The Spread of Flint Axes and Daggers in Neolithic Scandinavia

Högberg, Anders; Apel, Jan; Knutsson, Kjel; Olausson, Deborah; Rudebeck, Elisabeth

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THE SPREAD OF FLINT AXES AND DAGGERS IN NEOLITHIC SCANDINAVIA

ROZŠÍŘENÍ PAZOURKOVÝCH SEKER A DÝK V NEOLITU SKANDINÁVIE

Anders Högberg – Jan Apel – Kjel Knutsson – Deborah Olausson – Elisabeth Rudebeck

Flint has a limited distribution in the Scandinavian area, natural sources being largely confined to the southern regions. Here, the use of flint for making daggers and polished axes during the Neolithic is widespread and extensive. There is also evidence for mining of flint at Södra Sallerup in southern Sweden and on several sites in Denmark, but flint is available in till deposits as well. There are however a limited number of sites known in the north of Sweden, about one thousand kilometers from the flint sources, where flint axes made of south Scandinavian flint were deposited in settlement contexts. In some cases there is evidence that some of the axes were modified using knapping strategies which are linked to local raw materials such as quartz. In the Late Neolithic we find evidence for extensive movement of daggers made from the south Scandinavian flints.

The goal of the article is to study the distribution of flint as a raw material in Neolithic contexts, concentrating on local and long-distance movement. We begin with a discussion of flint sources and their exploitation during the Neolithic. Thereafter we present three case studies illustrating how the use of flint varied over both time and space.

Key words: Maastrichtian flint, Danian flint, Neolithic axes, Neolithic daggers, flint mines.

1. INTRODUCTION

This paper presents the results of the Swedish national working group in the IGCP/UNESCO 442 project *Raw materials of the Neolithic/Aeneolithic polished stone artefacts: their migration paths in Europe.* The IGCP/UNESCO 442 project aims at defining communication paths for raw materials during the Neolithic/Aeneolithic on the European continent. The national Swedish working group has focused on the Scandinavian peninsula, which is somewhat unique in that natural sources of flint are limited to the southern part. Here in the far north of the European continent, extensive exchange and transport of raw material, both on a small and on a large scale, has been taken place during the Neolithic (*fig. 1*). The aim has been to present a picture of these communication paths, manifested in the transport of flint axes and daggers. These two artefact types form the basis of the extensive specialized Neolithic flint technology complex which resulted in the production of highly elaborated flint objects. The flint axes are the only Neolithic flint artefacts in Scandinavia which were polished in their finished form. The following article begins with sections detailing the availability of flint in Scandinavia and describing evidence for its exploitation du-

	BC
Early Neolithic I	3950-3650
Early Neolithic II	3650-3300
Middle Neolithic A	3300-2700
Middle Neolithic B	2700-2350
Late Neolithic	2350-1700

Fig. 1. Chronological framework (calibrated) for the Scandinavian Neolithic, after *Larsson - Olsson 1997*, partly modified from *Vandkilde 1996* — *Obr. 1.* Chronologické schéma (kalibrovaná data) skandinávského neolitu. Podle: *Larsson - Olsson 1997*, zčásti upraveno podle: *Vandkilde 1996.*

ring the Neolithic. Three case studies, concerning polished flint axes and daggers, are then presented. Examples of local networks of production and distribution are contrasted to movement of finished tools over distances of up to 1000 km (*fig. 2*).

Anders Högberg et al.

2. *FLINT SOURCES IN SCANDINAVIA*

Limestone and chalk deposits containing flint underlie parts of Denmark and Scania (*fig. 3*). These deposits date from the Maastrichtian and Danian ages. In addition, deposits of Ordovician age and containing flint can be found in the Baltic and in minor outcrops in Västergötland, Sweden (*fig. 4*). In some instances mining activities during prehistory have been aimed exploiting these (see *below*). However, glacial action and erosion have also "mined" them, resulting in the numerous flint nodules which today litter the ploughed fields of Denmark and Scania and the beaches of Denmark, Norway and Sweden. These sources, both primary and secondary, provided a well-stocked larder for prehistoric - and indeed historic (*Högberg 2000*; *Knarrström - in press*) - flintknappers in southern Scandinavia (*Madsen 1993*,126).

2.1. Primary deposits of Danian flint

The Danian limestone forms the bedrock of all of southwestern Scania (*Magnusson et al. 1963*, 327). In Denmark, Danian limestone lies near the surface in northern Jutland and on northern and eastern Zealand (*fig. 3*). Danian formations can also be found in northern Germany, Holland, and southeast England. Unlike the Maastrichtian chalk, which only contains flint in the upper five to six meters, the Danian limestone is very rich in flint (*Thomsen 2000*, 19-20). Archaeologists, following a terminology developed by the Danish archaeologist *Carl-Johan Becker* (*1988*), generally distinguish three types of Danian flint: matte Danian flint, clear Danian flint, and bryozoan flint (*Petersen 1993*, 26).

Matte Danian flint can be found overlying the chalk layers at for instance Stevns Klint, in southwestern Scania, and at Nye Kløve in northern Jutland (*fig. 3*). This flint is light gray and homogeneous, with a matte flaking surface and a coarse structure. From a knapper's perspective, matte Danian flint is tough and not easily knapped (*Petersen 1993*, 26; *Thomsen 2000*, 31-32).

Clear Danian flint is gray to light gray. It is generally full of flaws and it flakes irregularly. Another distinguishing feature is the thick cortex with silicified limestone in some spots (*Becker 1988*, 47). This flint is seldom used to make larger objects (*Petersen 1993*, 26). According to Thomsen, some varieties of clear Danian flint have been formed in fine-grained limestone, making them hard to distinguish from Senonian flint. The only differences are that this type of clear Danian has a thin (2-3 mm) light-gray flint band between the darker core and the cortex and that the Danian flint is somewhat coarser and has a duller flaking surface than Senonian flint (*Thomsen 2000*, 31-34).

The bryozoan limestone is visible at Stevns Klint, Karlby Klint and Bulbjerg (*fig. 3*). In eastern Funen, near Klintholm, flint from bryozoan layers outcrops at the surface (*Petersen 1993*, 26; *Thomsen 2000*, 31-32). Gry and Søndergaard state that some of the bryozoan limestone contains up to 75 % flint (*Gry - Søndergaard 1958*, 15-16). However the limestone in northern Jutland contains very little flint, according to *Thomsen* (*2000*, 32). Bryozoan flint is dark gray and contains irregular patches of lighter flint. Characteristic is the microscopic traces of bryozoans, which can help to identify this flint type. Cavities and patches of chalk are common (*Nielsen 2000*, 223; *Petersen 1993*, 26; *Thomsen 2000*, 32).

At Elinelund, south of Malmö, limestone deposits containing Danian flint are visible at the surface. This Danian flint is gray to dark-gray in color and has a rough limestone cortex (*Högberg 1997*, 36). In the Klagshamn area of western Scania, near Limhamn (*fig. 3*), there is a deposit of Danian flint 15 m under the surface in the limestone. This flint occurs as irregular nodules 20-50 cm long and 20-30 cm thick. The flint is gray to gray-black and has a coarse structure and a dull flaking surface. The cortex is thin and white. Although the flint's coarse structure makes it difficult to knap, Klagshamn flint was used for knapping "bricks" to line mills until the 1940s (*Högberg 1999*, 185). However as it was probably not visible at the surface it has not been available to prehistoric people.

2.2. *Primary deposits of Maastrichtian flint*

The Maastrichtian chalk of northwestern Europe was deposited in an east-west running seaway from the Cretaceous Atlantic to Poland (*Johansen 1987*, 4). In southern Scandinavia the Maastrichtian flint of Senonian age is generally dark and glassy and it is more fine-grained than Danian flint. Modern flintknappers characterize Senonian flint as among the most easily knapped of any known flints. Chalk of early Maastrichtian age can be seen at Møns Klint, in the central parts of the Thisted structure in the Limfjord area of northern Jutland, and in the ice-transported slabs in the Södra Sallerup region. Late Maastrichtian chalk with flint occurs at Stevns Klint and in many places in northern Jutland (*Gry - Søndergaard 1958*, 8; *Seitzer Olausson et al. 1980*; *Thomsen 2000*, 28). An archaeological classification recognizes four main varieties of Maastrichtian flint: Zealand Senonian, Jutland Senonian, Falster flint and Kristianstad flint.

Zealand Senonian occurs in chalk layers at Stevns and Møn. Even though it has been named Zealand flint, it can also be found in northern Jutland in the Thisted structure - for instance at the Hov flint mines (see *below*). Zealand Senonian flint has a thin chalky cortex. Smaller nodules are black while larger ones are dark-gray to

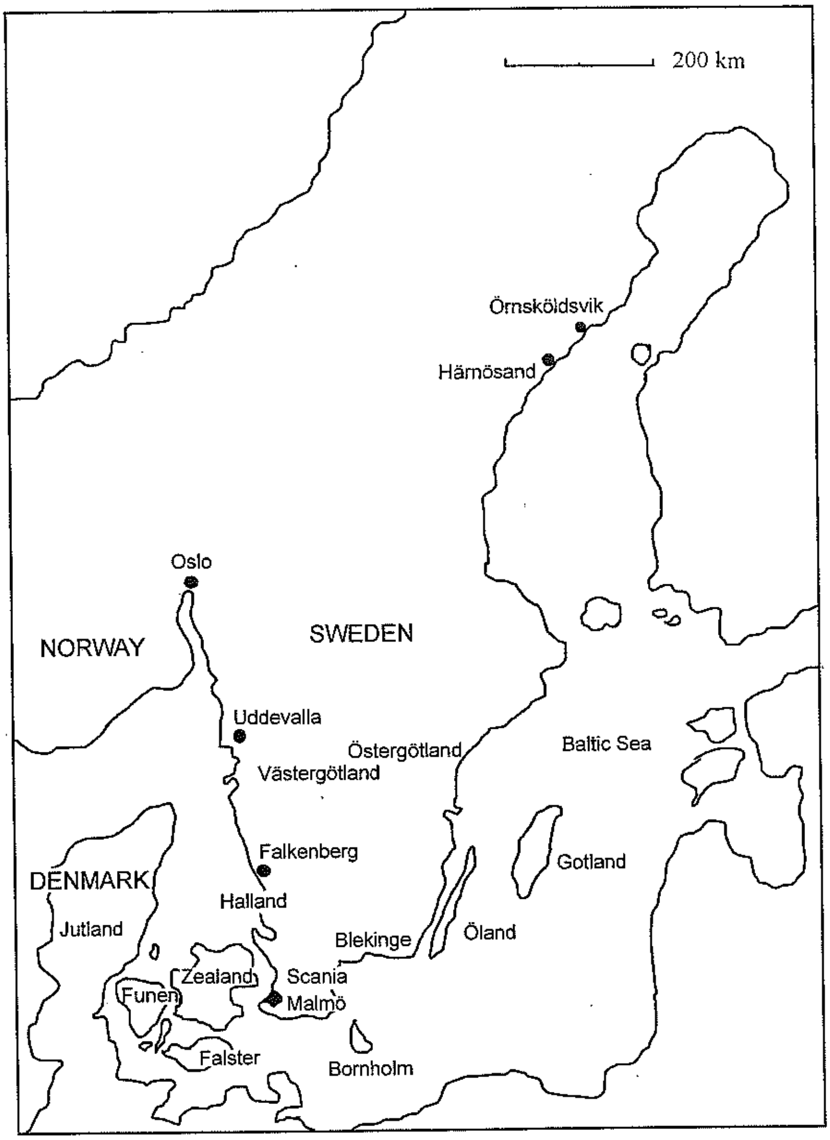

Fig. 2. Map of Scandinavia, showing places mentioned in the text. Varberg is located in the Halland area. Närke is located north of Östergötland. Hasselø and Lolland are located near the islands of Falster, Funen and Zealand. The distance between Malmö and Örsköldsvik is *c.* 1000 km — *Obr. 2.* Lokality zmíněné v textu. Varberg: oblast Hallandu; Närke: severně Östergötlandu; Hasselø, Lolland: poblíž ostrovů Falster, Funen a Zealand. Vzdálenost mezi Malmö a Örsköldsvikem činí ca 1000 km.

medium-gray and can contain lighter patches. There is a sharp limit between flint and cortex (*Becker 1988*, 46; *Petersen 1993*, 22).

Jutland Senonian occurs in chalk deposits in northern Jutland. However the Jutland chalks contain much less flint than in Zealand (*Berthelsen 1993*, 87; *Becker 1988*, 124; *Gry - Søndergaard 1958*, 8-9). Jutland Senonian flint is gray or dark-gray and it has a porous cortex. Numerous white specks in the darker flint characterize a particular variety of this flint. This speckled flint can be seen in the Limfjord area and at Aalborg (*Becker 1988*, 46-47; *Petersen 1993*, 23-24).

Falster flint, also called "blue Falster" or "striped Falster", is a superior quality chalk flint of Senonian age. It can be found in chalk outcrops at Hasselø on southern Falster and on eastern Lolland. This flint is fine-grained and homogeneous, with stripes swirling gracefully just under the cortex. Falster flint occurs in nodules up to a meter long (*Madsen 1993*, 126; *Petersen 1993*, 23).

Kristianstad flint is less glassy than the other Maastrichtian flints and it occurs in deposits of Senonian age in the Kristianstad area. It is dark-gray or black and speckled with numerous gray spots of limestone. Nodules may have a thick, irregular cortex of more or less silicified limestone. They are irregular in shape, 20-60 cm wide and 20-40 cm thick (*Gry - Søndergaard 1958*, 25; *Högberg 1997*, 37; *Thomsen 2000*, 31). Kristianstad flint is tough and less tractable than Zealand Senonian, according to experiments conducted by *Högberg* (*1997*).

2.3. Upper Cambrian/Lower Ordovician flint at Kinnekulle

Laufeld (*1971*) and *Königsson* (*1973*) mention flint in Upper Cambrian layers in Västergötland where it outcrops in the chasmops limestone at Kinnekulle (*fig. 4*) (*Westergaard 1943*, 75; *Werner 1974*, 14). This is not true flint, but silicified limestone (*pers. com. Ulf Sivhed - Geological Survey of Sweden, Lund*). Westergaard describes the limestone as green or blue-gray, hard and dense. Werner notes that flint has been found in the Upper Cambrian layers at Östergötland and Närke, although she does not state whether the flint layers outcrop anywhere (*Werner 1974*, 14).

2.4. Secondary flint sources

The primary flint sources described above have been exploited *in situ* by prehistoric people to a varying extent, either through conscious mining efforts or by taking advantage of flint layers eroding out of cliff faces such as occurred at Fornœs on the east coast of Jutland (*Glob 1951*). However glaciations, erosion, and ice transport have been important factors in "mining" these and other flint sources, making a "cocktail" of different flint types available in the glacial tills and along the beaches of Denmark and Sweden (*Madsen 1993*; *Nielsen 1993*). The flints in the till, although apt to be of poorer quality than freshly mined flint, were numerous. *Gry - Søndergaard* estimate that flint nodules make up 10 to 50 % of all stones in Danish soil (*1958*, 5). Becker notes, however, that secondary occurrences of flint are less frequent in northern Jutland than in southwestern Denmark and Scania (*Becker 1993*, 121).

The Thisted area in northern Jutland has a complex geological history. In an area of a few kilometers one can find all the different types of flint which occur in Denmark, with the exception of the coarse bryozoan flint. While this mixing was probably a positive factor for stone age peoples, it makes it very difficult to provenance Danish flints - only the bryozoan flint from Klintholm can be identified with any certainty (*Thomsen 2000*, 35). Zealand Senonian flint can be found over most of Denmark. Danish Falster flint, originating on Lolland or Falster, occurs in clays along the Zealand coast, along the southern and eastern Jutland coasts, and in the flint-rich east Jutland moraine (*Madsen 1993*, 126). Kristianstad flint occurs in till deposits in eastern Scania and Blekinge but also in Jutland, and ice transported nodules occur on Zealand and Bornholm (*Knarrström 1997*, 9; *Madsen 1993*, 26).

At Sibbarp, in the south of Malmö, a several kilometre long postglacial Littorina beach ridge called Järavallen follows the west coast. The beach ridge was originally about 1-1.5 meters high and about 100-200 meters wide, although today the ridge is heavily damaged. To the south the upper parts of the beach ridge consist on the whole entirely of flint nodules. These nodules are irregular, small and heavily affected by beach rolling. However, it is possible to find nodules suitable for axe manufacturing in this huge amount of flint (*Kjellmark*

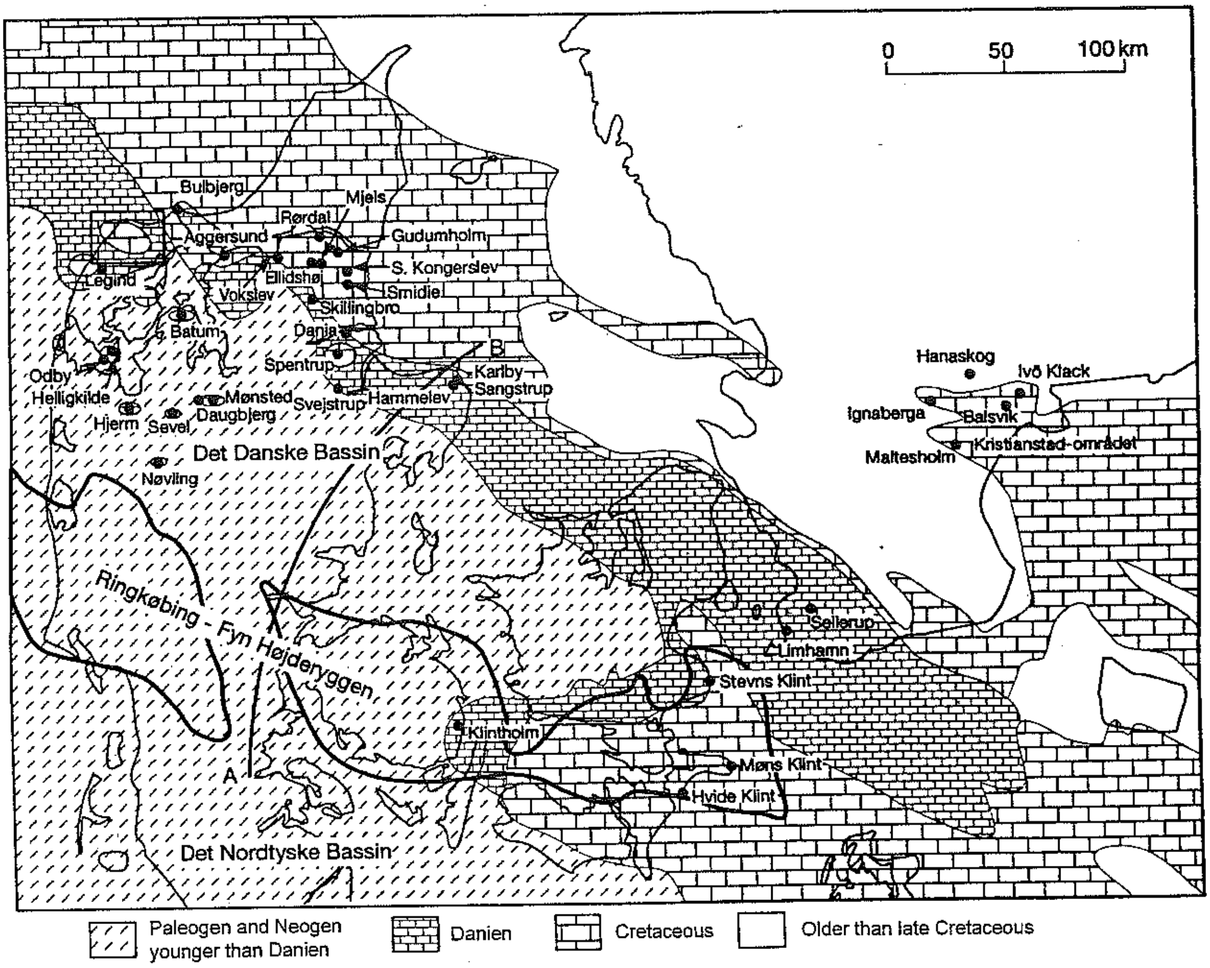

Fig. 3. Geological map showing the bedrock of Denmark and Scania, with the Quaternary deposits removed. The Aalborg area is in northern Jutland near Mjels and Ellidshøj. The mines at Skovbakken are located here. Thisted and Nye Kløve are south of Bulberg. The mines at Hov, Bjerre and Hillerslev are located in this region. After *Thomsen 2000* — *Obr. 3.* Geologická mapa podloží Dánska a Skanie bez kvartérních uložení. Oblast Aalborgu se nachází v severním Jutsku poblíž Mjels a Ellidshøj stejně jako doly ve Skovbakken; Thisted a Nye Kløve leží jižně od Bulbergu, kde jsou situovány také doly v Hov, Bjerre a Hillerslev. Podle: *Thomsen 2000*.

1905). The flint consists of two kinds of Danian flint (*Thomsen 2000*), one of them being the same type of the local Danian flint as that from the primary sources at Elinelund. Sporadic nodules of Maastrichtian flint occur as well (*pers. com. Anders Högberg*).

Erratic Cretaceous and Danian flints occur along the entire Swedish west coast and also along the Norwegian coast as far north as Andøya in Vesterålen (*Becker 1993*, 126; *Lidmar-Bergström 1982*, 98; *Petersen 1993*, 32). Most of the flint is found no more than 10-15 km from the present shoreline (*Lidmar-Bergström 1982*, 102; *Werner 1967*, 236). Both *Werner* (*1967*; *1974*) and *Lidmar-Bergström* (*1982*) have conducted field surveys to determine the amount and location of flint along the Swedish west coast. They have found that the richest flint localities lie roughly between Uddevalla and Falkenberg. In the Varberg area the content of flint in beach deposits can reach 10 %, according to *Påsse* (*1992*, 275). The number of flint localities decreases with increasing altitude. In southern Halland there is flint above the marine limit, while further north the flint does not exceed this limit. According to *Lidmar-Bergström* and *Johansson* (*1971*), only coarse types of flint of Senonian age occur above the marine limit and in non-rolled deposits. These "Halland flints" resemble Kristianstad flint (*Knarrström - in press*) and appear to be grainy and tough. These characteristics, combined with the effects of weathering, would have made these flints unattractive for knappers. Lidmar-Bergström and Johansson argue that these Senonian flints derive from now completely eroded former outcrops of Cretaceous rocks in Halland. According to Påsse, the flints below the marine limit (of Danian age) were transported by glacially derived icebergs which were produced in the southern Kattegat region (i.e. western Scania and eastern Zealand) and drifted northwards to Halland and Bohuslän (*Påsse 1992*, 277).

Another type of flint available in the south Scandinavian moraine is ball flint. This occurs as heavily rolled rounded nodules up to the size of a fist. These have originated in Upper Ordovician layers which run along the Baltic Sea floor from Öland to Estonia (*fig. 4*). Ball flint was formed in glacial outwashes and is most often found in gravel ridges or on beaches on the Scanian east coast and on Bornholm. This type of flint was used fairly often in southeastern Scania during the Stone Age, although its small size limits what can be made from it (*Knarrström 1997*, 11; *Strömberg 1982*, 60; *Tralau 1974*, 247). The Swedish islands of Öland and Gotland also have numerous small nodules of ball flint, transported to Öland and Gotland by Quaternary ice (*Königsson 1973*, 48; *Laufeld 1971*, 96; *Tralau 1974*, 247). Thorsberg notes that the Gotland ball flint resembles the flint from Kinnekulle, although the Gotland variety has a greater variation in color. Nodules are 5-15 cm and usually round. The cortex is limestone and there can be a small number of inclusions in the form of fossils. According to Thorsberg, the Ordovician flint is an excellent raw material which requires less force to knap than is needed for the south Scandinavian chalk flints (*Thorsberg 1997*, 51).

An unusual occurrence of secondary flint can be found at Södra Sallerup in southwestern Scania. The flint mining area at Södra Sallerup, also referred to as Kvarnby or Ängdala, has been an important flint source during most of prehistory. Senonian flint of the same type which is found on Zealand occurs embedded in chalk slabs deposited by the ice at this site (see *below* and *Rudebeck 1987*).

Finally, brief mention must be made of a possible flint source in the northern Baltic, published by *Königsson (1973)*. He notes that limestone occurs in the Baltic to a point halfway between Härnösand and Örnsköldsvik (*fig. 2*). Therefore it is possible that there is flint of local Baltic origin along the coast of Norrland, although in that case the nodules would have been quite small (*Königsson 1973*, 51).

2.5. Flint sources: conclusions

This brief summary of the primary and secondary flint sources in Scandinavia has shown that, while flint was readily available in large parts of Denmark and Scania, the only flint to be found north of here was in secondary rolled beach deposits. It is difficult to judge how easily available flint would have been to the prehistoric populations of southern Scandinavia. Flint eroding from chalk cliffs at for instance Stevns Klint or in the Limfjord area would have been easily visible (*Nielsen 1997*, 266). However in a forested landscape flint nodules in till deposits would have been less visible than they are in the ploughed landscape of today (*Knarrström - in press*). Tree-falls or the activities of moles or wild boars could have brought flint nodules to the surface, and vegetational clues to the presence of lime-rich soils under the ground cover might lead to flint finds. Obviously in some periods and regions people were motivated to expend the effort required to actively mine for the good quality flint which was available underground. Whether this motivation was due to economic needs or to ritual behavior, or perhaps both, is still an open question.

Deborah Olausson

3. FLINT EXTRACTION IN SOUTHERN SCANDINAVIA DURING THE NEOLITHIC

This section will give a general overview of Neolithic flint extraction sites in primary deposits in south Scandinavia and a more detailed description of the mining area in the large secondary deposit at Södra Sallerup.

3.1. Flint mining in Denmark

The rich outwash deposits of Danian and Maastrichtian flint on the coasts of Denmark were utilised during the Neolithic. Flint may have been extracted from the chalk bedrock at these and other coastal sites, but as yet there is no evidence of mining here, probably because the sea has eradicated all possible traces (*Petersen 1993*, 32). Apart from these sites, there are two main areas in Denmark where flint was mined during the Neolithic;

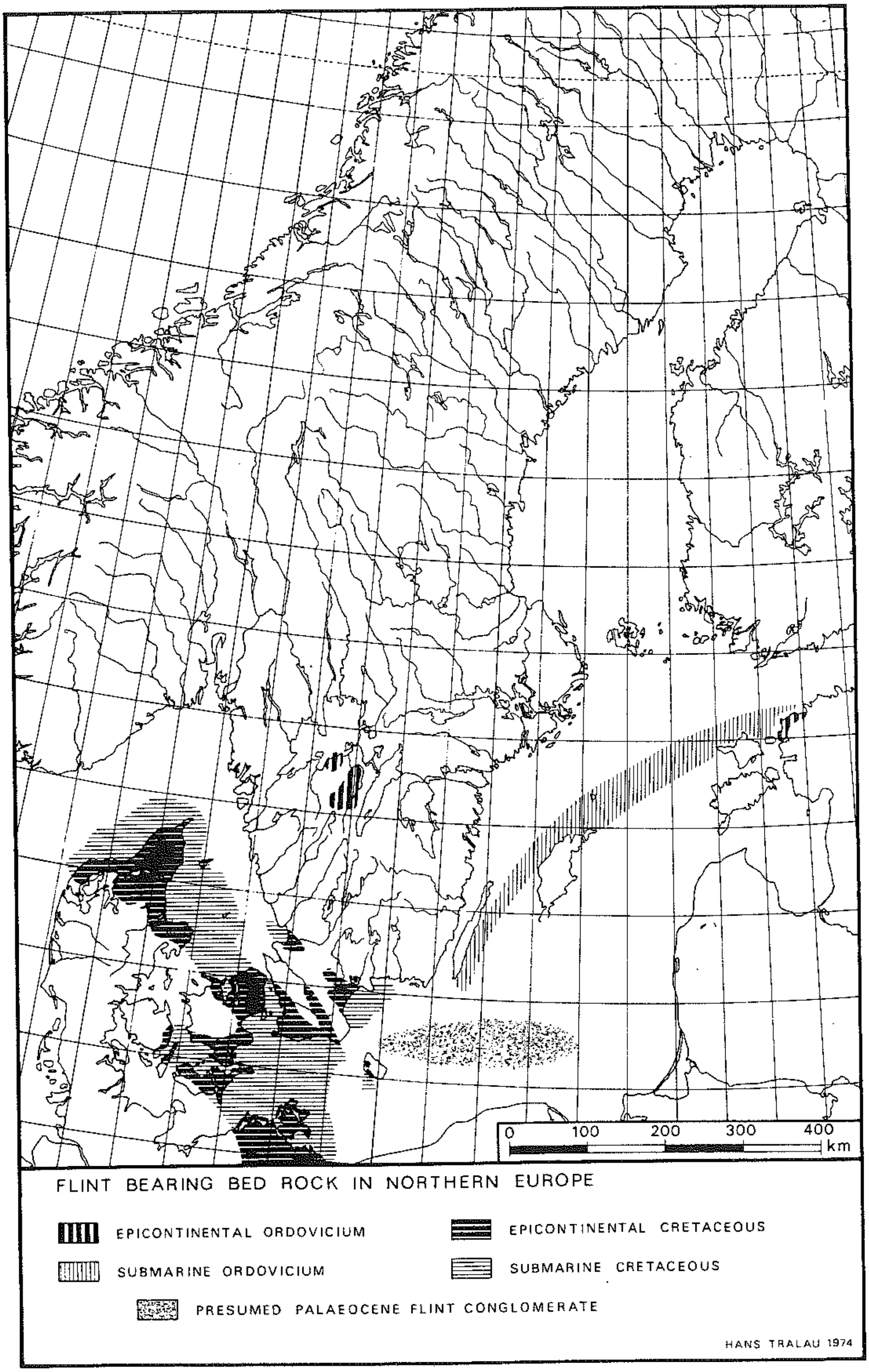

Fig. 4. The location of bedrock containing flint in northern Europe. The outcrops of limestone at Kinnekulle are marked as the Epicontinental Ordovicium in Sweden. After *Tralau 1974* — *Obr. 4.* Zdroje pazourku v severní Evropě. Zdroje vápence v Kinnekulle jsou ve Švédsku značeny jako epikontinentální ordovik. Podle: *Tralau 1974.*

both located in northern Jutland. To the northeast is the Aalborg area with the Skovbakken site and to the northwest is the Hov - Bjerre - Hillerslev area (*fig. 3*).

The mines at Skovbakken (also named Hasseris) were investigated in the 1950s. The Maastrichtian flint was extracted from densely situated pits with horizontal extensions at the bottom but no true galleries. The mining area is estimated to cover c. 5000 square meters. Blanks and hammerstones were found as well as a cache of 19 flint daggers. The mines are dated to the Late Neolithic (*Becker 1951a, b*; *1959*; *Grantzau 1954*).

The mines at Hov were investigated in the 1950s and 60s. The extension of the mining area is unknown and the mineshafts are not visible at the surface. The flint was mined in two ways, depending on the depth of the flint layer in the Maastrichtian chalk. When the flint was available close to the surface, pits of a maximum of four meters in depth were sunk into the chalk, very close to each other. In areas where the flint layer was deeper, shafts were dug at some distance from each other and up to seven meters down into the chalk. When the flint layer was reached, galleries were dug in several directions (*fig. 5*). Four of the 25 documented shafts were investigated. Traces of wooden ladders and a platform were documented in one shaft, as were pick marks from antler tools. One antler wedge and altogether 430 axe blanks in all stages of production, together with hammerstones, flakes and nodules, were found. Blanks of thin-butted axes and a potsherd of early TRB pottery date the mines to the Early Neolithic (*Becker 1951a, b*; *1959*; *1976*; *1980*).

The chalk in Bjerre is covered by aeolian sand and the extent of the mining area is not known. Nine shafts were investigated in the 1950s. Both horizontal extensions and true galleries were dug into the Maastrichtian chalk (*fig. 5*). High-quality flint for the production of axes was not very abundant. Potsherds from a hearth in a refilled shaft date the mines to the Early Neolithic (*Becker 1976*; *1980*).

The flint mines at Hillerslev were discovered and investigated in the 1960s. They were dug down into the Maastrichtian chalk to a depth of a maximum of two meters and they were horizontally extended at the bottom, following the flint layers (*fig. 5*). The mines are dated to the Late Neolithic. The extension of the mining area is not known (*Becker 1980*).

3.2. The mining area in Södra Sallerup, Scania

The flint mining area in southwest Scania was discovered because of commercial exploitation of chalk, which started in the late nineteenth century. The discovery of many finds of worked antlers by the quarry workers led to an investigation of a chalk quarry by the Swedish geologist Nils-Olof Holst in 1904. In the walls of the quarry he found the remains of vertical bell-shaped pits, two meters wide at the mouth and dug through 0.5-3 meters of till and one to three meters of underlying chalk. As the chalk contained flint nodules of varying sizes, Holst interpreted the pits as flint mines (*Holst 1906*). A couple of years later an additional number of flint extraction pits in nearby chalk quarries was documented by the archaeologist *Bror Schnittger* (*1910*). The next investigation was in the early 1950s, when Carl-Axel Althin investigated a few shafts. Due to various factors, e.g. flint nodules left at the bottom of a shaft and the find of unusual pottery (later identified as an Early Neolithic collared flask), Althin interpreted the pits as chalk quarrying pits from the Roman Iron Age (*Althin 1951*).

The Department of Antiquities at the Museum in Malmö became engaged in the documentation of prehistoric remains in the chalk quarry area in 1968. An additional investigation was conducted in 1975, and thereafter excavations took place almost every year between 1977 and 1992 in the vicinity of the Ängdala farm north of the village Södra Sallerup (*fig. 3*). Apart from the chalk quarrying and some road constructions, two other large-scale exploitation projects have affected the area: the gas pipeline project *Sydgas* in 1984-85 and the highway constructed as part of the *Öresundsförbindelsen*, the bridge linking Malmö and Copenhagen, in 1996-98. A larger company purchased the chalk quarrying company and in 1998 the chalk quarrying was shut down, after having been a characteristic feature in the area for about 120 years.

It is estimated that, since the late nineteenth century, deposits under an area of about 325 000 square meters have been quarried for chalk. As the chalk quarries were located where the chalk was close to the surface, it is clear that they were simultaneously located in the areas where the prehistoric flint mining was the most intense. Most of these areas were quarried for chalk without any preceding archaeological documentation. Hence, from a surface area of c. 200 000 square meters, today often converted to ponds, we have little or no knowledge of the prehistoric activities. We have documentation of varying quality from c. 125 000 square meters. In the 1980s one area with about 400 flint mine shafts and pits was declared a National Heritage Monument and protected from future exploitation by the National Board of Antiquities (*fig. 6*).

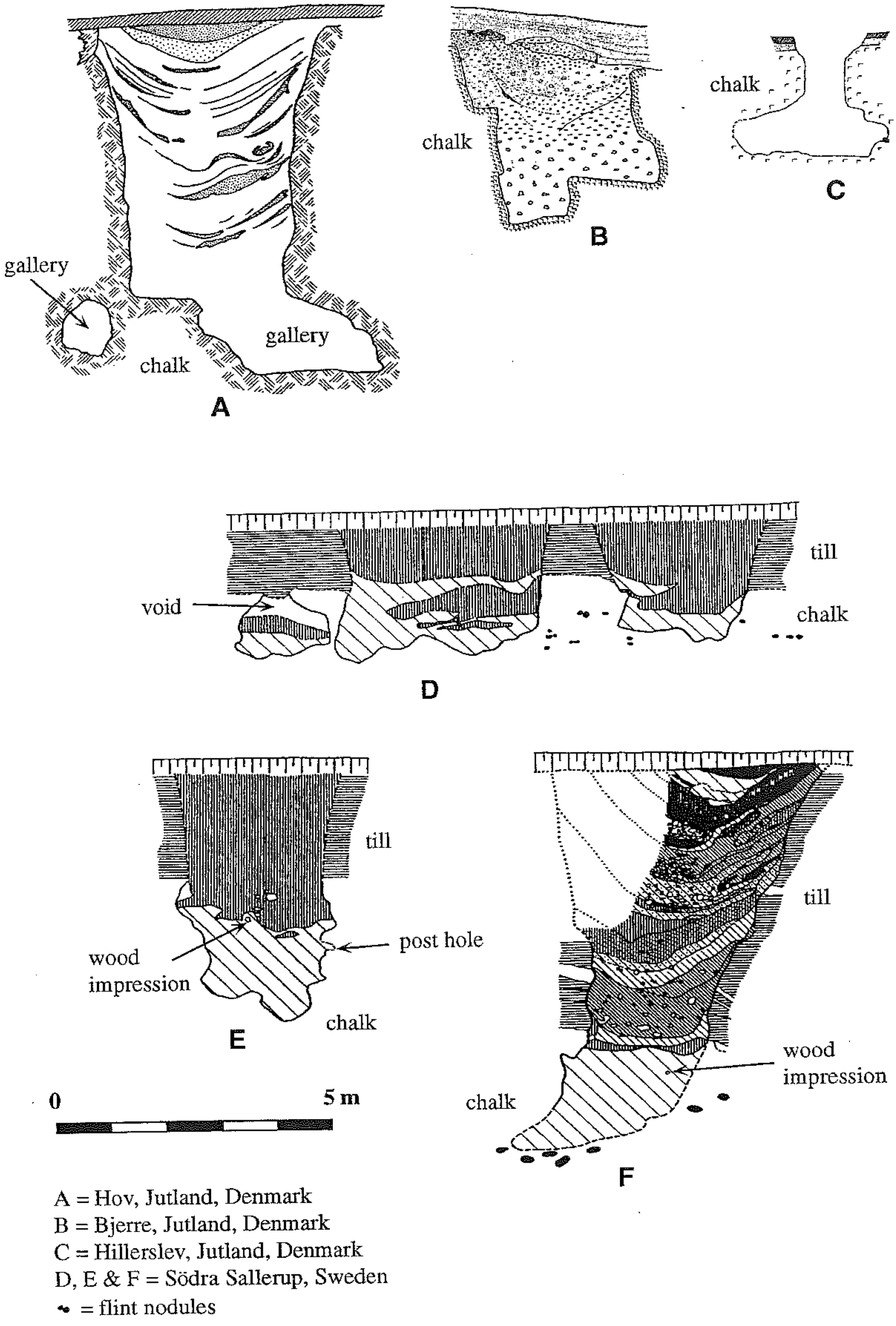

Fig. 5. Profiles from four of the Scandinavian flint mine areas. After *Weisgerber 1980* — *Obr. 5.* Profily čtyř skandinávských dolů na pazourek. Podle: *Weisgerber 1980.*

Södra Sallerup is an area of particular spatial and chronological complexity. The oldest evidence, so far, of more substantial human activity is from the earliest phase of the Neolithic TRB Culture. Seven radiocarbon dates of charcoal and bone from flint mines have yielded dates between c. 4000 and 3600 BC (cal). A few dates are from later periods of the TRB Culture and from the subsequent Battle-Axe Culture, c. 3300-3100 and 2800-2600 BC (cal) respectively. In addition to the flint mines, there are several traces of occupation in the mining area from the Early Neolithic and all the way up until modern time. One of the factors responsible for the very dense occurrence of remains from c. 6000 years of human activity was obviously the presence of the high-quality flint embedded in the Maastrichtian chalk slabs. However, there is as yet no evidence of prehistoric flint mining from periods later than the Middle Neolithic - apart from the secondary "mining" of flint nodules and debris scattered all over the area. As late as the eighteenth century, flint was extracted for the production of gunflints (*Linneaus 1982*). It is not known precisely where and how the flint was extracted during that period. Other attractive features in the area are the fertile soil and the presence of chalk, which was used for whitewashing daub walls already during the Bronze Age and clearly also during historical times. There are several other probable uses to which the chalk may have been put, e.g. for colouring and decorating dress and body, tools and pots.

Because the chalk slabs are not primary deposits but embedded in the moraine they have been affected by the different ice streams that covered southern Scania during the later part of the Wiechselian glaciation. The movement of the ice streams and the repeated freezing and melting has made the chalk soft and crumbly and between the chalk slab and the clayey till there are often mixed layers of clay, chalk, gravel and sand. As a consequence of the geological processes the flint layers, which originally were probably more or less horizontal, have been tilted in different directions so that the flint nodules are unevenly distributed within the chalk. Moreover, the nodule size is on the average quite modest; usually five to 15 centimetres with a maximum length of c. 25 centimetres, and very rarely up to 40 centimeters. Hence, it could not have been easy for prehistoric peoples to predict the amount and size of nodules. This also makes it clear that very large Neolithic axes could only rarely have been produced from nodules extracted in the area (*Rudebeck 1987*; *1998*).

The flint mining was conducted in different ways depending on the depth of the covering till and on the depth of suitable flint nodules in the chalk. The flint has been extracted from shallow surface pits, from pits of a few meters in depth and from deeper shafts, at the most c. seven meters deep (*fig. 5*). Sometimes about five meters of clayey till was removed before the chalk layer was reached. The irregular layers of flint nodules were then followed in the chalk. The width of the pits and shafts varies between 1.5 and six meters. Due to the soft and crumbly character of the chalk it would not have been possible to make long galleries between the shafts. However, horizontal extensions of a maximum length of two meters were sometimes dug, which could lead to the collapse of the layers above (*fig. 5*).

Antler picks made from red deer antler were used for the extraction of flint, as were scapula shovels made from the same animal or from cattle bones. In some cases pick marks have been documented in the chalk walls of the shafts. There is also evidence for rough flint picks and composite tools made from wooden handles, antler sockets and pointed flint picks. Apart from these, tree trunks used as ladders have been documented; the decaying wood having left an imprint in the fill. The most common find material in the flint mining area is debitage from the primary shaping of flint nodules.

Attempts have been made to calculate the temporal distribution of the flint mining activities and the intensity of the extraction on the basis of the radiocarbon dates, estimates of the number of shafts and pits per square meter and estimates of the total mining area. Several possibilities emerge. If there were 2500 shafts and pits in the area, which is a reasonable estimate, and if they were mainly worked during the Early Neolithic phase I, within the limits indicated by the majority of radiocarbon dates (c. 4000-3650 BC cal), the average number of shafts worked per year would be about seven. This is not very impressive, if we have an image of the mining as an efficient raw-material procurement for utilitarian purposes only. However, it may have been that the flint was intensely mined during shorter and recurrent periods, and that people from many different communities visited the mining area, also from quite distant places. In order to make more realistic interpretations of the mining activity we cannot merely rely on the data, but we also need theories about social life, social relations and possible emic meanings of flint and flint extraction during the Neolithic.

So far in this paper the geological conditions for the access of flint and the conditions for extraction have been discussed. In the following sections the utilisation and the transport of flint during south Scandinavian Neolithic is investigated. Here we present two examples, one focusing on the local use of flint in the surroundings of Malmö, a flint rich area, and one with a long-range perspective, focusing on areas in northern Scandinavia which lack natural sources of flint.

Elisabeth Rudebeck

4. AXES AND AXE MANUFACTURE IN A FLINT RICH AREA - A LOCAL PERSPECTIVE

This part of the paper will deal with the production and distribution of Early and Middle Neolithic axes in the Malmö area in southwest Scania (*figs. 2 & 7*), with a focus on raw material. By comparing the type of flint from which axes were made with waste material from axe production sites, we can compare the number of axes of a certain flint type *made* here with the number of axes of this flint type actually *used* here. The access to local high quality flint is considerable in this area. The focus here is to look at how these supplies were reflected in the utilisation of flint for axe production and the use of axes of different flint types on a local level during the Early and Middle Neolithic.

4.1. The Early and Middle Neolithic flint axe types

The Early to Middle Neolithic axe typology in southern Scandinavia is based mainly on the shape of the butt of the axe; from point-butted, over thin-butted, to thick-butted axes. This typology has chronological significance (*Nielsen 1977*; *1979*). Two types of flint axes dominate during the Early Neolithic: the point-butted axe and the thin-butted axe. The point-butted axe is generally considered to be the earliest type of Neolithic polished flint axe in this region. This axe is seen as a transitional type between the unpolished core axe of the late Mesolithic Ertebølle culture and the thin-butted axe of the Early Neolithic TRB Culture (*Nielsen 1977*; *Jennbert 1984*). The thin-butted axe is assigned to the TRB Culture and dates to the Early Neolithic and the first phases of Middle Neolithic (*Karsten 1994*). There are a number of examples of hoards containing both point-butted and thin-butted axes and it is a common conception that these two axe types existed simultaneously during part of

Fig. 6. Aerial view of the Södra Sallerup area showing modern chalk extraction. Flint mines, visible as white spots in the upper part of the picture, were declared a National Heritage Monument in the 1980s — *Obr. 6.* Letecký pohled na oblast Södra Sallerup s moderní těžbou křídy. Doly na pazourek (bílé skvrny v horní části obrázku) jsou od 80. let národní kulturní památkou.

the Early Neolithic (*Karsten 1994*). Both the point-butted and the thin-butted axes are divided into several more or less local and chronologically significant types. The thick-butted axe exists from the Middle Neolithic to the early Bronze Age. However, in this paper we will only deal with the thick-butted axes from the Middle Neolithic. The thin-butted and the thick-butted axes are different chronological types, existing simultaneously only for a short period of time (*fig. 8*).

The thin-bladed flint axe is a type of thin- and thick-butted axe which occurs in the late Early, Middle and Late Neolithic. It is distinguished by its thin blade, less than 2,4 cm thick (*Højlund 1975*). The typology and chronology of these axes is not sufficiently well known (*Ebbesen 1983*). Therefore this axe type will not be considered in this paper.

4.2. Flint for axe manufacturing in the Malmö area

The till in southern Scandinavia contains flint of both Maastrichtian and Danian origin and there were both primary and large secondary sources available during the Neolithic in the Malmö area (see *above* and *fig. 8*). The Danian flint in primary deposits at Elinelund could have been used for axes (*Högberg - in press a, b*). This Danian flint also occurs as secondary deposits in the beach ridge Järavallen on the coast of Malmö (*Kjellmark 1905*) near the primary deposits at Elinelund. Also, this Danian flint is common in the till. However, few nodules in the beach ridge, and even fewer in the till, are suitable for axe production. At the mining area in Södra Sallerup huge amounts of Maastrichtian flint have, as previously mentioned, been extracted (*Rudebeck 1986*; *1987*; *Seitzer Olausson et. al 1980*). This Senonian flint also occurs frequently in the till. To complicate the issue even further, flint of both Danish Senonian and Danish Danian type also occurs in the till. These different

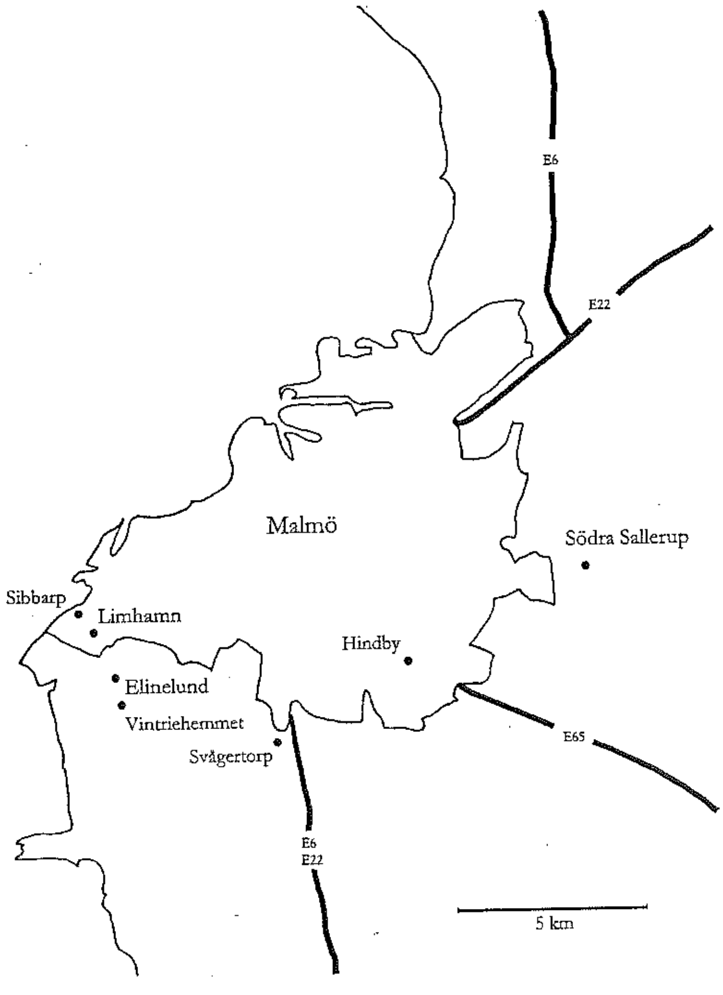

Fig. 7. The Malmö area, with sites mentioned in the text — *Obr. 7.* Oblast Malmö s lokalitami zmíněnými v textu.

flint materials are all represented in flint axes found in the Malmö area, which means that the raw material conditions for axe manufacturing there are considerable and varied. The question here is to what extent this raw material was used.

4.3. Axe manufacturing and the diagnostic flake debitage - a methodological position

Extensive studies of Neolithic axes have been carried out on different occasions (*Malmer 1962*; *1975*; *Becker 1973*; *Højlund 1975*; *Nielsen 1977*; *1979*; *Hernek 1988*; *Ebbesen 1983*; *Olausson 1983*; *Karsten 1994*). These studies all concentrate on the axes themselves. But to get insight into the production of these axes the study of flakes from their production is essential (*Hansen - Madsen 1983; Högberg - in press a, b*). Much simplified one can say that instead of the product, the waste material from production is in focus. On several occasions it has been shown that flakes present the same variation in their patterns of deposition as has generally been seen for the axes. Therefore within reason they should be treated with the same considerations (*Nordqvist 1988*; *1991*; *Knarrström 1997*). To accomplish this it is necessary to work with methods that define and distinguish

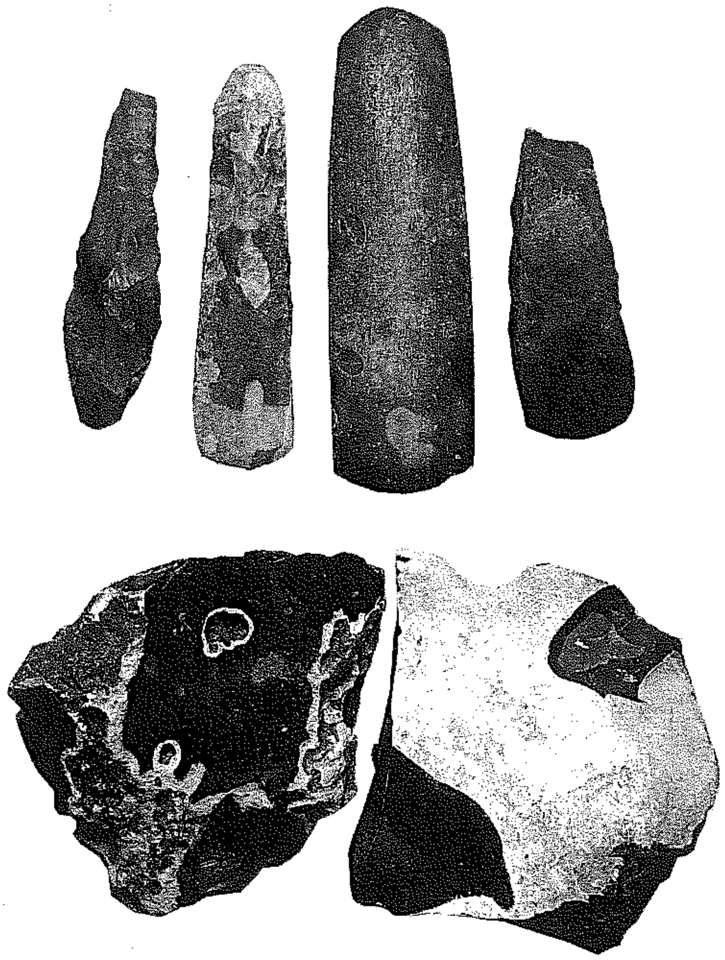

Fig. 8. Scandinavian axes and flint types. To the left is a Late Mesolithic core axe, second left is a point-butted axe type III, next is a thin-butted axe and the axe to the right is a thick-butted axe. The point-butted axe is c. 20 cm long. Flint nodules: below left - local Danian flint from Elinelund; below right - from the mining area in Södra Sallerup — *Obr. 8.* Skandinávské sekerky a typy pazourku. 1 - *Kernbeil*, pozdní mezolit (dél. ca 20 cm); 2 - sekerka s hrotitým týlem typu III; *3* - sekerka s tenkým týlem; *4* - sekerka se silným týlem. Hlízy pazourku: vlevo dole - místní pazourek z Elinelundu (nejstarší kenozoikum - stupeň Dan); vpravo dole - pazourek z dolů v Södra Sallerup.

the axe debitage from debitage associated with other types of production (*Arnold 1981a, b*; *Hansen - Madsen 1983*; *Högberg - in press c*).

4.4. Point-butted axes type I & II - production and debitage

The point-butted axes types I & II are generally produced with a bifacial method resembling the method used for production of the Ertebølle core axes from the late Mesolithic. It is a method that, in the case of the point-butted axes types I and II, has created either a thick biface with lenticular cross-section or an elaborated type of core axe with triangular cross section. Unlike the late Mesolithic core axes, the point-butted axes are often polished after they have been knapped (*Nielsen 1977*). The resemblance between the techniques of producing these two different kinds of axes makes it difficult to distinguish the production debitage from the manufacturing of point-butted axes from that of core axe production with certainty (*Högberg - in press c*). It is therefor difficult to locate production sites for point-butted axes by looking only at the flint material. It is necessary to take into consideration the complete archaeological record, that is to say for example radiocarbon dates, the find context and other features at the site.

However, a few guidelines can be drawn to help us to discover the point-butted axe production. The majority of the flakes from the production of point-butted axes exhibit the following attributes: platform angle of 60-70 degree (*angle de chasse*), bowed curvature and impact point off the edge (*fig. 8* and *Högberg - in press c*; *Jansson 1999*). However it must once again be pointed out that these attributes are not diagnostic in themselves. In this study they are used as hints of possible production sites for point-butted axes.

4.5. Square-sectioned axes - production and debitage

The point-butted axes of type III, the thin-butted axes and the thick-butted axes are all produced with what is known as the quadrifacial method (*Knarrström 1997*; *Stafford 1995*; *Nordqvist 1988*; *1991*; *Waldorf 1988*; *Hansen - Madsen 1983*). The basis of this method is a four-sided surface flaking that results in a blank with squared or rectangular cross-section. The production of these square-sectioned axes can be divided into various working stages, with the accomplishment of each stage being dependent upon the result of that preceding it. The initial stage involves obtaining suitable raw material, while the last stage is the polishing of the axe. Flakes from each manufacturing stage have a distinctive size and shape.

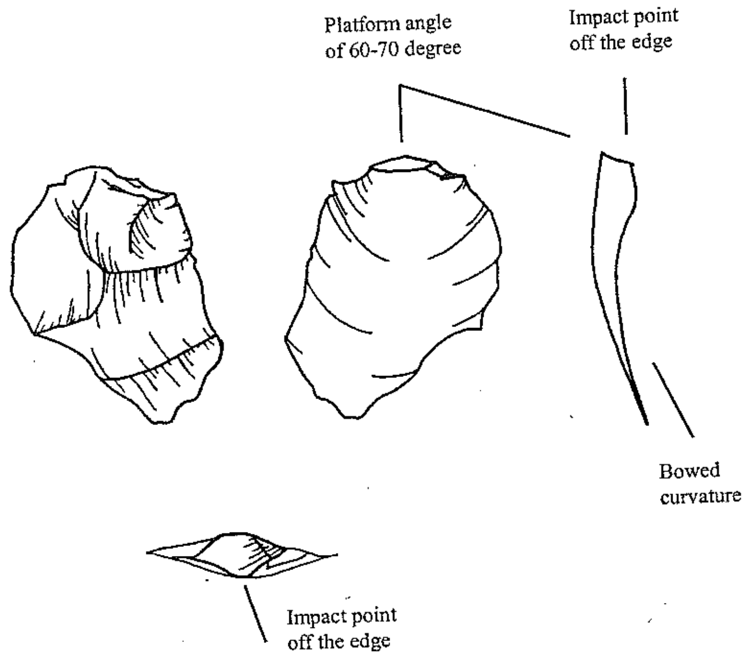

Fig. 9. A typical flake from the production of a point-butted axe — *Obr. 9.* Typický úštěp z výroby sekerky s hrotitým týlem.

The diagnostic flakes from the production of square-sectioned axes are marked above all by a combination of six attributes specific to these flakes: platform angle of 90 degree (*angle de chasse)*, pronounced bulb, lenticular platform shape, impact point off the edge, straight curvature and faceted platform (*fig. 10*). It is thus the presence of a combination of these six different attributes, partly on individual flakes, partly in the flake material as a whole, that is diagnostic for the flakes using the quadrifacial method (*Högberg 1998*; *in press c*). These attributes are essential for distinguishing waste material from the production of square-sectioned axes in the archaeological record. In this study it is used to locate knapping sites and places of production for such axes.

4.6. Local manufacture of flint axes

To locate places of production, two kinds of material are used. First, the investigation of finds of flakes indicating knapping floors and the production of axes, second finds of axe preforms, are examined.

4.6.1. Knapping floors

Södra Sallerup (*fig. 7*): Extensive traces of knapping activities have been excavated and an innumerable amount of flakes and debitage from knapping floors and waste deposits has been collected at the mining area of Södra Sallerup. However, only a few flake analyses have been carried out on debitage from knapping floors and settlements (*Jansson 1999*; *Sarnäs - Rosberg 1997*). Jansson has suggested that production of point-butted axes took place at several of the knapping sites he has examined. He based his interpretation on a technological investigation of the flake material using the attributes presented earlier in this text. Taking into consideration the results of several radiocarbon dates from flint mining shafts which date the bulk of the mining activity to the Early Neolithic, he argues for a production of point-butted axes at the site, using the local Maastrichtian flint. However, as has been pointed out earlier, it must be stated that the diagnosis of flakes from the production of point-butted axes using the presently available methods is uncertain. Together with the radiocarbon dates it is a conceivable, and even probable, interpretation. Point-butted axes are generally produced of a Maastrichtian flint and the axe finds are concentrated to southwestern Scania and eastern Zealand (*Rudebeck 1998*). This indicates the mining area in Södra Sallerup as a possible production place for point-butted axes. But there are other artefacts besides core axes which have been produced with the same method. A common artefact from sites with flint mining activities is roughly shaped flint picks, interpreted as mining tools (*Hubert 1980*). There are finds of this type of picks in Södra Sallerup as well (*Seitzer Olausson et al. 1980*). These tools have the same triangular or thick bifacial cross-section as point-butted axes, and they were manufactured with the same type of method. The flint could also have been used for the production of other kinds of tools e.g.

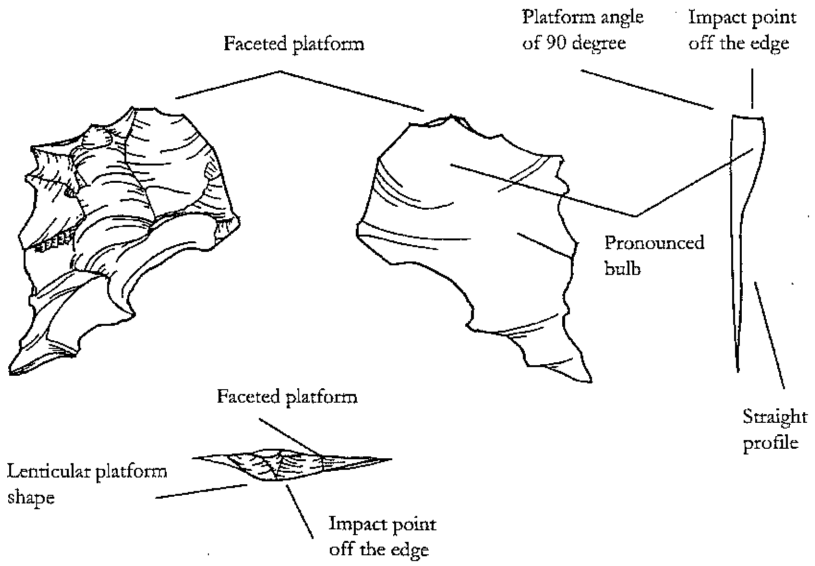

Fig. 10. A typical flake from the production of a square sectioned axe — *Obr. 10.* Typický úštěp z výroby sekerky se čtvercovým průřezem.

scrapers, burins and knives. Hence, the flint mining in Södra Sallerup, which was obviously very unpredictable as to the amount and size of nodules, could hardly be interpreted as an "axe-factory" (*Rudebeck 1998*). Arguments for the production of point-butted axes at Södra Sallerup are strong, but not conclusive.

Elinelund (*fig. 7*): Traces of settlement activity of both profane and sacred character have been excavated at the site Elinelund south of Malmö. The activities can be dated to two periods, late Early Neolithic/early Middle Neolithic and late Middle Neolithic/Late Neolithic. The archaeological record consists of, among other things, house constructions, hearths, different types of pits, and a huge amount of flint material. The flint material was found both in features and in the ploughzone, either as waste deposits or as knapping areas. Together with flakes from household production and tools such as scrapers and drills, a large amount of flakes and other debitage material from production of square-sectioned flint axes was found (*Sarnäs - Nord Paulsson - in press*). The flakes from this production have been roughly estimated to represent the production of c. 50 axes.

The flint raw material used for axe production at Elinelund is partly the earlier mentioned local Danian flint from Elinelund, partly a Maastrichtian type of flint. The origin of this Maastrichtian flint cannot be more precisely determined than to south Scandinavia. In a population of several hundred axe flakes, the relation between the Danian flint and the Maastrichtian flint was found to be roughly 3 to 1.

Vintriehemmet (*fig. 7*): At the site Vintriehemmet, located close to Elinelund, remains from activities dated to the Early Neolithic have been excavated. The archaeological record consists of different kinds of refuse pits, hearths, and a cultural layer. The flint material from the pits represents ordinary and specialised household activities, with simple flake production and tools such as scrapers and flake denticulates. The flint material from the cultural layer consists of flakes knapped from simple cores, together with flakes from the production of square-sectioned axes (*Öijeberg - in press*).

The flint raw material used for the production is partly the earlier mentioned local Danian flint from Elinelund, partly a Maastrichtian flint. The origin of the latter cannot be more precisely determined than to southern Scandinavia. In several hundred flakes from the axe production, the relation between Danian flint and Maastrichtian flint is about 5 to 1.

Svågertorp (*fig. 7*): At the site Svågertorp, under excavation as this is being written (summer 2000), a refuse pit containing flakes and other debitage from the production of one or several square-sectioned axe(s) has been excavated. The find has not yet been analysed in detail and therefore the results are only preliminary. The find was made in an area with activities from Early Neolithic to Middle Neolithic. A few fragments of TRB ceramics dating to late Early Neolithic/early Middle Neolithic were found with the flakes. The flake material consists entirely of flakes of the local Danian flint from Elinelund mentioned earlier.

4.2.6. Preforms

A hoard with point-butted preforms and axes: A hoard with seven preforms for point-butted axes was discovered in the beach ridge Järavallen during gravel quarrying at Sibbarp (*fig. 7* and *Rydbeck 1918*). The preforms are patinated and slightly affected by beach rolling. Six of them are made out of flint from the beach ridge: five of the same kind of Danian flint as can be found at the primary sources at Elinelund, and one of another kind of Danian flint. One of the preforms is made of the same type of Senonian flint as occurs in Södra Sallerup (*fig. 11*).

Finds of a large number of thick-butted preforms: In connection with gravel extraction in the 1800s and early 1900s, a large number of axe preforms was collected in the beach ridge at Sibbarp. They are all roughly shaped preforms, heavily beach rolled and patinated. The preforms are all made out of flint from the beach ridge, the majority being the same kind of Danian flint as that found at the primary sources at Elinelund (*fig. 12*). Information about the total number of specimens differs from writer to writer, but it can be estimated to c. 300-500 pieces. The suggested dating for these preforms is the Middle Neolithic (*Kjellmark 1905*; *Salomonsson 1971*). Similar finds are known from Denmark (*Ebbesen 1980*). It is obvious that these preforms indicate a massive axe production using Danian flint from the beach ridge as a raw material resource.

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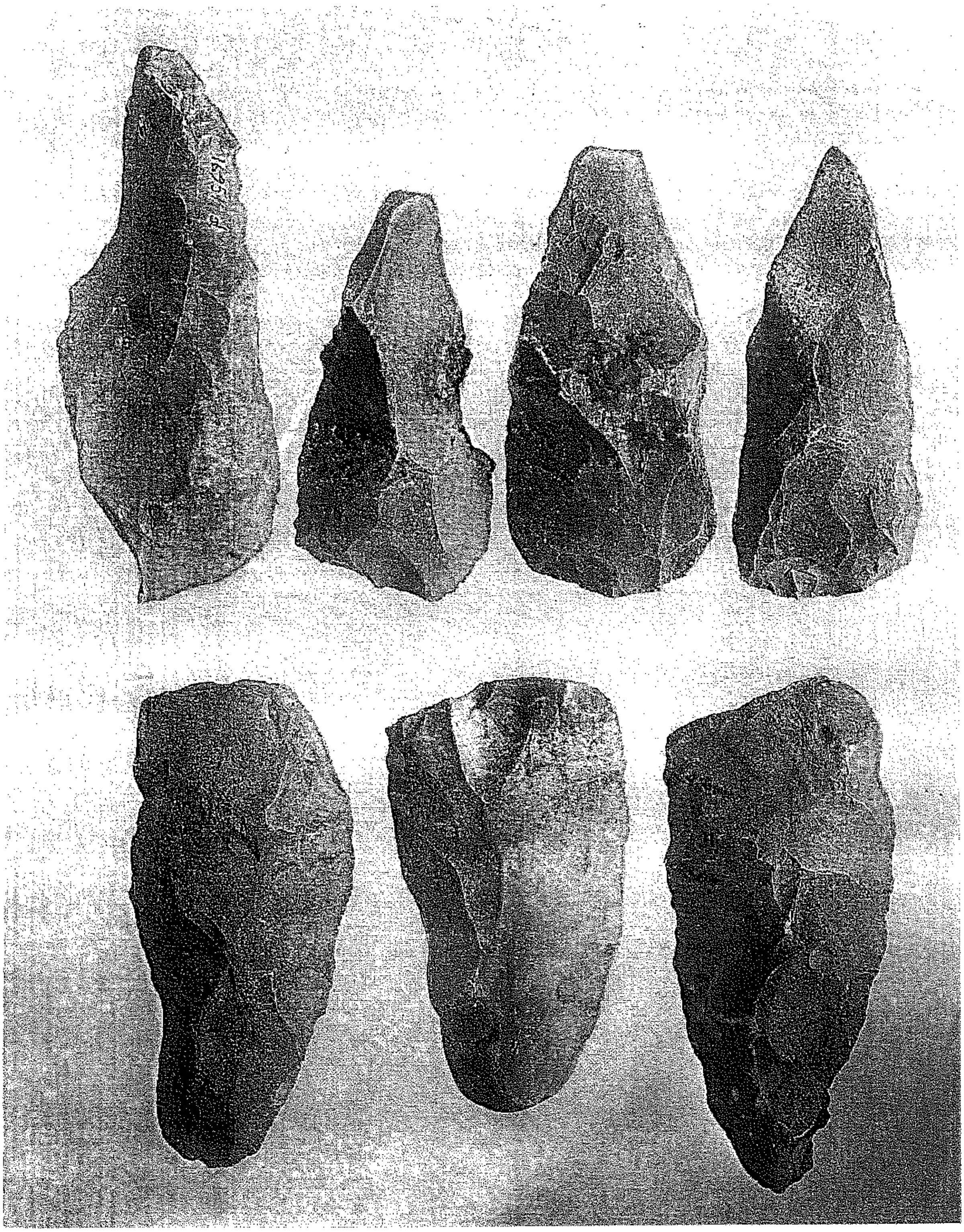

Fig. 11. A hoard with seven point-butted preforms found in the beach ridge Järavallen at Sibbarp — *Obr. 11.* Depot sedmi polotovarů s hrotitým týlem z pobřeží Järavallen - Sibbarp.

4.7. Local consumption of flint axes

The local use of flint axes, based on material from settlement remains, known caches and from the surface find collection at the Museum of Malmö, will now be analysed.

4.7.1. Settlement remains

Hindby (*fig. 7*): Extensive traces of prehistoric activities dated to the Neolithic have been excavated at the Hindby site in the southeast of Malmö. The site shows, among other things, extensive settlement remains. Within the area a sacrificial bog full of finds from the Neolithic has been excavated (*Svensson 1986*; *1993*).

Magnus Peterson has analysed Early and Middle Neolithic axes and fragments of axes from the settlement remains at the site. The study comprised 96 axes and fragments of axes. These are four point-butted, six thin-butted, 21 thick-butted and 65 indetermined axes (*Petersson - Nilsson 1999*). The number of indetermined axes is due to the fragmentary status of a large number of the specimens coming from settlement remains. The four point-butted axes were all made out of south Scandinavian Senonian flint, as were the six thin-butted axes. Of the 21 thick-butted axes, six were made of south Scandinavian Maastrichtian flint, and 15 were made out of a Danian flint. Forty-four of the total 65 typologically indeterminable axes were made out of south Scandinavian Senonian flint, and twenty-one out of Danian flint. It is obvious that in the settlement remains at Hindby flint axes made out of Maastrichtian flint are most frequent.

Vintriehemmet (*fig. 7*): Nineteen polished flakes were found in the same cultural layer as the find of diagnostic axe production flakes at Vintriehemmet. Based on patination and technology, these flakes have been interpreted as coming from reflaking of four square-sectioned axes. Reflaking, where the axe has undergone flaking but still retained its function as an axe, should be distinguished from reworking, where the axe has functionally been reshaped from an axe into something else. These flakes represent more the axe use rather than axe production, since the flakes are knapped from a polished axe and not from a preform. The four refla-

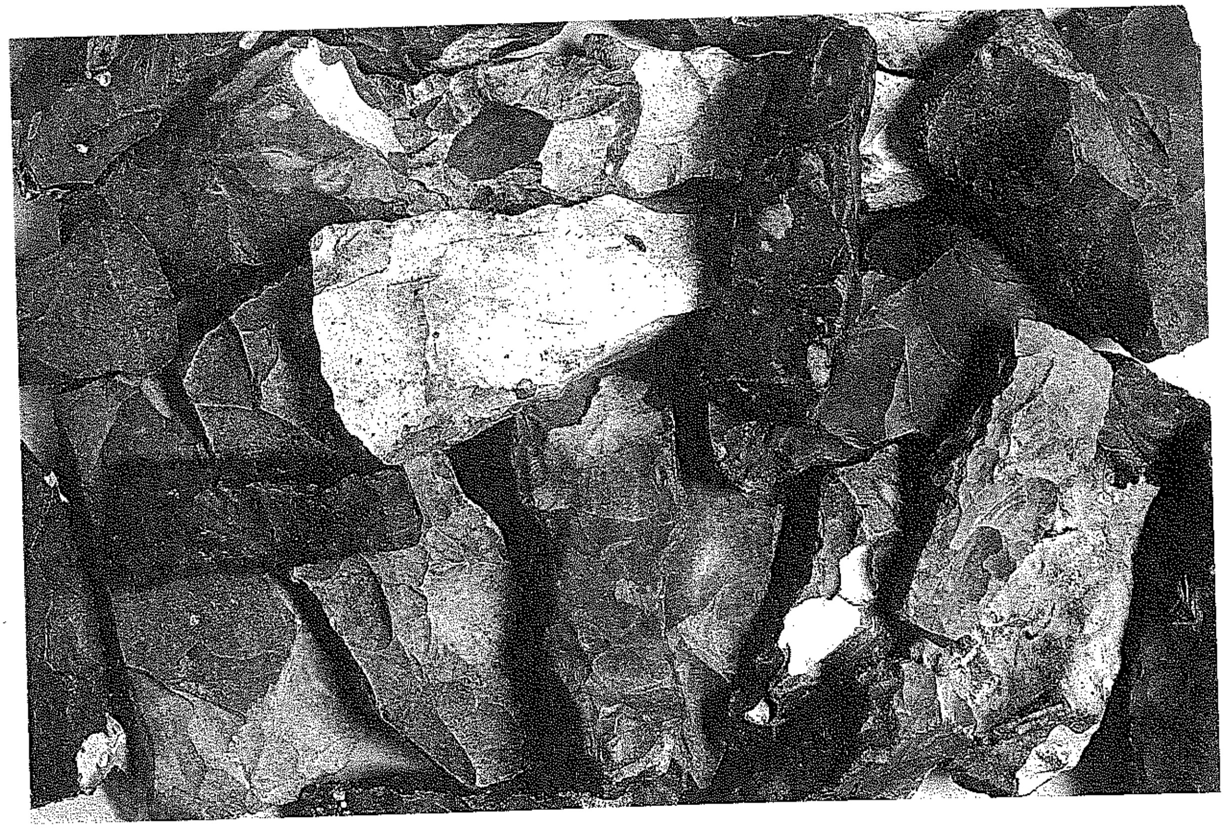

Fig. 12. Thick-butted preforms from the beach ridge Järavallen at Sibbarp — *Obr. 12.* Polotovary se silným týlem z pobřeží Järavallen - Sibbarp.

ked axes, represented by the polished flakes, show a relation of 50/50. That is to say, two were of local Danian flint and two were of south Scandinavian Maastrichtian flint.

4.7.2. Hoards

The tradition of placing hoards of axes and other artefacts as offerings on settlements and in bogs, streams and other wetlands during south Scandinavian Neolithic is well known. In the Malmö area and its surroundings, a large number of different types of hoards containing one or more intentionally deposited axes have been found. Examples of ten and even more axes from one find spot are known (*Karsten 1994*).

Linda Nilsson has studied 96 axes from different hoards found in the surroundings of Malmö. These comprised 11 point-butted, 54 thin-butted and 31 thick-butted axes. Ten of the point-butted, 46 of the thin-butted and 26 of the thick-butted axes were made of south Scandinavian Maastrichtian flint, in comparison with one point-butted, eight thin-butted and five thick-butted axes made out of Danian flint (*Petersson - Nilsson 1999*). It is obvious that the axes from hoards in the Malmö area most frequently consist of specimens made out of Maastrichtian flint.

4.7.3. Axes from a surface find collection

Rudebeck conducted a study of axes from the surface find collection at the Museum of Malmö. The study comprised 97 point-butted and 100 thin-butted axes. (Thick-butted axes were not included in her study.) Fifty-four of the point-butted and 56 of the thin-butted axes were made of south Scandinavian Maastrichtian flint, in comparison with 43 point-butted and 44 thin-butted made out of Danian flint (*Rudebeck 1998*). The distribution of axes from the surface finds collection gives approximately a 50/50 relation of Maastrichtian to Danian flint.

4.8. Conclusions

There is an apparent difference between the production and consumption of Neolithic axes in the Malmö area. While the major part of the production was based on local Danian flint, the axes used within the area are made of Maastrichtian as well as Danian flint (*fig. 13*). It is possible that the imbalance between "input" and "output" in EN/Early MN can be explained by extensive production at the mining area in Södra Sallerup. However, as has been stated earlier, Södra Sallerup should probably not be seen as a comprehensive axe production site. And since the radiocarbon dates place the mining activity in Early Neolithic, production at Södra Sallerup can-

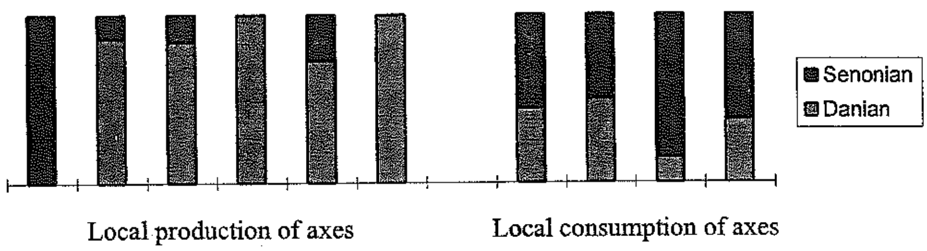

Fig. 13. Axes and flint types in the Malmö area: local "input" and "output". The diagram compares flint types used for local production with flint types used for locally found axes. From left to right: Södra Sallerup, Järavallen with hoards of point-butted preforms, Vintriehemmet, Svågertorp, Elinelund, Järavallen with finds of thick butted preforms; surface find collection, Vintriehemmet, hoards in the surroundings of Malmö and Hindby. Axes made locally are more often made of Danian flint than axes used locally — *Obr. 13.* Sekerky a typy pazourku v oblasti Malmö: dovoz a vývoz. Diagram srovnává typy pazourku používané pro místní výrobu s typy pazourku použitými na zde nalezených sekerkách. Zleva doprava: Södra Sallerup, Järavallen s depoty polotovarů s hrotitým týlem; Vintriehemmet, Svågertorp, Elinelund, Järavallen s nálezy polotovarů se silným týlem; povrchový nález, Vintriehemmet s depoty v okolí Malmö a Hindby. Lokálně vyrobené sekerky jsou častěji zhotoveny z pazourku z kenozoika - stupeň Dan než sekerky lokálně používané.

not explain the imbalance between the production and actual use of axes in the Middle Neolithic in the Malmö area. It is reasonable to assume that, together with (and in spite of) an extensive local production, a network of supply of non-locally produced and distributed axes also occurred. So, even in a flint rich area such as the Malmö region, flint of non-local origin was transported.

Anders Högberg

5. FLINT TOOL MANUFACTURE AND DISTRIBUTION IN SCANDINAVIA - A LONG-RANGE PERSPECTIVE

The use of flint in Scandinavia during the Late Neolithic period will be discussed in this part of the paper. The discussion concerns the production and distribution of Scandinavian types flint daggers and polished axes. However, it might be appropriate to start of with a brief introduction to the cultural historical setting.

On the basis of a thorough chronological investigation of the early metalwork in Denmark the Late Neolithic period in southern Scandinavia has been divided into two phases: LN I and LN II (*Vandkilde 1996*, 139 ff). During LN I, in the Limfjord area of northern Jutland, a Bell Beaker phase manifested itself in single burials and settlements with Bell Beaker pottery, slate wrist guards and heart-shaped bifacial arrowheads. In these contexts the earliest flint daggers were made under the influence of western European forms (*Müller 1902*, 131). All through LN I, northern Jutland remained a core area for the production of lanceolate flint daggers (*Rasmussen 1990*, 37; *Vandkilde 1996*, 13; *Apel 2000a*, 141).

The Battle-Axe and Pitted-Ware traditions in Denmark and the southern and central parts of Sweden and southeast parts of Norway merged into a unified material expression during the course of the LN I phase. Thus, at the transition between LN I and LN II, a Late Neolithic tradition embraced the central and southern parts of Scandinavia. The material expressions of this tradition include the production and use of characteristic flint artefacts (see *below*), simple shaft-hole axes in stone, slate pendants, bone needles and bronze axes. This tradition was under heavy influence from the netice area in central Europe as well as from western Europe during LN II. The practice of a single burial tradition as well as the production of fishtailed flint daggers and elaborately shaped bone needles emerged as a result of impulses from the Únětice area.

5.1. The production of flint daggers

Lomborg (*1973*) has divided the Scandinavian flint daggers into six main types (*fig. 14*) and several subtypes. The chronological importance of the dagger typology was somewhat overemphasised in earlier research (*Müller 1902*; *Forssander 1936*; *Lomborg 1973*). However during the last thirty years it has been established that although the types do reflect important chronological aspects, they also mirror regional differences (*Ebbesen 1975a*; *Madsen 1978*; *Rasmussen 1990*; *Vandkilde 1996*; *Apel 2000a*). The chronological and geographical aspects can be summarised in the following way. Types I - III daggers belong to LN I. Type I daggers were produced mainly in the Limfjord area on northern Jutland while types II and III were produced on the east Danish isles and in southwest Scania. Type IV and V daggers belong to LN II and were mainly produced on the east Danish isles and in southwest Scania.

Both ordinary and prestige daggers of each type were made. The production of the ordinary types was more widespread than the production of the prestigious daggers. Through experiments we have concluded that the production of prestigious flint daggers required a great deal of theoretical knowledge and practical know-how (*Apel 2000a*, 141 ff). Thus, it has been suggested that the reproduction of the dagger technology through the generations demanded some form of institutionalised apprenticeship system (*Apel 2000a*, 150). Such apprenticeship systems are based on the acquisition of practical know-how achieved only through practical training, and it is likely that the dagger technology could only be handed down from generation to generation in areas where there was an abundance of raw material. Thus it has been suggested that the production of prestigious daggers took place near the natural Maastrichtian flint sources: i.e. in the Limfjord area on Jutland and on the east Danish isles and in the southwestern part of Scania (*fig. 2*). These two areas have therefore been interpreted as the main production areas. The fact that different dagger types were produced in these two areas

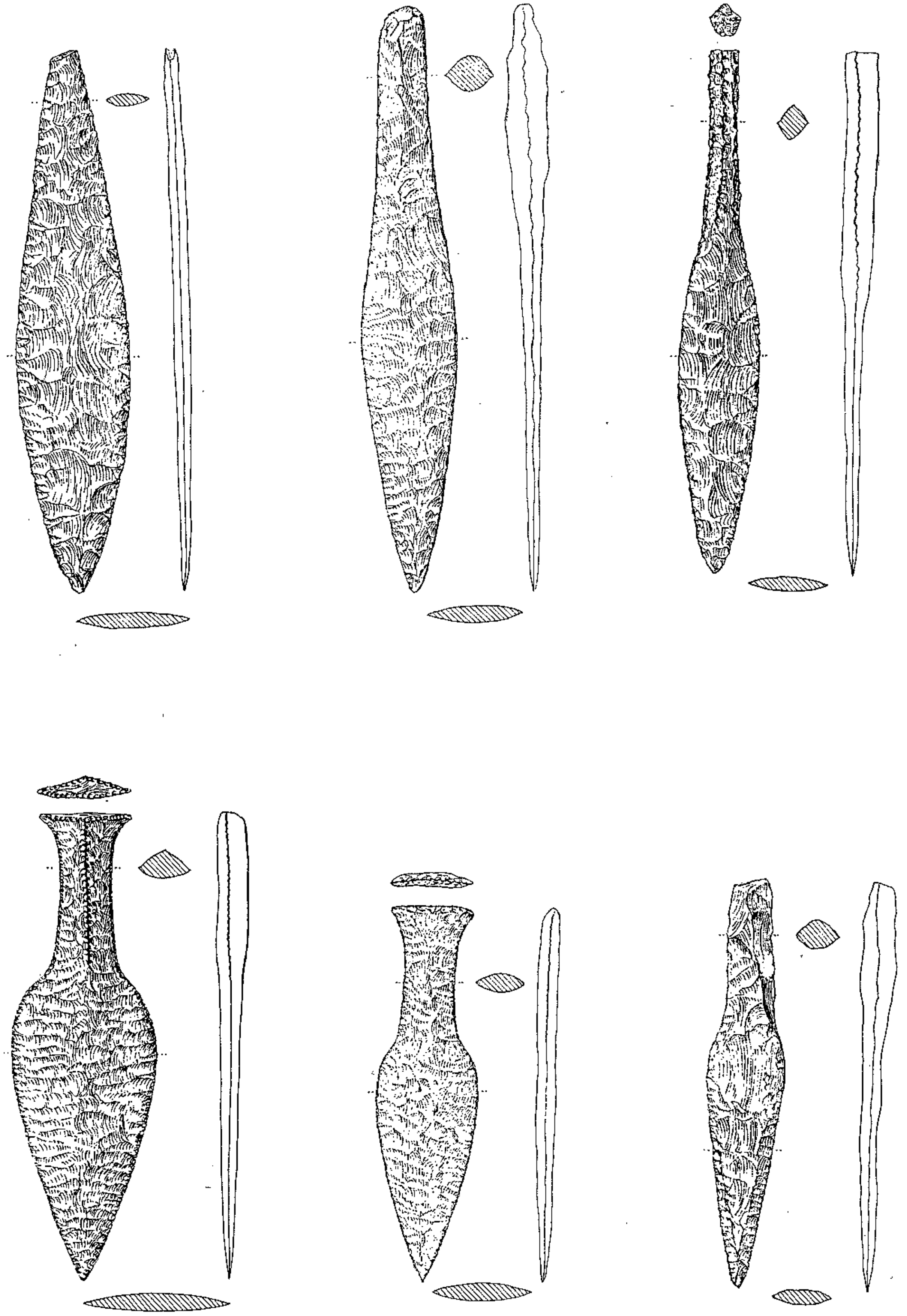

Fig. 14. The six main Scandinavian dagger types as defined by *Lomborg (1973)*. Types I-III in the upper row, types IV-VI in the lower row. The type I dagger is 30 cm long — *Obr. 14.* Šest hlavních skandinávských typů dýk, podle: *Lomborg 1973*. Horní řada: typy I až III, dolní řada: typy IV až VI. Délka dýky typu I: 30 cm.

probably reflects conscious choices stemming from a need to demonstrate cultural differences (*Apel 2000a*, 150). A common aspect of the daggers produced in northern Jutland is a lack of pronounced handles. On the other hand, the handles of the dagger types produced in the eastern production area all display more or less elaborate constructions. The differences in handle construction suggest that the dagger types, as *Lomborg* (*1973*) defined them, are real types in the sense that they reflect regional normative technological traditions (*Apel 2000a*, 150).

5.2. The consumption of flint daggers in Scandinavia

In this context the Limfjord area is considered to have been one regional production area and the Danish isles and southwestern Scania another. We shall now see how these production areas affected other parts of Scandinavia where flint daggers were consumed. With Lomborg's typology as a starting point, Scandinavian exchange routes during LN I will be discussed. The discussion concerns the relative frequencies of first three main dagger types in different parts of Scandinavia presented in *fig. 14*.

It is obvious that the frequencies of the different dagger types vary within the production area (*fig. 15*). Jutland on the one hand and the east Danish isles and Scania on the other differ in two important respects. The type I daggers make up 60 % of the total amount of daggers on Jutland while only 32 % on the Danish Isles. This tendency is further strengthened in Scania where type I daggers only make up 30 % of the material

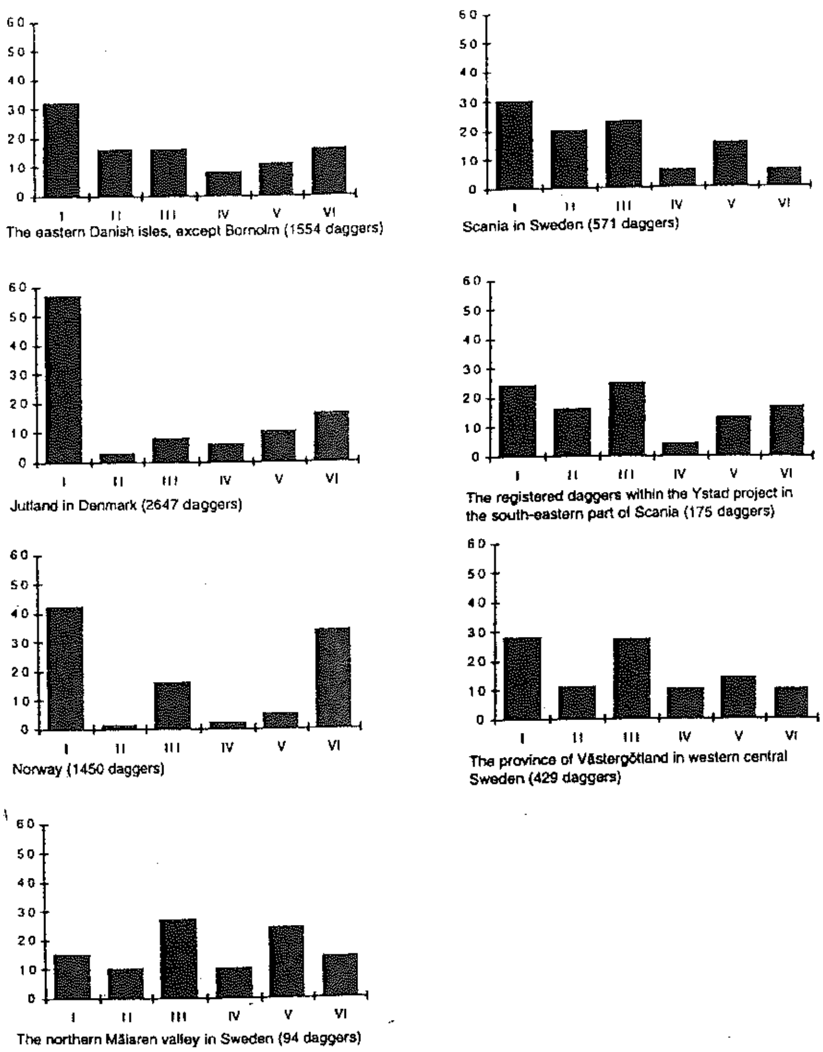

Fig. 15. The relative frequencies of Lomborgs six main dagger types in different regions of Scandinavia. The diagrams are based on information extracted from museum collections by Jan Apel and Per Lekberg, at the department of Archaeology and Ancient History at Uppsala University, and from the following publications (*Lomborg 1973*; *Scheen 1979*; *Bondesson 1980*; *Larsson 1992*) — *Obr. 15.* Relativní frekvence šesti typů dýk podle Lomborga v jednotlivých oblastech Skandinávie. Diagramy vycházejí z informací získaných z muzejních sbírek (Jan Appel, Per Lekberg), z Department of Archaeology and Ancient History uppsalské univerzity a z následujících publikací: *Lomborg 1973*; *Scheen 1979*; *Bondesson 1980*; *Larsson 1992*.

(*fig. 15*). In this context these differences are seen as mirroring the occurrence of the regional technological traditions described above.

In Norway, the type I daggers make up more than 40 % of the total number of daggers (*fig. 15*), implying that the Norwegian daggers, in general, derive from Jutland. This impression is further strengthened if we consider that the Norwegian part of the type II daggers (c. 2 %) is considerably lower than that on the Danish islands (17 %) (*fig. 15*). In 1952 Carl-Johan Becker argued that of the 20 flint daggers found in the northern parts of Sweden, 15 were made of a flint type that originated from the Limfjord area on Jutland (*Becker 1952*, 77). He suggested that these daggers were brought to Norrland from Jutland over the Norwegian west coast to the Trondheim area and then east over the mountains into northern Sweden. This interpretation is now strengthened by the compositions of the Norwegian dagger material. In southeast Norway the dominant features in the Late Neolithic archaeological materials are simple shaft-hole axes in stone while flint daggers are characteristic on the west coast. It seems as if the people on the southwest Norwegian coast had contacts with Jutland and that the people in the area around the Oslo fjord had contacts with areas in Sweden.

In order to investigate how these internal differences are reflected in the frequencies of the two dagger traditions, Norway can be divided into a western and an eastern part (*fig. 16*). It seems as if the impulses from Jutland reached southeast Norway quite early. There are at least two Norwegian contexts which include type I daggers and have been C14-dated. These consist of a grave from Hurum in Buskerud where five type I daggers were found together with human bone remains, and a grave at Ruskenesset where a type I dagger was recovered together with bone remains (*Scheen 1979*, 90). These dates suggest that the introduction of the Late Neolithic period on the Norwegian west coast should be set to approximately 2100 BC (cal).

In central Sweden the relative frequencies of the first three dagger types show similarities to the eastern production area. The same goes for the material in southeastern Norway. An interpretation of the exchange routes for LN I daggers is presented in *fig. 17*. Accordingly, daggers made on the Danish isles and in southwestern Scania were distributed to areas in southern and central Sweden and to the southeastern parts of Norway. Daggers made on northern Jutland were exported north to western Norway and from there into northern Sweden.

Jan Apel

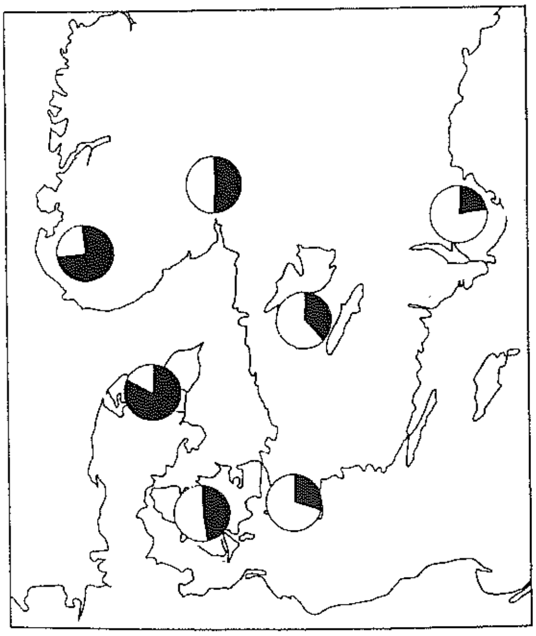

Fig. 16. The frequencies of dagger forms produced during LN I. Black represents lancet-shaped daggers without pronounced handle (except subtype ID). White represents daggers of type II, III and subtype ID (*Apel 2000a, b*) — *Obr. 16.* Frekvence tvarů dýk vyráběných ve fázi "Late Neolithic I". Černě: lancetovité dýky bez výrazné rukojeti (bez podtypu ID); bíle: dýky typu II, III a podtyp ID (*Apel 2000a,b*).

5.3. *The flint axe hoards in Northern Sweden*

Along the Swedish northeast coast, especially in the parish of Västerbotten, at least 400 thick-butted, hollow-ground axes in numerous hoards have been found (*fig. 18*). These axes have been deposited at least 1000 km from where they were produced, somewhere in southern Scandinavia. On typological grounds, the axes can be dated to the transition between the Late Middle Neolithic and the Late Neolithic I periods. A large part of the material consists of axes belonging to the Middle Neolithic period (*Ebbesen 1975b*; *Bertvall 1985*, 13). However, there are also some examples of broad- and thin-bladed axes with curved edges that can be dated to an early phase of the Late Neolithic period (*Siemen 1981*, 172). Many axes also display iron-oxide patina not acquired on the find locations. It is therefore likely that they were of some age when they were brought to Västerbotten. Consequently, the flint hoards of northern Sweden seem to belong to an early part of the Late Neolithic period (*Knutsson 1988*, 256 see also an extensive discussion of axe typology: 252 ff). Incidentally, such a dating roughly coincides with C14-datings of the first cereal horizon in pollen diagrams from the area (*Königsson 1989*).

The majority of the axes in the north Swedish axe hoards are semi-finished objects and only some are ground (*Christiansson 1966*, 91). In the hoards the axes have been placed in elaborate patterns. An example is for instance one of the largest hoards found at the Bjurselet site where over 70 axes forming a star-shaped circle with a diameter of about 1 m were discovered in the 1830s (*Becker 1952*, 35; *Christiansson 1966*, 93). Generally, the hoards were deposited in moist sediments (*Knutsson 1988*, 77). Not only axes but also flint nodules and flakes from the production of square-section axes were brought up to Västerbotten (*Knutsson 1988*, 87). There have been several explanations put forward during the years for the presence of the unique axe hoards. *Knutsson* (*1988*) has interpreted the caches from a slightly different angle. His interpretation is based on a thorough investigation of the lithic technologies present on the Bjurselet site - both those applied to local material such as quartz and those applied to south Scandinavian flint. According to Knutsson the lithic materials can be divided into five functional categories which vary between different tentative chronological horizons (*Knutsson 1988*, 198). The second unit of these coincided in time with the deposition of the flint hoards and differed in important respects from the previous and the following units, all of which were interpreted as connected to seal hunting. The flint technology in the second unit included technological elements that were alien to the Norrland hunter-gather groups. For instance it included a method by which blade-like flakes were struck from cylindrical blade cores and flint objects were habitually exposed to fire (*Knutsson 1988*, 198). Knutsson suggested that the people who deposited the flint hoards in Västerbotten originally belonged to a south Scandinavian cultural group. In addition to prismatic blades struck from cylindrical blade cores this immigrating group used transverse arrowheads, pressure-flaked blade points, Battle-Axe pottery, and corpus flakes from thick-butted axes. The group immigrated to Norrland but something happened and they were forced to abandon the settlements. Later hunter-gatherer groups scavenged the flint when visiting the site to hunt seal and incorporated it into their own technological repertoire (*Knutsson 1988*).

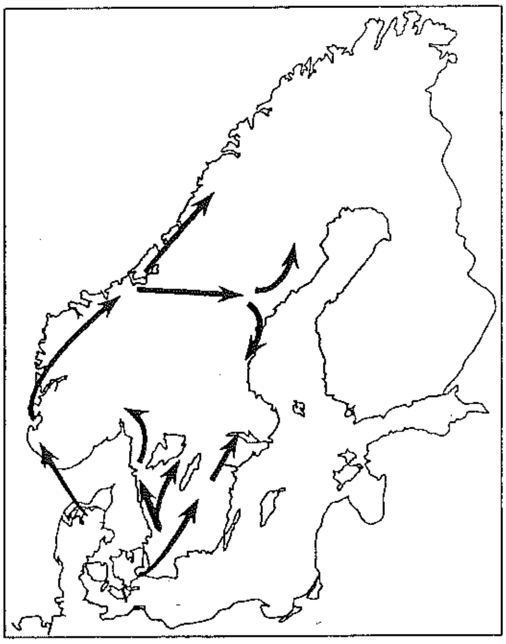

Fig. 17. Hypothetical exchange routes from the two main production areas to different parts of Scandinavia. After *Apel 2000a,b* — *Obr. 17.* Hypotetické obchodní cesty ze dvou hlavních výrobních oblastí do různých částí Skandinávie. Podle: *Apel 2000a,b.*

If in fact the north Swedish flint hoards were deposited during the LN I one may ask if they originated from the western or the eastern production area in south Scandinavia discussed above. However this question has not yet been resolved. The use of blade technology based on cylindrical cores suggests a western origin. If this were the case, the people who deposited the axes at Bjurselet came from Jutland up to Rogaland in Southwest Norway and along the Norwegian coast up to the Trondheim area, where they went inland and walked over the mountains to Norrland. Yet important objections can be made to such an interpretation. First of all, the finished axes in the hoards are ground in a way which is similar to the way axes were ground within the Single Grave Culture in eastern Denmark (*Becker 1952*; *Knutsson 1989*). Secondly Becker, who claimed that the majority of the flint daggers in Norrland were made of flint from the western production area, has also investigated the flint qualities of the flint hoards. According to him, the axes are made of flint from the eastern

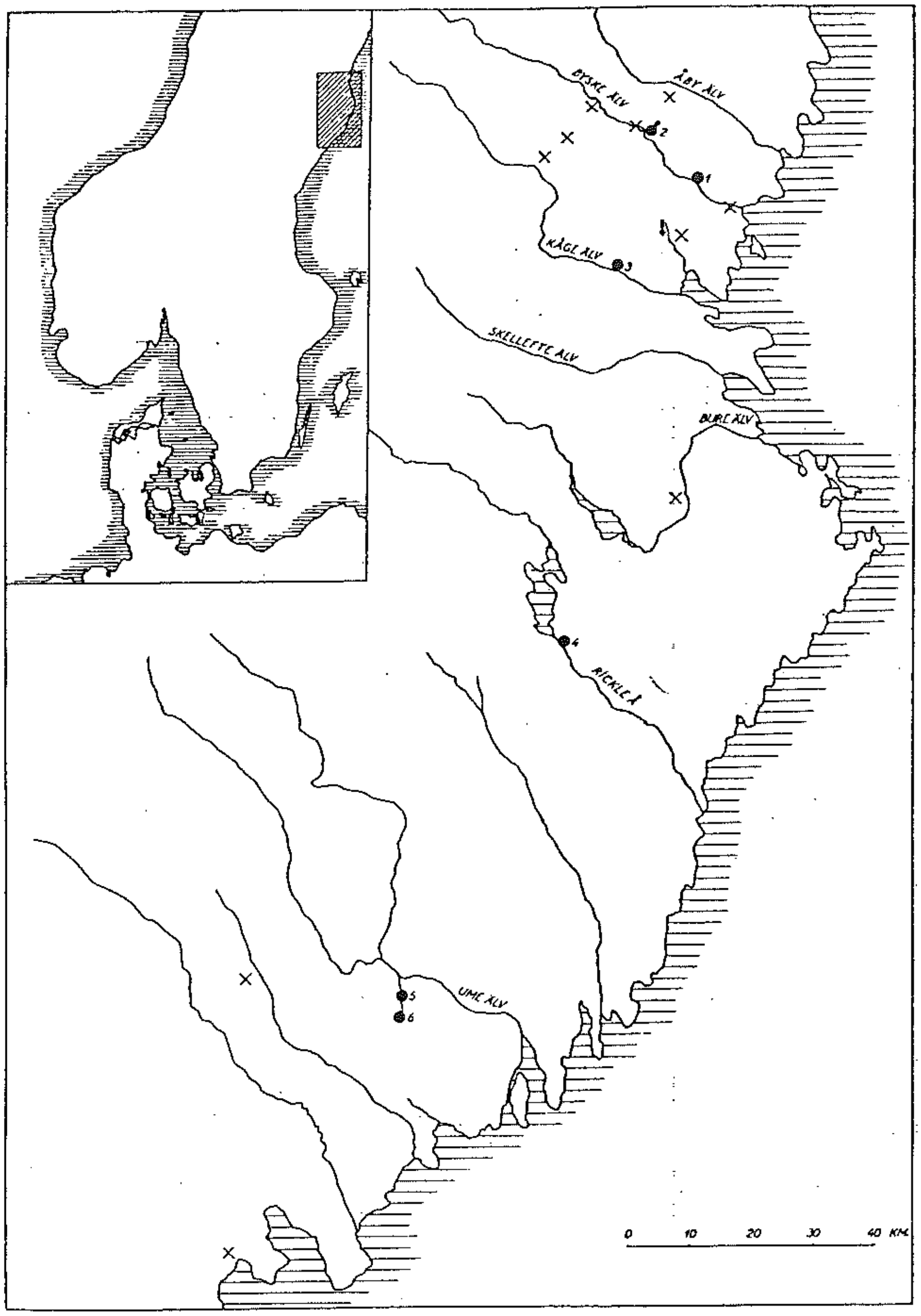

Fig. 18. Finds of flint axes in Västerbotten (after *Becker 1952*). ● - hoards, x - single finds — *Obr. 18.* Nálezy pazourkových sekerek ve Västerbotten. Podle: *Becker 1952*. ● - depoty, x - jednotlivé nálezy.

production area (*Becker 1993*). *Malmer* (*1962*, 518 f) has also pointed out that the formal properties of the north Swedish axes correspond to the flint axes in the graves of the Swedish-Norwegian Battle-Axe Culture, which would mean they belonged to an east Scandinavian tradition. Future investigations may shed more light on this issue.

Jan Apel – Kjel Knutsson

6. CONCLUSIONS

We have tried to illustrate the complex nature of humans' use of flint raw materials in Scandinavia during the Neolithic. Flint is readily available in southern Scandinavia, in the form of nodules occurring on beaches, in till deposits, and in primary contexts in chalk and limestone bedrock. We also have evidence for flint mining in southwestern Scania and northern Jutland during the Neolithic period. However, natural flint deposits are absent in the north. Detailed study shows that daggers made of flint from the Danish isles and southwestern Scania were distributed to southern and central Sweden and to the southeastern parts of Norway, while daggers made on northern Jutland were exported north to western Norway and from there into northern Sweden. Polished flint axes made from south Scandinavian flint have been transported distances up to 1000 km from the flint sources during the Neolithic. Even in the flint-rich south, the use of the different types of flint is complex and varied. A detailed analysis of production and consumption of polished flint axes illustrates that these parameters do not spatially coincide, suggesting that non-locally as well as locally produced axes were used, or that more locally produced axes were exported from the area.

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SOUHRN

Článek předkládá výsledky švédské národní pracovní skupiny v rámci projektu IGCP/UNESCO 442 "Suroviny neolitických/eneolitických broušených kamenných nástrojů: migrační cesty v Evropě". Cílem projektu je poznání cest, po nichž se suroviny přemísťovaly po evropském kontinentě.

Švédská pracovní skupina se zaměřila na skandinávský poloostrov, v jehož jižní části se zdroje pazourku vyskytují (*obr. 2*). Tam docházelo v neolitu k extenzívní směně a transportu surovin (*obr. 1*).

Záměrem této práce je identifikovat cesty, po nichž byly pazourkové sekery a dýky transportovány (*obr. 8* a *14*).

Tyto dva typy artefaktů tvoří základnu specializovaného neolitického silexového technologického komplexu, jehož produkt představovaly pečlivě vypracované pazourkové předměty. Zmíněné sekery reprezentují ve Skandinávii jediný typ pazourkového artefaktu, který byl v závěrečné fázi výroby broušen. Probírána je dostupnost pazourku ve Skandinávii a popsány doklady jeho těžby v neolitu (*obr. 4, 5, 6*). Problematika broušených pazourkových seker a dýk je předvedena na třech příkladech. Lokální výrobní a distribuční sítě jsou porovnávány s pohybem hotových výrobků napříč skandinávským poloostrovem (*obr. 2*).

Autor konstatuje, že pazourek v podobě hlíz vyskytujících se na pobřeží, v jílovitých uloženinách a v primárním kontextu v křídě a vápenci byl ve Skandinávii dobře dostupný. V jihozápadní Skanii a severním Jutsku je doložena neolitická těžba pazourku (*obr. 3, 5, 6*), dále na severu však jeho zdroje chybějí.

Detailní výzkum ukazuje, že pazourkové dýky z dánských ostrovů a z jihozápadní Skanie se distribuovaly do jižního a středního Švédska a do jihovýchodních částí Norska, zatímco dýky vyrobené v severním Jutsku se exportovaly do západního Norska a odtud do severního Švédska (*obr. 17*).

Broušené sekery vyrobené z jihoskandinávského pazourku byly v neolitu transportovány až do tisícikilometrové vzdálenosti od zdrojů suroviny (*obr. 18*).

Použití různých druhů pazourku bylo značně variabilní i na jihu studovaného území, kde byly zdroje pazourku velmi bohaté (*obr. 7, 8*).

Detailní analýza jihoskandinávských broušených pazourkových seker přinesla poznatek, že jejich produkce a spotřeba spolu prostorově nesouvisejí. To naznačuje, že používány byly lokálně i jinde vyráběné sekerky, nebo že odtud bylo větší množství zde zhotovených sekerek vyváženo jinam (*obr. 13*). Tyto závěry odrážejí nejednoduché způsoby využívání pazourkové suroviny během skandinávského neolitu.

Překlad N. Venclová

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Addresses: Jan Apel, Department of Archaeology and Ancient History, Uppsala University, St. Eriks torg 5, 753 10 Uppsala, Sweden, e-mail: Jan.Apel@arkeologi.uu.se

Anders Högberg, Department of Antiquities, Kultur Malmö, Box 406, 201 24 Malmö, Sweden, e-mail: Anders.Hogberg@malmo.se

Kjel Knutsson, Department of Archaeology and Ancient History, Uppsala University, St. Eriks torg 5, 753 10 Uppsala, Sweden, e-mail: Kjel.Knutsson@arkeologi.uu.se

Deborah Olausson, Institute of Archaeology, University of Lund, Sandgatan 1, 223 50 Lund, Sweden, e-mail: Deborah.Olausson@ark.lu.se

Elisabeth Rudebeck, Department of Antiquities, Kultur Malmö, Box 406, 201 24 Malmö, Sweden, e-mail: Elisabeth.Rudebeck@malmo.se