In search of Hindsgavl: experiments in the production of Neolithic Danish flint daggers

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Few chipped stone artefacts from prehistory were as technically complex as the flint daggers of Late Neolithic Denmark. Here Michael Stafford present a study that examines, through experimental archaeology, many aspects of dagger production.

Key-words: Denmark, Neolithic, Bell Beaker, Bronze Age, flint dagger, reduction, craft specialization

This study presents a project which explored the complex production technology of Danish flint daggers of the 'Hindsgavl' type. Whereas the chronology and variation in the Late Neolithic flint dagger sequence are widely understood, the complex lithic technology used to create flint daggers is relatively unexplored. This paper discusses the technology of the most complex and arguably most spectacular of the dagger forms, the type IVe dagger of the 'Hindsgavl' or stitched type (Lomborg 1973).

The main thrust of this article is the importance of innovation to the development of flint dagger technology. Although technological precursors to dagger production were present as far back as the Early Neolithic, unique technological innovations were necessary for the successful production of certain dagger forms. Driven by social and economic demands, these precursors and innovations coalesced in Denmark during the Late Neolithic to produce what are likely the most technologically complex chipped-stone tools found anywhere in the world during prehistory.

The chronological and typological scheme

The first flint daggers in Denmark appeared during the Late Neolithic, at the juncture of the Single Grave and Bell Beaker cultures. Dagger production extended into the Early Bronze Age, ending shortly after 1600 BC. Work by Lomborg (1973a) and more recently by Rasmussen (1990) has effectively illustrated the variation in dagger forms and their associated temporal relationships. Lomborg identified six distinct dagger forms, all having chronological and/or geographical significance (FIGURE 1).

The emergence of flint dagger production in south Scandinavia is considered to be in response to an influx of metal daggers from central Europe near the close of the 3rd millennium BC. West European Bell Beaker copper daggers are generally considered inspirational templates, both stylistically and ideologically, for the production of Danish flint daggers (see Brønsted 1960: 322–3 for several comparative samples; FIGURE 2). Evidence for a prestige-based social structure among Denmark's west European neighbours offers a parallel to the emerging differentiated social systems in many areas of Denmark near the end of the Neolithic. The fact that imported metal daggers were copied in flint on such a large scale in such a short period is testament indeed to the significance of novel foreign metal goods in Late Neolithic Danish culture (Vandkilde 1993: 147).

Flint daggers have been recovered from a variety of contexts in Scandinavia, including votive caches, grave offerings, settlements and, most frequently, as unassociated stray finds. Although flint daggers are known from all areas of Denmark, the highest concentration is found west of the Great Belt, particularly in

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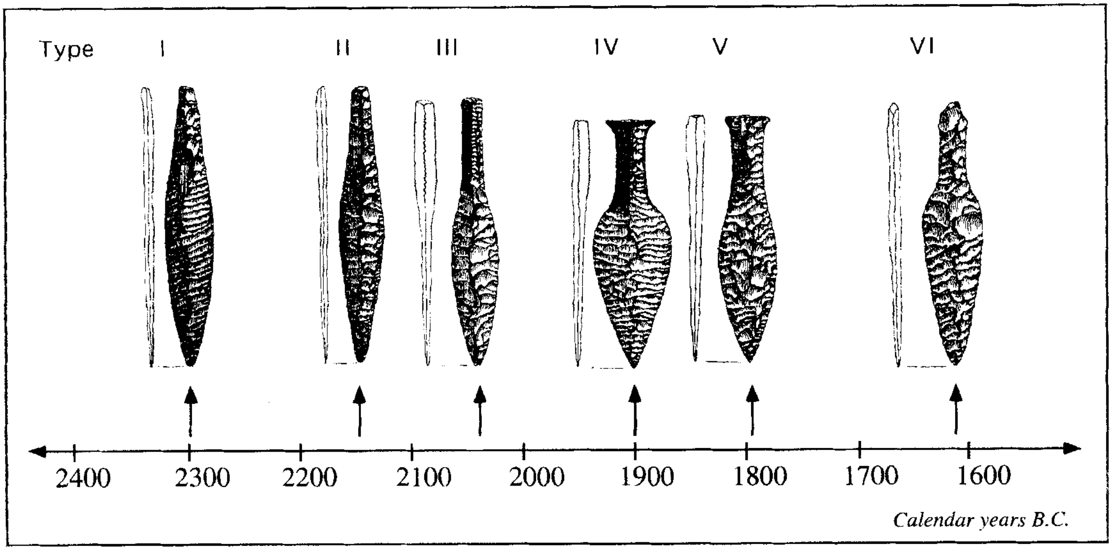

FIGURE 1. *Chronological and typological change in Danish flint daggers. (Drawings adapted from Petersen 1993.)*

northern Jutland. This concentration, particularly in regard to early lanceolate forms, probably reflects specialized dagger production centred around large-scale flint mining at places like Bjerre, near Limfjorden (see Becker 1993). The availability of good quality flint in considerable size made these areas ideal for a craft industry which eventually saw Danish flint daggers travel as far north as Norway (Ebbesen 1993:125).

Beyond the presence of generous flint resources, a rapid population expansion in northern Jutland, particularly in Thy, led to the establishment of a dense population base by the Early Bronze Age (Jensen 1993: 133). Thus, while it is likely resource availability was a key component to the establishment of dagger production centres, so too was a growing population base of eager consumers. Intense economic demand coupled with virtually limitless raw material may help explain the rapid development of such a complex technology.

Many dagger types have sub-variants based on outline form, although the significance of this remains somewhat unclear. Some inter-type variation probably reflects differential resharpening intensities or use (the so-called 'Frison effect'; Jelinek 1976: 21), but typologically based distribution differences for some sub-types may reflect group-based style zones within individual dagger forms. Such an inference is not entirely implausible, considering the regional artefact style zones known from earlier in the Neolithic in regard to both pottery and polished flint axes (Madsen & Petersen 1984: 96; Nielsen 1985: 114). A further explanation, that of differential reduction strategies during production, is impossible to evaluate at present given our nearly complete lack of production-site data for many dagger varieties, including the type IV.

Type IV daggers: the world's most complex stone tool form?

Type IV daggers are characterized by broad, leaf-shaped blades with tapering handles, a squared base or 'pommel', and a pressure-flaked handle with a seam-like appearance on the lateral handle margins and median. Some subvarieties have a ground and pressure-flaked blade, resulting in the elegant parallel flake patterns common to the earlier type Ic lanceolate form. Lenticular transverse cross-sections are common to type IV dagger blades, and handles are either triangular or diamond-shaped in transverse section. A rare subvariant, the type IVf, has a square-section handle, much like that of a quadriface flint axe.

Based on the earlier work of Sophus Müller (1902), Lomborg separates type IV daggers into six letter-designated sub-types based on edge outline, handle cross-section and surface finish (Lomborg 1973: 32–63). The most famous of the Danish daggers, the bog patinated dag-

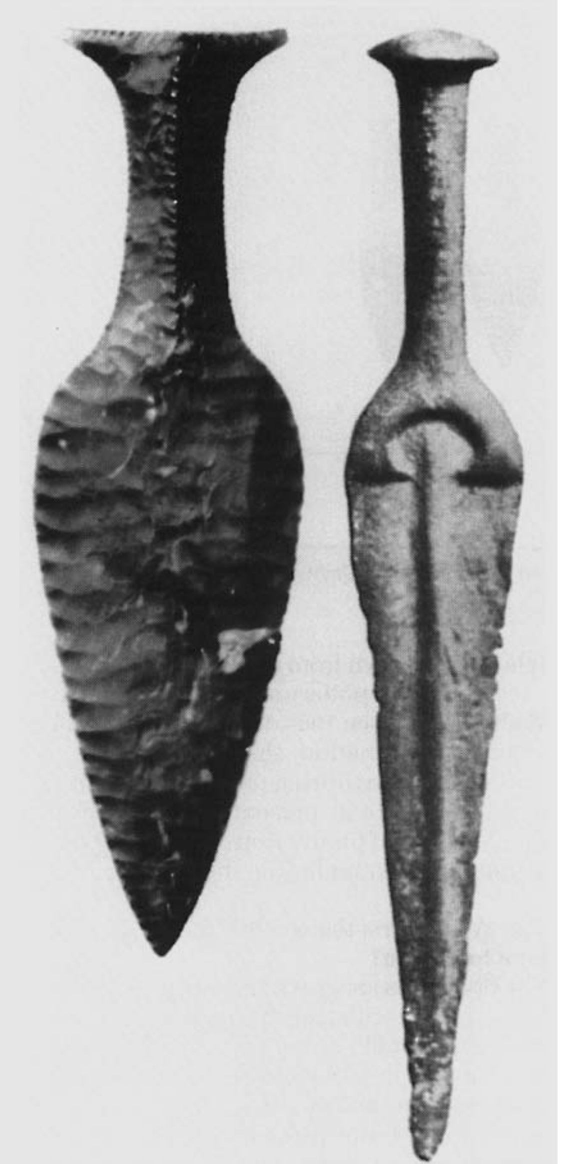

FIGURE 2. *Type IVe flint dagger from Hindsgavl, Denmark (left), and a rounded-shoulder bronze dagger common to the Únětice culture of Germany and Poland. (Danish National Museum photos.)*

ger from the town of Hindsgavl on Fyn, is of the IVe variety (see FIGURE 2, left).

Type IV daggers are known from virtually every area of Denmark (FIGURE 3). Lomborg lists 270 type IV flint daggers from Danish museums in 1973; however daggers in private collections and more recent finds make this figure a fraction of the actual total.

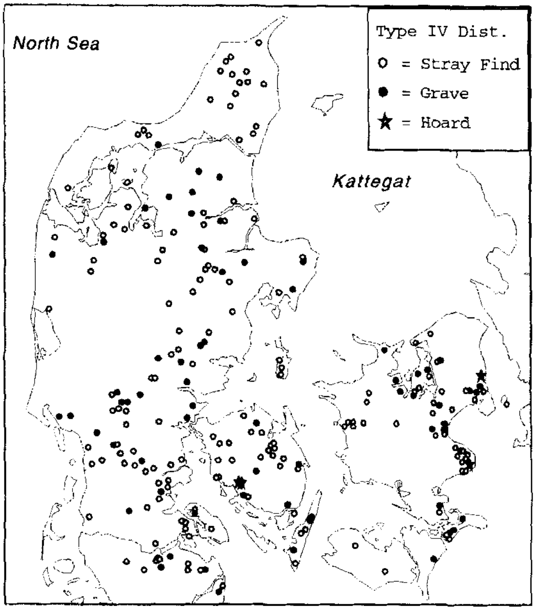

FIGURE 3. *Cumulative distribution of type IV flint daggers in Denmark. (Data after Lomborg 1973.)*

The experiments

Type IV dagger production is difficult to analyse because few sites exist where these daggers were produced. Whereas several locales are known for the production of percussion preforms or lanceolate dagger types, sites with debitage from stitched daggers have proven illusive. Thus, basic information relative to the production of stitched daggers in an emerging system of Late Neolithic craft specialization is lacking. We have no idea, for example, of the time necessary to create a stitched dagger, of what tools might have been used or what the production event might look like in terms of debitage. All of these issues are critical to developing an understanding of the role flint daggers played in the Late Neolithic economy, and specifically, how dagger production varied through time and space in the context of a south Scandinavia craft network.

Following a period of study on original type IVe daggers at the Danish National Museum in Copenhagen (both the finished pieces and the few preforms), a hypothesized reduction sequence was formulated through trial and error using a series of developing steps, or reduction 'stages' (Magne 1988:2). The end goal of this process was the successful production of a series of typologically accurate type IV dag-

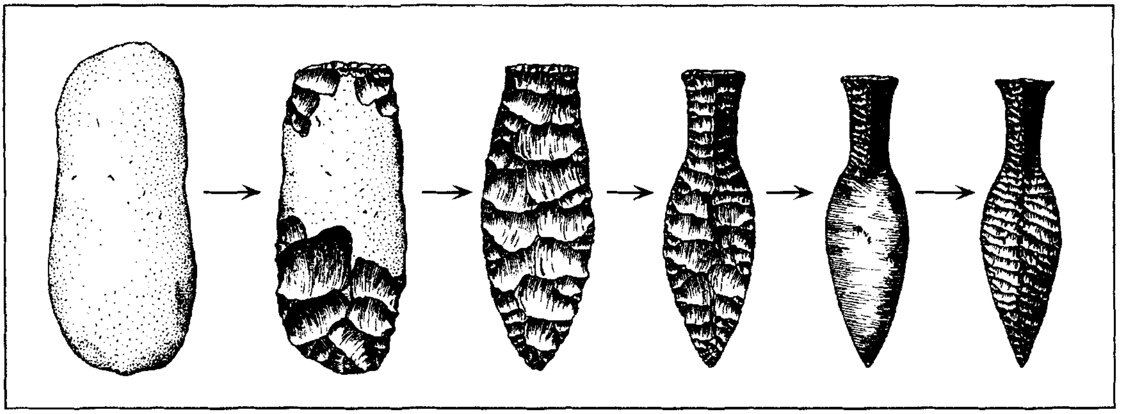

FIGURE 4. *Hypothesized reduction stages of type IV daggers.*

FIGURE 5. *Two of the type IV replicas made in this study.*

gers in Danish flint using only tools available during Late Neolithic time. Furthermore, it was decided that the resulting replicas must be of workmanship similar to the best-quality originals in order to encompass the widest possible range of variation. Stages (FIGURE 4) developed during these experiments were:

1 Procurement of suitable raw material.
2 Production of a bifacial preform.
3 Refinement of the bifacial preform, tapering of handle area, and establishment of a square base (pommel).
4 Formation of a distinctive ridge on the handle median.
5 Stitching the resulting median ridge and grinding the blade.
6 Pressure flaking the blade over the grinding and addition of the side and pommel seams.

Following the refinement of the various reduction stages, a series of 30 type IVe daggers were produced in Danish flint over a period of one year (FIGURE 5). This work serves as the basis for the following discussions.

The tools

The ability to produce an accurate replica, and hence applicable technological inferences, hinges on the use of period-appropriate tools for the production experiments. These experiments used tools of antler and stone as percussors, and pieces of coarse sandstone as abraders and grindstones (FIGURE 6).

An intriguing issue relative to all stitched daggers (types III and IV respectively) is the possible role of metal fabricators for flint working. Although metal knapping tools would have limited technological advantage for the preparation of the percussion preform, the experiments found that pressure flakers tipped with copper or soft bronze are ideal for the detailed stitching on the handle median ridge and lateral margins.

The use of metal to chip stone in prehistoric contexts is relatively rare. It has been argued that material traces left on the platforms of chert blades from prehistoric Harappan sites in the Indus were the result of using a metal punch (Anderson-Gerfaud *et al.* 1989: 446). On the basis of his experiments with the production of Egyptian Gerzean flint knives, Kelterborn has suggested that copper was employed by stone-tool craftsmen for the final pressure flaking over a ground preform (Kelterborn 1984: 441). Finally, in an example from the American Upper Midwest, Whittaker & Ramano (1996) have identified several prehistoric copper tools which display wear patterns consistent with their use as pressure flakers.

Metal fabricators for flint working are presently unknown from Danish Neolithic sites. It is interesting to note, however, that the first production of metal goods in Denmark using imported ores occurred around 1900 BC, about the same time as the first type IV daggers were being made (Poul Otto Nielsen pers. comm.). The argument can certainly be made that craft specialists, such as the dagger makers, would have had access to quality tools for their work via vast trade networks for the circulation of their finished items. The current lack of metal-tipped flintworking tools in Denmark may reflect either a recovery bias from the lack of dagger production sites or, perhaps more likely, the low visibility of metal tools due to their diminutive size and potential for corrosion.

It is argued here that the detailed stitching present on the handles of some type IV daggers could not have been done without the aid of metal tools. Although the majority of type IV daggers lack the flawless, detailed stitching which typifies the Hindsgavl dagger, numerous type IV daggers are known which display stitching of similar quality. Based on experiments carried out for this paper, it is suggested that such work could not have been done *sans* the aid of metal fabricators.

In order to test this hypothesis, several type IVe preforms were made, and a copper-tipped tool was used for the median ridge stitching on the dagger handles. On some of the replicas, small traces of copper were left on the handle stitching, occasionally visible to the naked eye. Following completion of the experimental daggers, nine type IV Neolithic daggers were selected from the National Museum collections of roughly the same size and subjective quality as the replicas. Both the replicas and the original pieces were given to Helle Juel Jensen of Moesgård for a microwear examination on their stitched areas.

While none of the daggers had microscopic traces of copper on every medial stitch, both the replicas and several originals had what appeared to be traces of metal on their stitched areas (Helle Juel Jensen pers. comm.). Moreover, these patterns occurred in the same areas on both the replicas and the originals, i.e., in the deep negative depression where the tool is placed for the next flake removal (FIGURE 7). Whereas a microwear inspection provides only a visual identification, the similarity of these unique patterns in both form and placement provides at least a preliminary basis to assert that metal-tipped tools may have been used during the production of some type IV daggers. A more thorough microprobe analysis of the same pieces in planned for the near future.

Stages of reduction

A lengthy technical discussion of the intricacies of dagger production is beyond the scope and intent of this paper. Nevertheless, it is con-

FIGURE 6. *Tools used for the production of type IV flint daggers in these experiments. White scale in upper right is 15 cm.*

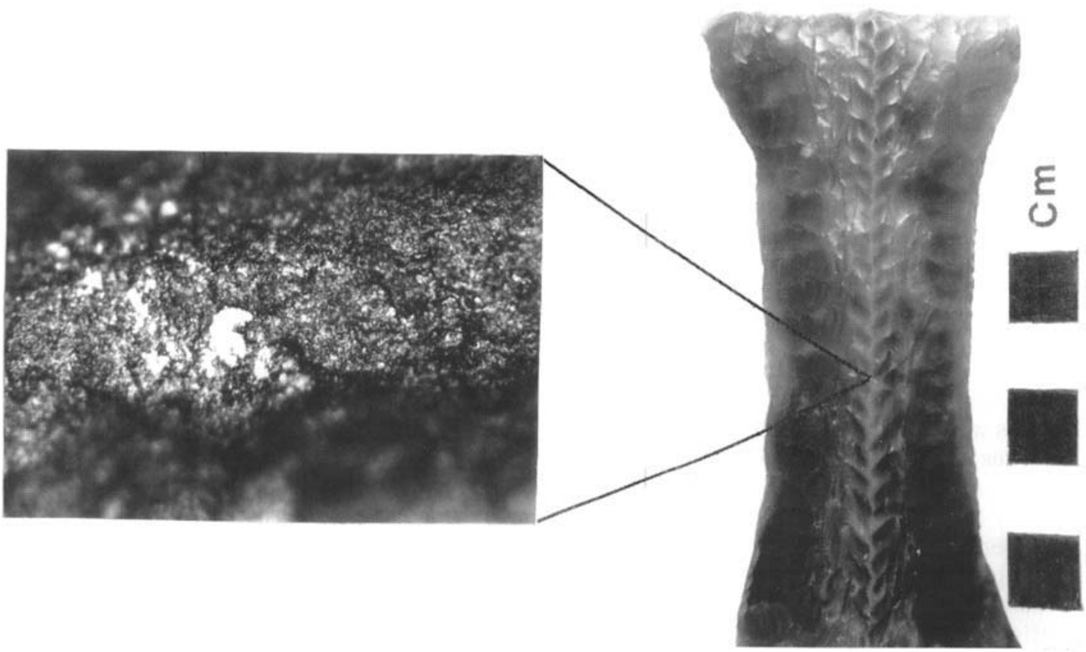

FIGURE 7. *Prehistoric type IV flint dagger with repeating traces of metal on the stitching. Magnification is 100x. Metal appears as bright white in the photograph.*

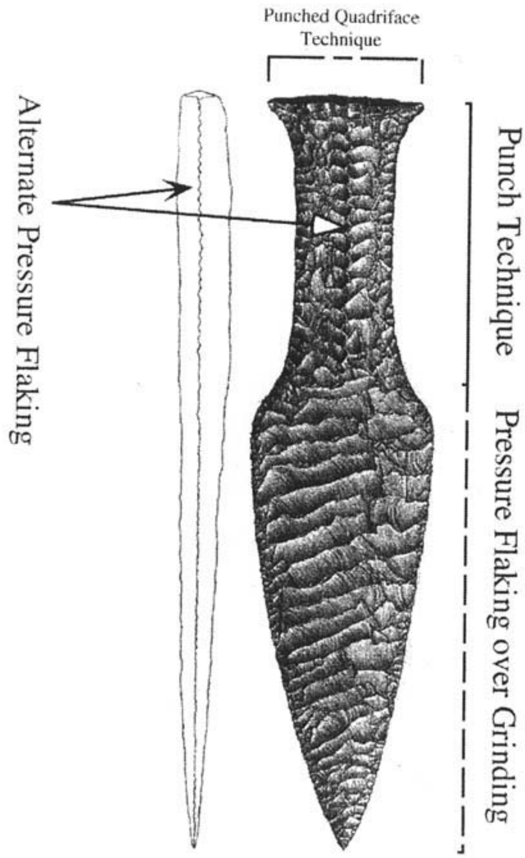

FIGURE 8. *Techniques used in the production of type IV flint daggers.*

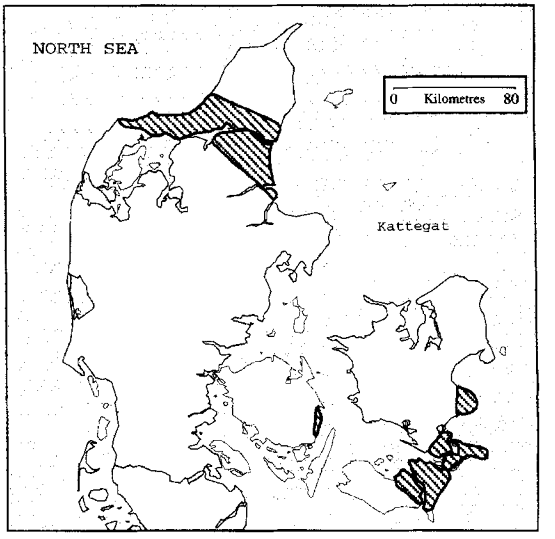

FIGURE 9. *High density deposits of dagger-quality flint in Denmark.*

sidered useful to provide an overview of the dagger production process and offer some comments on key technical elements. The most fundamental point is that type IV dagger production requires the successful combination of a suite of unrelated technical components (FIGURE 8). As will be discussed later, some of these techniques were present centuries earlier, near the beginning of the Danish Early Neolithic.

Raw material

Obtaining suitable raw material is crucial to successful dagger production. Nearly without exception, original type IV daggers were made of the best quality flint Denmark had to offer. The island of Falster in south central Denmark, the Limfjord Region of northwest Jutland and Stevns and Møns Klint in eastern Zealand are places where dagger-quality flint is available today (FIGURE 9). The selection of high-silica, homogeneous flint, free of inclusions and cracks, is a critical first step in production.

Although a skilled flintworker probably could create a dagger from flint with highly variable geometry, pieces having two somewhat flat sides seem preferable. These experiments utilised flint in a wide variety of shapes. By far the most straightforward reduction events occurred on pieces which had existing lenticular transverse sections and sharp or sub-ovoid lateral edges.

Reduction

Following procurement of suitable raw material, alternating combinations of hammerstones and soft hammer bifacing were used to form a bell-shaped preform. Continued reduction with soft hammer percussion and the squaring of the preform's distal end prepared the preform for the formation of a median ridge on the handle (FIGURE 10). Following the formation of a straight median ridge via use of a punch, the handle median was stitched from the pommel towards the blade using an alternating pressure technique, and the blade was either percussion finished or ground and pressure flaked. The addition of the side and pommel seams completed the work.

It is highly likely that grinding played a major role in the production of the best quality type IV daggers. There are several daggers in the collection of the Danish National Museum which re-

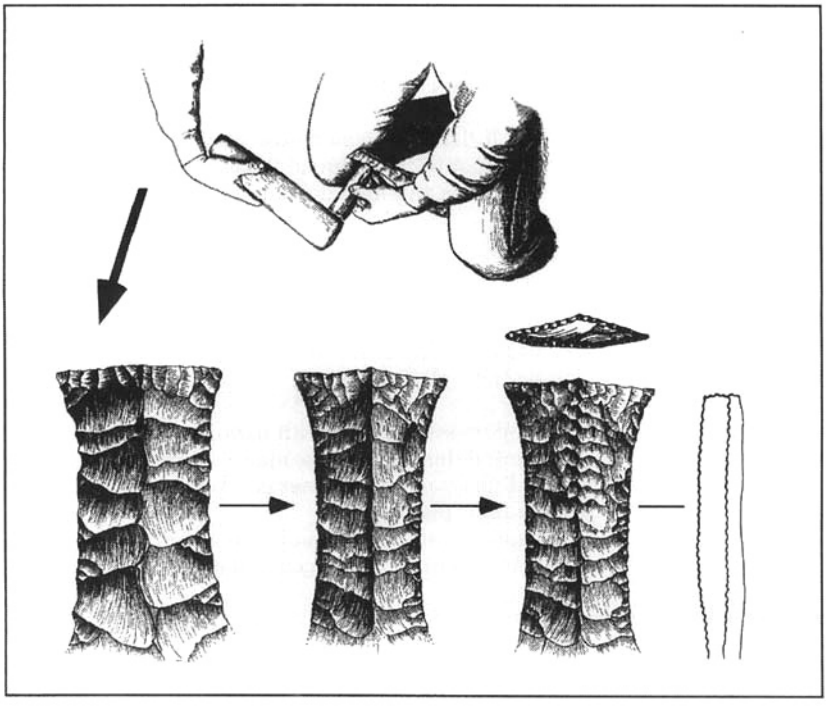

FIGURE 10. *Handle development on a type IVe dagger and production holding position.*

FIGURE 11. *Type IV dagger preform from Denmark with a heavily ground blade. (Danish National Museum photo.)*

tain grinding traces on their blades (FIGURE 11). Experiments for this paper suggest that daggers with the best quality stitching (e.g. straight, long and regular) may have had their median ridges formed all or in part by grinding which was obscured by further reduction. Remarkably regular pressure flakes on the lateral margins of some dagger handles may suggest pressure flaking over a ground surface. Indeed, a grinding-based reduction approach would not be surprising considering the extensive use of grinding common to chronologically earlier type Ic daggers (see FIGURE 1).

Time investment and debitage characteristics

The time investment necessary to produce a high-quality type IV dagger such as those shown in FIGURE 6 is considerable. Of the experiments conducted here, the greatest amount of time spent on any single dagger from an unworked piece of flint was slightly over 22 hours, the least 8 hours, with an average production time of nearly 12 hours, including any grinding. The complete production process typically generates between 3000–4000 individual pieces of debitage larger than one square centimetre.

reduction activity	debitage characteristics
1 preform production	broad, lipped flakes with a low dorsal scar count and large cortified area
2 pommel squaring, percussion blade thinning	small flakes with an obtuse-angle distal termination; thin, broad flakes with faceted platforms and high dorsal scar counts
3 medial ridge formation	small, wide flakes with an accented lip and a lateral facet on a feathered distal termination
4 medial ridge stitching	small flakes with a bulbular ventral face and narrow platforms; some may have traces of metal on their platforms
5 pressure flaking over a ground blade, *handle and pommel seams	long pressure flakes with parallel sides and ground dorsal surfaces; micro debitage with bulbular ventral surfaces and possibly metal traces on their platforms * percussion finish would have high dorsal scar counts with lipped faceted platforms

TABLE 1. *Reduction stages and associated debitage characteristics for type IV dagger production.*

Type IV debitage is best characterized by overall technological composition, that is, assemblages with evidence for several different yet distinctive reduction techniques (TABLE 1). Preform production, while somewhat dependent on the nature of the raw material, can be broadly characterized by massive, soft-percussion bifacing flakes with a high percentage of dorsal cortex. The initial squaring of the pommel during early stage preforming may be detected through the presence of small flakes displaying typical quadriface failure characteristics, e.g. 'overshot' flakes with near-90° angles on their distal terminations (see Hansen 1984 for a more detailed discussion of quadriface debitage).

As reduction continues past the initial preforming stage, lipped flakes with increasingly high numbers of dorsal scars are typical, as are heavily lipped flakes with longitudinal facets on their distal terminations (FIGURE 12). The latter is generated by the punch technique used to form the medial ridge on the handle. Final stage reduction is typified by long, parallel-sided pressure flakes with ground dorsal surfaces. Small pressure flakes with bulbar ventral sur-

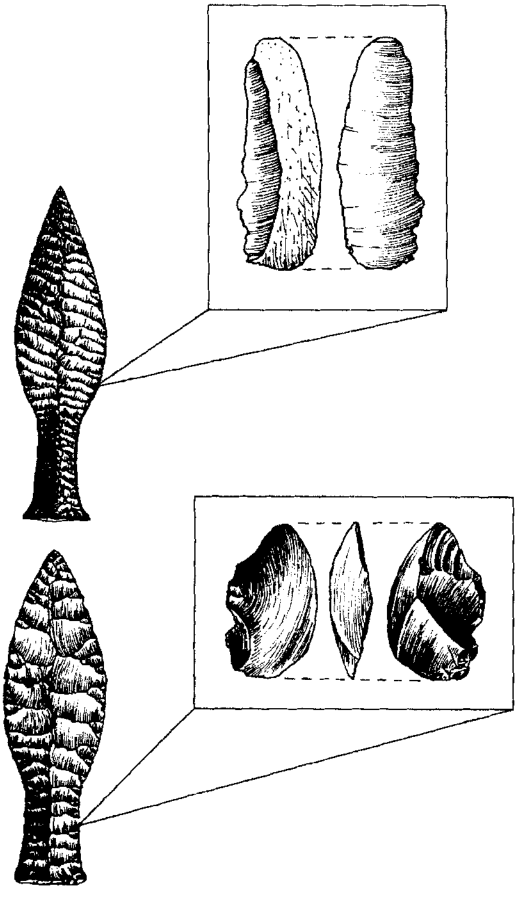

FIGURE 12. *Common flake types associated with the production of stitched flint daggers. Pressure flaking over grinding, top; punching the medial ridge, bottom.*

faces generated by the medial and lateral 'stitching' are also common. These small pressure flakes may occasionally have traces of metal on their platforms from the use of metal pressure flaking implements.

Discussion

Craft specialization in Late Neolithic and Bronze Age Denmark is a somewhat unexplored issue. The term 'specialization' has been used by numerous authors, and typically refers to a group or groups of full-time craftspeople who derive at least a portion of their income from participation in a structured system of goods production and distribution (see Dow 1985; Earle 1987; Rice 1981; Tosi 1984). In light of this definition, there can be little doubt that at least some of the flint dagger makers could appropriately be termed 'specialists'. The technological complexity and time investment of their production mode, widespread distribution of their end products and frequent recovery of these products in status graves all suggest that many of the individuals who produced flint daggers did so to their benefit. The demise of the flint daggers in the Early Bronze Age likely signalled the growing availability of ideologically and technologically superior metal items, forcing an economic reorganization on the part of the remaining dagger producers into other areas of the Bronze Age economy.

One of the most interesting aspects of type IV flint daggers is their role as prestige objects at a time when highly prized metal objects were also present. The emulation of a metal dagger in stone can be considered in two ways:

1. as an effort by specialist flintworkers to create a 'niche' in an emerging market due to declining demand for goods they produced previously (i.e. flint axes), or
2. as an economic response to demands by eager consumers for copies of metal goods they either cannot obtain or afford.

Of these, the latter is probably more viable, and has precursors in other world areas. Production of ceramic bangles in the Indus Valley by 2600 BC has been interpreted as emulation of status bangles for lower-status consumers (Halim & Vidale 1984). While some flint daggers were clearly prestige items due to their recovery in status burials, imported *metal* daggers were probably in the possession of a class of supra-élite, defined either through social standing or by considerable personal resources available for expenditure. The wide range of subjective quality in type IV flint daggers, however, suggests their use in a variety of settings, by a variety of consumers who functioned at a variety of different status levels.

The production of stitched flint daggers involved a skill level which took years of training to acquire, and was probably beyond the abilities of most utilitarian tool makers. It is possible that individual dagger makers passed on their trade through family generations, or that a *group* as opposed to an individual was responsible for producing a single finished piece. While it is not inconceivable that different craftspeople might have specialized in differing stages of dagger reduction, i.e. passing a single dagger amongst themselves for each 'stage', based on these experiments, an overall understanding of the entire production process seems essential to successful dagger production.

With the exception of the highly developed bifacial technique, there are very clear technological precursors which led up to the dagger period. Most notable is the production of square-section flint axes (Hansen 1984). Although square axes and flint daggers are utterly disparate from one another in terms of morphology, the reliance on punch flaking, an alternate flake removal technique and the use of grinding are all technical elements common to both tool types. Like flint daggers, some square-section flint axes were deposited as grave offerings and votive hoards and were probably produced by full-time, skilled craft specialists who invested considerable time in their production (Madsen 1984: 60).

An especially curious technical element relative to both type IV flint daggers and other earlier dagger types is bifacing. With the exception of lance-shaped early Neolithic bifaces called *dolkstaves*, later crescent-shaped flint sickles and small pressure-flaked arrowpoints, there is little bifacial lithic technology in Denmark prior to the dagger period. It is as if a mastery of bifacial technology was acquired in a span of 100 years or less during the Late Neolithic, first emerging by about 2300 BC in the lanceolate type 1 variety. Cultures to the south of Denmark had very modest bifacing technologies during the same period, dispelling the notion that more advanced specialist craftspeople were somehow imported into Denmark for the purpose of dagger production. The considerable demand for a prized tool form coupled with virtually limitless raw material evidently produced a technological advance so rapid as to be instantaneous.

It is likely that type IV preform production took place near primary flint sources because of the flaws, e.g. cracks and voids, common to Danish chalk flint. The key point here is that not just any flint will do for daggers. The extensive Late Neolithic shaft mines in north Jutland and Scania testify to the demand for top-quality Senonian flint. This point becomes even more compelling when one thinks of the vast quantities of flint available on Denmark's beaches without having to dig. Clearly, the demand for high-quality flint was an overriding factor to the dagger makers, either as part of an exchange network with the quarry labourers or as the primary diggers themselves.

Given the amount of grinding used for the production of many stitched daggers, it is likely that late-stage reduction took place near coastal areas with ample supplies of water and sand for the grinding process. This may partly explain why such sites have yet to be located. Denmark's beaches are notorious erosional zones and sites located near them would be easily destroyed or deeply buried.

Given their fairly even dispersal over the Neolithic landscape, the variation in shape of type IV daggers may involve factors other than regional style zones. Style among individual knappers or knapping groups is perhaps a better explanation, although these sorts of inferences are notoriously difficult to extract from the archaeological record. The common feature of the 'stitch' seams on the handle is thought-provoking, however, as this element would seem to have no functional purpose. While it is almost certainly a decorative emulation based on a metal counterpart, the flaring handles of the type IVe go beyond simple adornment, into the impractical realm of making the dagger uncomfortable to hold in the hand in some cases. Although we have some data on the design of the foreign metal daggers of the period, it may be that the stone version sacrificed a degree of functional efficiency in favour of stylistic emulation. Clearly, however, to wrap the handle of a type IV dagger for the purpose of padding would be to obscure the stitch seam, an evidently important feature given the elaborate technological staging which went into its formulation.

Closing comments

This study represents a first effort to analyse the technology of the type IV flint daggers in relation to the available production data, which admittedly are few. Such an endeavour is especially difficult given the lack of sites where these daggers were produced, in effect abandoning a deductive analytical approach in favour of an inductive one.

There is no way at present of knowing for certain if the production stages hypothesized here are accurate; the ability to produce a typologically accurate replica is no substitute for a thorough debitage analysis of archaeological materials, especially relative to complex tool forms. Nevertheless, this study offers a starting-point for exploration of the complex and relatively unknown system of craft specialization in Late Neolithic and Bronze Age Denmark, a system in which stitched flint daggers may have played a significant role.

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