID	Autonumber	Relation to Context table	
Name_1	Text		
Name_2	Text		
Percussor_Category	Active Passive Active/Passive Indeterminate	= moving component = stationary component = combination / unclear of above = not sure if used	
Geological_Type	Text		
Condition	Good Fair Poor Indeterminate	Refers to presence/absence of damage understood to have occurred post-use	
Length_-_mm	Number		
Width_-_mm	Number		
Thickness_-_mm	Number		
Weight_-_g	Number		
Shape	Flat Elongate Cuboidal Spheroidal Pyramidal	Top-down view; or viewing longest face	Westman 1994
Rotundity	Very Angular Angular Sub-angular Sub-rounded Rounded Well-rounded		Westman 1994
Profile	Text	Side-on view; or viewing shortest face	
Broken	Yes No Indeterminate		
Use_Wear	Yes No Indeterminate		
Edge_Abrasion	Yes No Indeterminate		Torre *et al*. 2013
Surface_Abrasion	Yes No Indeterminate		Torre *et al*. 2013
Edge_Impacts	Yes No Indeterminate		Torre *et al*. 2013
Surface_Impacts	Yes No Indeterminate		Torre *et al*. 2013

Distribution_Of_Marks	Very Scattered Scattered Clustered Clustered/Connected Clustered / Dispersed	Refers to the overall distribution of marks present on percussor	Torre *et al*. 2013
Original_Name	Text	Identifier given by initial recorder	
Notes	Memo		
Photography	Memo		
Void	Yes/No	Selected if entry is a mistake	

4. **[LITHIC]**

Field	**Options**	**Definition**	**Reference**
Lithic_ID^	Autonumber	Primary key field	
Lithic_Number	Text		
ContextID	Autonumber	Relation to Context table	
Name_1	Text		
Name_2	Text		
Geological_Type	Chert Flint Quartz Other		
Reduction_Sequence	Primary Secondary Tertiary	Extent of cortex on piece: 0% = tertiary; >0%, <50% = secondary; >50% = primary	
Abraded	Yes No Indeterminate		
Edge-damaged	Yes No Indeterminate		
Patinated	Light Heavy No Indeterminate		
Rolled	Yes No Indeterminate		
Ignition_Scale	0 1 2 3 4 5	Rising scale from 0, being not heat affected at all; to 5, being a pot-lid fracture or serious discolouration with crazing	
Sub-class	Blade Microblade Chip Chunk Flake – Regular Flake – Irregular Modified Type Other Indeterminate		Inizan *et al*. 1999 Woodman *et al*. 2006 Ballin 2017
Modified_Type	N/A Arrowhead Awl/borer	Designation of formally retouched lithics	Woodman *et al*. 2006

	Bifacial Form Fabricators/Rods Javelin Head *Petit Tranchet* Derivative Plano-convex Form Retouched Piece Scraper – Concave Scraper – Convex Scraper – Hollow Transverse Form ………		
Re-used_Form	Yes No Indeterminate	If a piece from an earlier period has been adapted for use in the Bronze Age	
Category	Freehand Freehand Possible Bipolar Bipolar Possible Indeterminate	Reduction method	
Length_-_mm	Number		
Width_-_mm	Number		
Thickness_-_mm	Number		
Weight_-_g	Number		
Broken	Yes No Indeterminate		
Break_Type	Distal Medial Proximal Indeterminate		Inizan *et al*. 1999
Retouch	Yes No Indeterminate		
Platform	Yes No Indeterminate		
Platform_Condition	Extant Crushed Indeterminate		
Bulb_of_Percussion	Yes No Indeterminate		
Bulb_of_Percussion_Description	Flat Diffuse Pronounced Indeterminate		
Waves_of_Percussion	Yes No Indeterminate		
Waves_of_Percussion_Extent	Complete Neutral Indeterminate		Drift 2012
Termination	Yes No Indeterminate		
Termination_Type	Feathered Hinged Stepped		Inizan *et al*. 1999

	Plunging Other Indeterminate		
Dorsal_Scars	Yes No Indeterminate		
Number_Of_Dorsal_Scars	Number		
Relationship_Of_Dorsal_Scars	N/A Parallel Opposed Perpendicular Irregular Indeterminate		
Notes	Memo		
Photography	Memo		
Void	Yes/No	Selected if entry is a mistake	

5. **[CORE]**

Field	Options	Definition	Reference
Core_ID^	Autonumber	Primary key field	
Core_Number	Text		
ContextID	Autonumber	Relation to Context table	
Name_1	Text		
Name_2	Text		
Geological_Type	Chert Flint Quartz Other		
Reduction_Sequence	Primary Secondary Tertiary	Extent of cortex on piece: 0% = tertiary; >0%, <50% = secondary; >50% = primary	
Abraded	Yes No Indeterminate		
Edge-damaged	Yes No Indeterminate		
Patinated	Light Heavy No Indeterminate		
Rolled	Yes No Indeterminate		
Ignition_Scale	0 1 2 3 4 5	Rising scale from 0, being not heat affected at all; to 5, being a pot-lid fracture or serious discolouration with crazing	
Category	Platform Bipolar Combination Split pebble Tested pebble	Form of core	Inizan *et al*. 1999 Woodman *et al*. 2006 Ballin 2017

	Re-used form Indeterminate	
Length_-_mm	Number	
Width_-_mm	Number	
Thickness_-_mm	Number	
Weight_-_g	Number	
Broken	Yes No Indeterminate	
Removal_Type	Blade Flake Combination Indeterminate N/A	
Number_of_Removals	Number	
Removal_Length_min_-_mm	Number	0 = indeterminate extent
Removal_Width_min_-_mm	Number	0 = indeterminate extent
Removal_Length_max_-_mm	Number	0 = indeterminate extent
Removal_Width_max_-_mm	Number	0 = indeterminate extent
Crushing	Yes No Indeterminate	
Relationship_Of_Removals	Single Parallel Opposed Perpendicular Multiple Indeterminate	
Core_Rotation	0 1 2	= no evidence of rotation = single rotation = multiple rotations
Notes	Memo	
Photography	Memo	
Void	Yes/No	Selected if entry is a mistake

6. **[INDETERMINATE]**[18]

Field	Options	Definition	Reference
Indeterminate_ID^	Autonumber	Primary key field	
Indeterminate_Number	Text		
Context_ID	Autonumber	Relation to Context table	
Name_1	Text		
Name_2	Text		
Geological_Type	Chert Flint Quartz Other		
Reduction_Sequence	Primary Secondary Tertiary	Extent of cortex on piece: 0% = tertiary; >0%, <50% = secondary; >50% = primary	
Abraded	Yes No Indeterminate		
Edge-damaged	Yes		

[18] Referred to as [UNCLASSIFIED] within the main body of the thesis text.

	No Indeterminate		
Patinated	Light Heavy No Indeterminate		
Rolled	Yes No Indeterminate		
Ignition_Scale	0 1 2 3 4 5	Rising scale from 0, being not heat affected at all; to 5, being a pot-lid fracture or serious discolouration with crazing	
Length_-_mm	Number		
Width_-_mm	Number		
Thickness_-_mm	Number		
Weight_-_g	Number		
Notes	Memo		
Photography	Memo		
Void	Yes/No	Selected if entry is a mistake	

7. [NATURAL]

Field	Options	Definition	Reference
Natural_ID^	Autonumber	Primary key field	
Natural_Number	Text		
Context_ID	Autonumber	Relation to Context table	
Name_1	Text		
Name_2	Text		
Geological_Type	Chert Flint Quartz Other		
Possible_Raw_Material	Yes No Indeterminate N/A		
Length_-_mm	Number		
Width_-_mm	Number		
Thickness_-_mm	Number		
Weight_-_g	Number		
Rotundity	Very Angular Angular Sub-angular Sub-rounded Rounded Well rounded		Westman 1994
Notes	Memo		
Photography	Memo		
Void	Yes/No	Selected if entry is a mistake	