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The chipped stone industries of the Early Neolithic communities of Moravia and Lower Austria (see Appendix) and their comparison with the lithic industries of selected regions

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6. THE CHIPPED STONE INDUSTRIES OF THE EARLY NEOLITHIC COMMUNITIES OF MORAVIA AND LOWER AUSTRIA (SEE APPENDIX) AND THEIR COMPARISON WITH THE LITHIC INDUSTRIES OF SELECTED REGIONS

6.1. Raw materials

6.1.1. The early phase of the LBK and its comparison to the Mesolithic

The Mesolithic

First, information relating to the management of raw materials in the Mesolithic is summarised; then attention is turned to the use of stone raw materials and their distribution in the LBK (**map 10**).

Mesolithic finds in Moravia are scarce. Only the finds from the site at Smolín are stratified (Valoch 1978), with the others coming from surface collection. On the basis of typological analyses, most of the sites in south Moravia can be dated to the latter half of the Boreal and to the period at the end of the Boreal and the beginning of the Atlantic. Some of these sites were probably settled repeatedly (Smolín, Přibice, Mikulčice; Vencl 1993, 149). In Lower Austria, too, the Mesolithic is known only from surface sites, with the exception of Kamegg (Leitner 1984; Antl-Weiser 1986, 192–220). In northern Hungary, topographic survey at the beginning of the 1990s identified Mesolithic sites in the north of the Great Hungarian Plain, where according to some authors Mesolithic settlement was not to be expected (Kertész 1994a, 24). The sites of Jászberény I and Jásztelek I are also documented stratigraphically, and radiocarbon dates have been obtained from Jászberény I (Kertész *et al.* 1994, 28; Kertész 1996a).

The composition of raw materials of the stations at Smolín and Přibice is very similar. At both, there is a predominance of raw material of local origin (ca 83 %), which is represented by Krumlovský Les chert (in its fine-grained variety II), complemented by regional Olomučany chert, spongolites[6], rock crystal and also radiolarites (ca 10–12 %). Imported raw materials[7] make up some 6–7 % of the total and come from distances of 120–420 km. These may be divided into raw materials coming from northern and north-eastern regions (erratic silicites, Krakow Jurassic silicites, chocolate silicites) and those from the east and south-east (obsidian and Szentgál radiolarites; Mateiciucová 2001a, 285).

Similar compositions, but also connections to the west have been identified at Dolní Věstonice, where the local Krumlovský Les chert accounts for around 43 %. Raw materials of regional origin (for the distinction between local, regional and supra-regional/imported see chapter 7.2.), such as Olomučany chert, spongolites and radiolarites represent a further 35 %, while raw materials not identified more closely account for 12 %; imported raw materials make up about 10 %. In addition to raw materials from the north (erratic silicites), north-east (Krakow Jurassic silicites, chocolate silicite) and the south-east (radiolarites from the Bakony mountains), Skršín quartzite from north-west Bohemia and Bavarian Abensberg-Arnhofen striped tabular chert[8] from the west are also present (Mateiciucová 2001a, 285, 287).

6 In addition to their primary sources, spongolites could have come from the gravels of the rivers Svitava and Svratka (Přichystal 1999). The closest, but not very rich sources of radiolarites known are in the Miocene gravels of the Carpathian Foredeep; they also occur in the Danubian gravels and along the Moravian-Slovak border (Přichystal 1994, 46).

7 Raw materials imported from great distances were used at the Smolín, Přibice and Dolní Věstonice stations to produce typical Mesolithic microliths.

8 In Dolní Věstonice "Písky" two sherds of Stroke-Ornamented Ware were found. Thus, the core of Bavarian Abensberg-Arnhofen striped tabular chert could be a later intrusion (Šebela 2002). On the other hand, in the Stroke-Ornamented Ware this

At Mikulčice, raw materials of local and regional origin make up 91 % of the total; some of these probably come from the gravels of the Morava or Svratka (spongolites, radiolarites and porcelainite). Imported raw materials make up only an insignificant proportion of the whole (1 %); among them are siliceous weathering products of serpentinites, sources of which are known in south-western Moravia and in the Waldviertel region, as well as erratic silicites and – from the east – obsidian and limnosilicites (Škrdla, Mateiciucová & Přichystal 1997, Tab. 1; Mateiciucová 2001a, 286–287).

The small assemblage from Šakvice (35 pieces) comprises local Krumlovský Les chert, spongolites and radiolarites, complemented by imported erratic silicites. Radiolarites were used to make very regular, bifacially retouched segments. The closest analogies to these come from the Early Neolithic of the French Mediterranean (Betey type) and are also typical of the Natufian of the Near East (Ginter & Kozłowski 1990, 238; Mateiciucová 2001a, 286–289; S. K. Kozłowski 2001, 269). These radiolarites could have come from any of several regional sources (Přichystal 1994, 46), but their specific dark red tint with dark grey to black dappling suggests that they may have been of other provenance (made outside Moravia?). Given that no similar segments have yet been found in central Europe, the question of their origin remains open.

In north Moravia, finds from Mesolithic sites around Příbor have been collected for several years; the main source of raw material here is glacial moraine, complemented by raw materials of regional origin (radiolarites and porcelainites; Hudec 1996).

The majority of the chipped stone artefacts from the Mesolithic site at Wien-Bisamberg are made of raw materials (mainly radiolarites) from local Danubian gravels. Some artefacts may be of Mauer radiolarite from the south-western edge of Vienna. Imported raw materials comprise several examples of Krumlovský Les chert and limnosilicites from south-western Slovakia or north-eastern Hungary. In Waldviertel, at the site of Kamegg, there is a predominance of the regional Krumlovský Les chert from south-west Moravia. As was the case with the Mesolithic stations in south Moravia, there is once again a predominance of the fine-grained KL II variety. In addition to the Krumlovský Les cherts, local siliceous weathering products of serpentinites appear, along with various raw materials from the gravels (radiolarites and cherts). Rock crystal also appears sporadically; its primary source are probably the pegmatites in the Waldviertel region. At the sites of Limberg-Mühlberg and Burgschleinitz there is a predominance of local raw materials from gravels of the Kamp river, complemented by siliceous weathering products of serpentinites and Krumlovský Les chert. The station at Burgschleinitz also yielded a single core made from rock crystal. With the exception of the Krumlovský Les chert at the Wien-Bisamberg station (ca 75 km), raw material imported from a great distance has not been identified with certainty at any of the Lower Austrian sites.

The assemblages from northern Hungarian sites in the Zagyva Basin between the Tisza and the Danube are fairly uniform in their composition. There is a heavy predominance of limnosilicites, complemented by hydrosilicites (90–96 %), probably from the Mátra mountains. They also occur in the riverine alluvial deposits of the Zagyva (Kertész *et al.* 1994, 25). Imported raw materials are represented by obsidian from the north-east and Szentgál radiolarite from the south-west. It is interesting that the sites which are typologically and stratigraphically younger (Jásztelek I, Jászberény II and III) contain larger numbers of these imports[9]. On the surface site at Kaposhomok in southern Transdanubia there is a preponderance of radiolarites from the Bakony mountains, complemented by Mecsek radiolarites (Marton 2003, 45).

The early phase of the LBK

In the earliest phase of the LBK, the settlements at Brunn IIa and Brunn IIb in the Vienna Wood region display a preference for raw materials of south-eastern origin, specifically for the Hungarian radiolarites from the Bakony mountains (**tables 40 & 41**; **map 11**). The orange-red Szentgál was most commonly imported. By contrast, the local Mauer radiolarites, which predominate in the later phase, account for around 37–38 % of the total (**table 38**). On the basis of C-14 dating and an unclear differentiation in house orientation, P. Stadler believes that Brunn IIa is somewhat earlier than Brunn IIb (Stadler, pers. comm.). This difference is not expressed in the proportions of stone raw material employed; rather, the proportions at the two sites are very similar. Other imported raw materials do not occur in any great quantity; if they appear at all, they are of eastern and south-eastern origin – there are isolated examples of limnosilicites and hydrosilicites from either south-western Slovakia or northern Hungary. A single radiolarite from Brunn IIb may have come from the Gerecse mountains in northern Transdanubia, or perhaps the Mecsek mountains in southern Transdanubia.

raw material is mostly found in the form of blades and finished tools, not cores.

9 I wish to thank R. Kertész (Damjanich Museum, Szolnok) for making it possible to study the chipped stone material from the Mesolithic sites of Jásztelek I and Jászberény I, II and III.

Mecsek radiolarites occasionally, but relatively regularly, appear in chipped stone assemblages dating to the early phase of the Transdanubian LBK (Szentlörinc, Rigyác; Biró 1987, 145). Bakony radiolarites were probably imported to Brunn II as unworked nodules, but also as prepared cores, as is indirectly attested by the presence of cores in an advanced state of exploitation, crested blades and flakes and other technical flakes, e.g. rejuvenation flakes from a core's striking platform. Blade blanks and tools were made directly at the site. Intensive production activity is attested by the large quantity of chips of this raw material. Some of the high number of blades and tools may, however, have been imported as finished products as well. By contrast, local Mauer radiolarite (3–5 km) was brought to the settlement in unworked form, or was only partially prepared into core form; the majority of the preparation and the production of blanks itself then took place directly within the settlement area.

At the settlements of Brunn III and Brunn IV, which are somewhat younger than Brunn IIa and Brunn IIb, the proportion of Bakony radiolarite declines in favour of local Mauer radiolarite[10]; the latter is of relatively high quality. KL I chert from south-western Moravia has also been identified at the Brunn IV settlement (**table 38**).

Bakony radiolarites are also relatively strongly represented at the site of Perchtolsdorf, which is roughly contemporary with Brunn III and Brunn IV.

None of the sites in the eastern part of the Vienna Wood made use of raw materials from the Danube gravels, which were the main source for the Mesolithic station at Wien-Bisamberg, some 25 km to the north. This is despite the fact that the settlements at Brunn were located on the terrace of the Danube.

A similar situation is encountered further up the Danube in the Waldviertel region. Here, too, there is a predominance of raw materials imported from the south-east at early LBK settlements some 25–30 km from the present course of the Danube. At Rosenburg I there is again a preponderance of Bakony radiolarites (**table 87**); alongside the Szentgál type, the Úrkút-Eplény type makes up about half of the material. This raw material was transported in the form of prepared cores; cores of other than Transdanubian raw materials do not appear at Rosenburg I. The second most abundant raw material at the site is Krumlovský Les chert, most often the coarse grained KL I variety. This was particularly used to make tools, among which slim perforators stand out. Local siliceous weathering products of serpentinites were essentially neglected.

10 The chipped stone from Brunn III and Brunn IV, as well as the material from the site of Perchtolsdorf mentioned below, could only be studied preliminarily, as the archaeological excavations at these sites were still ongoing at the time of writing.

Other significant imports were single pieces of silicite from the Krakow Jurassic and erratic silicites, both in the form of blades. At the settlement at Strögen, which lies just a couple of kilometres south-west of Rosenburg and which is dated to the same horizon as Rosenburg I, there is also a predominance of Bakony radiolarites[11]. In addition to the Transdanubian radiolarites, "chalcedony-like material" has also been identified at the site (Gronenborn 1997, 24). In this case, its description might match that of Krumlovský Les chert, abundantly represented at both Rosenburg and Mold; alternatively it may be a variety of siliceous weathering products of serpentinites.

Turning now to the situation in the Early Neolithic of Moravia, Bakony radiolarites were also present, but they did not dominate. In south-western Moravia, at Vedrovice- "Za dvorem", local Krumlovský Les chert predominates (**table 246**); again, there was a preference for the coarse-grained KL I variety. The appearance of Olomučany cherts from the central parts of the Moravian Karst, which regularly occur in the Mesolithic, is also fairly significant. Only a few pieces of Bakony radiolarite appear; other imports are one blade of Krakow Jurassic silicite and another perhaps from an erratic silicite.

The assemblage at the settlement Brno-Ivanovice in the Brno Basin (**table 107**) is dominated by raw materials of local origin – mainly Olomučany chert, complemented by Moravian Jurassic chert and Krumlovský Les chert. The raw materials from further afield include not only Transdanubian Szentgál radiolarite, but also isolated instances of raw materials from the north-east – Krakow Jurassic silicites and erratic silicites (Mateiciucová 2000, Tab. 6).

The situation regarding raw material supply in central and eastern Moravia appears somewhat different. At the Žopy I settlement, Krakow Jurassic silicites imported from Little Poland were used most often (**table 289**), while there was a significant presence (almost 15 %) of Bakony radiolarites. Erratic silicites and one artefact of KL I chert also occur.

11 Unfortunately, in the case of Strögen there is probably a mixed inventory, as D. Gronenborn concludes from the find of a triangular arrowhead made of Bavarian striped tabular chert (Gronenborn 1997, 24, Tab. 2. 1, 8). I believe that the appearance of Bavarian striped tabular chert need not necessarily be associated with the Lengyel culture; in south Moravia it has been found at the Mesolithic station at Dolní Věstonice, as well as being known from sites of the earliest phase of the LBK at Schwanfeld (Bavaria) and Mintraching (Bavaria). In these cases, too, Gronenborn presumes that it is a later intrusion. By contrast, A. Zimmermann suggests that it is an Early Neolithic import (Gronenborn 1997, 35; Zimmermann 1995, 12). Bavarian chert has also been found at Ostheim (Hessen), but at this site a Middle Neolithic (according to the western European chronology) settlement of the Großgartach culture was also identified.

Likewise, at Kladníky, near Přerov, there is a predominance of Krakow Jurassic silicites (**table 147**). The smoothed surfaces of some pieces point to an origin in fluvial or glaciofluvial gravels. The greater part of the Krakow Jurassic silicites from the settlement at Mogiła 62 (Caspar, Kaczanowska & Kozłowski 1989, 159), as well as some at Kazimierza Mała, also comes from gravels. Local erratic silicites assumed a secondary role in supplying the site, but in contrast to the situation at settlements of the middle phase were not entirely insignificant. At Kladníky, a single artefact of Szentgál radiolarite was recovered (Mateiciucová 2000, Tab. 1).

In the first phase of the settlement at Mohelnice, the composition of raw materials is also similar to that at Žopy I and Kladníky[12]; here, too, Krakow Jurassic silicites enjoyed particular favour, and were complemented by erratic silicites. Transdanubian radiolarites, Krumlovský Les chert and Olomučany chert also appear several times. A highly exotic flavour is added by Carpathian obsidian and Spotted Świeciechóv and chocolate silicites, but in different proportions to those known from the settlement at Kazimierza Mała and from the earliest occupation phase at Bylany. At Bylany there is no obsidian, but there is Szentgál radiolarite and Krumlovský Les chert (Lech 1989a, 112).

In connection with Bakony radiolarite, sites in western Hungary and in Burgenland should also briefly be mentioned. Until recently, there were only a small number of chipped stone assemblages from the western part of Hungary that could be classified as belonging to the earliest phase of the LBK (Biró 1987). Only in the second half of the 1990s was a larger assemblage added from the site at Szentgyörgyvölgy-Pityerdomb, which dates to the beginning of the LBK and which contains a range of Starčevo cultural elements (Bánffy 2000). This site is dominated by Bakony radiolarites (Biró 2001, Fig. 8; 2002, 124, Table 6) transported from a distance of around 120 km (**map 6**). At the settlement at Neckenmarkt, some 80 km north of Szentgyörgyvölgy-Pityerdomb, there is again a predominance of Transdanubian radiolarites (Gronenborn 1997, 20) – and in the same way there is a similar predominance at all of the Transdanubian sites linked to the earliest phase of the LBK, namely those at Bicske-Galagonyás, Szentlörinc-Téglagyár, Hidegkút, Veszprém-Nándortelep and Budapest-Aranyhegyi út (Biró 1987, 131–167, 145; 1998, 46, 59, 145–146, 251; Makkay, Starnini & Tulok 1996, 158). In addition to Bakony radiolarites, these sites have yielded stray imports of radiolarite from the Mecsek mountains in southern Transdanubia. However, with the exception of the contentious examples from Brunn IIb and Rosenburg I, Mecsek radiolarites did not spread further to the north-west in this period (Biró 1998, 36). Bakony radiolarites, by contrast, are known from distances of up to around 800 km from their primary source, from the site of Ostheim-Mühlweide in Hessen (**map 6**).

In the same way that there is a predominance of Bakony radiolarite in the Earliest Neolithic in western parts of Hungary and in areas further to the west and north-west (at sites up to 250 km from the primary source), in the Körös culture of eastern and south-eastern Hungary there is a predominance of Carpathian obsidian of almost certainly Slovakian provenance, up to 260 km distant from the source and complemented by northern Hungarian limnosilicites. At Körös culture sites further south, an important role is played by a honey coloured silicite with light spots – Banat silicite (the so-called "Banat flint"; Kaczanowska, Kozłowski & Makkay 1981; Starnini 1994; Starnini & Szakmány 1998; Mateiciucová 2007). Here, too, individual imports of Szentgál radiolarite are known from some sites (Ecsegfalva 23, Méhtelek-Nádas, Tiszacsege-Homokbánya; Starnini 1994, 102–103; Mateiciucová 2007).

The general characteristics of the raw material supply (**table 5**) of earliest LBK sites may be summarised as follows:

1) Artefacts made from Bakony radiolarite have been found at all sites associated with the earliest phase of the LBK in Transdanubia, Lower Austria and Moravia.
2) At Lower Austrian sites, Bakony radiolarites predominate over the local raw material. They are a raw material of supra-regional character.
3) In north Moravia, Krakow Jurassic silicites imported from distances of 170–200 km predominate from the earliest LBK phase (Žopy, Kladníky, Mohelnice).
4) In contrast to the middle phase of the LBK, at a settlement of the early phase a particular type of raw material does never utterly dominate an assemblage (i.e. is not present in a proportion of over 80 %), but is accompanied by other raw materials often of fluvial or glaciofluvial origin which must have been selectively collected from the gravels, as during the Mesolithic.
6) At all sites in Lower Austria, raw materials from areas to the south-east predominate in the earliest phase, while in the later period there is a predominance of raw materials that are either local or come from sources to the north. In Moravia, while raw materials originating to the south-east do not predominate in the earliest phase, they are

12 Unfortunately, this site was occupied for the whole duration of the LBK, and the various phases cannot be securely distinguished from each other.

still present more often than in the later phases; by contrast, raw materials from outcrops located to the north were more common in later phases.

Comparison of the early phase of the LBK with the Mesolithic

A comparison of raw material supply in the Early Neolithic and Mesolithic in Moravia, Lower Austria and neighbouring regions leads to the following conclusions:

1) The range of raw material employed is not as wide in the Early Neolithic as it had been in the Mesolithic. In Moravia, the use of spongolites, rock crystal and radiolarites – i.e. the majority of raw materials of a regional character – ceased, probably in conjunction with the shrinkage of the exploited territory during the Neolithic and with the limitation of mobility. In a hunter-gatherer society, the territory used to secure subsistence was far more extensive than that required by a society supporting itself by means of food production; in order not to exhaust resources (animals, fish, plants), stations moved seasonally, and raw material sources 30 to 80 km away from the camp were still within range during the Mesolithic. In Early Neolithic society, the area necessary to support existence shrank by around half (to perhaps 30 km). Nevertheless, compared to the middle phase of the LBK, the proportion of such regional raw materials was still higher, and indicates the greater mobility of the early LBK population.

2) In the Mesolithic, raw materials were most likely obtained through individual activity, and in particular by uncoordinated selective collection. In the early phase of the LBK, too, there are isolated occurrences of raw materials obtained from gravels; unlike the situation in the Mesolithic[13], however, priority was given to raw materials of higher and standardised quality, satisfying the demand for the production of regular blades. The higher quality of the raw material required a different set of measures than was used in the Mesolithic, and it is not impossible to discount even the extraction (mining) of raw materials, which peaked in the later phase. These facts are underlined by the disappearance of stone raw materials obtained mainly by collection from gravels of various kinds (river, Tertiary sediments, glacial sediments). In the LBK, the following materials are abandoned:

a) spongolites, which could be collected on the Svitava and Svratka terraces as erratic silicites
b) the fine grained KL II variety of Krumlovský Les chert, which judging from the situation today did not occur *en bloc* but could only be obtained by collection
c) raw materials from Danubian gravels, particularly radiolarites
d) erratic silicites obtained from glacial gravels, which still predominated in the early LBK in eastern Bohemia (Bylany I) and in Lower Silesia (Gniechowice a Stary Zamek), but were replaced in the later phases by Krakow Jurassic silicites (Bylany, Niemcza and Skoroszowice; Lech 1985, 75; 1989a; Přichystal 1985)
e) Krakow Jurassic silicites with smoothed natural surfaces, which had been obtained from glaciofluvial gravels. They were used in the early LBK phase (Kladníky, Mogiła 62, Kazimierza Mała), but disappeared in the later phases of the LBK

3) At both Mesolithic and early LBK sites, the following very long-distance imports appear:

a) Krakow Jurassic silicites: these occur both in the Mesolithic (in Moravia at Smolín, Přibicíce and Dolní Věstonice, and in south-western Slovakia at Sereď, Tomášikovo and Bratislava; Hudec 1996) and in the early LBK (at Kladníky, Žopy I, Mohelnice, Bylany I, Brno-Ivanovice, Vedrovice "Za dvorem" and Rosenburg I)
b) radiolarites from the Bakony mountains: these occur both in the Mesolithic (Smolín, Přibice, Dolní Věstonice ?) and in the early LBK
c) chocolate silicite: thus far, this material is only known from Mesolithic sites in Moravia[14].
d) Carpathian obsidian: thus far, this is only known from Mesolithic sites in Moravia; in the early phase of the LBK it appeared at the Transdanubian sites of Szentlörinz-Téglagyár (Biró 1987, 131–167, 145) and Budapest-Aranyhegyi út (Biró 1998, 46, 145–146) and has also been identified at Kazimierza Mała in Little Poland[15].

4) At Mesolithic sites, raw materials imported over great distances are never predominant, but priority is given to raw materials of local or regional character.

13 There is no difference between the Early and Late Mesolithic.

14 A single artefact of chocolate silicite has been identified by D. Gronenborn at Neckenmarkt in Burgenland (Austria). It is presumed that this could be a later intrusion, or that the site dates to the end of phase I of the LBK, when this raw material was also distributed in this region (Gronenborn 1997, Abb. 2.2, 110, 113). Otherwise, chocolate silicite is known from the early phase of the LBK at Kazimierza Mała in Little Poland and from Boguszewo 41 in the Chełmno-land, near Toruń (Małecka-Kukawka 1992, Tab. 1). In Moravia several examples have been discovered at Mohelnice, but their classification into the early phase of the LBK is uncertain.

15 At the Budapest-Aranyhegyi út and Kazimierza Mała sites, settlement activity dating to the later phases of the LBK or from other Neolithic periods was also identified, when obsidian is much more likely to have occurred.

			Raw material provenance (%)									
Region	Dating (after Tichý)	Site	Local	South-west	South	South-east	East	North-east	North	North-west	West	Other
Vienna Woods	LBK phase Ia	Brunn IIa	37.7			56.6	< 0.1					5.6
	LBK phase Ia	Brunn IIb	38.8			56	< 0.1					5.1
	LBK phase I	Brunn IV	45			45	3.3		3.3			3.3
	LBK phase I/II	Brunn I	70.5			12.5	0.9	0.9				15.2
Waldviertel	LBK phase Ib	Rosenburg I	12.8			54.6		25.4		1.8		5.4
	LBK phase I	Strögen				41.7						
	LBK phase I/II	Mold I	23			2.6		69.2				5.2
Wein-viertel	LBK phase I/II+II	Kleinhadersdorf – cemetery (24 pcs)				17		46	17			20
	LBK phase II+III	Asparn-Schletz	0..3			7.1	0.3	28.5	39.3			24.5
SW Moravia	LBK phase Ia	Vedrovice "Za dvorem"	77.2			1.6		0.4	18.8			2
	LBK phase I/II+II	Vedrovice "Šir. u lesa" – cemetery	31.4			9		38.8				20.8
	LBK phase I/II+II	Vedrovice "Šir. u lesa" – settlement	91.9			0.1		1.5	0.2			6.2
	LBK phase II ?	Nové Bránice	95.1									4.9
	LBK phase II	Těšetice-Kyjovice "Sutny"	76.5			1.2		2.3	6.9			13
Brno basin	LBK phase Ia	Brno-Ivanovice	88		2			2	4			4
	LBK phase I/II	Brno-Nový Lískovec	85.9					6.1	1			7
	LBK phase II+III	Kuřim	99.4					0.3	0.1			0.2
Eastern Moravia	LBK phase Ia	Žopy I	2.6	2.6	14.5	3.9		63.2	6.6			6.6
	LBK phase II	Žopy II (18 pcs)						94.5	5.5			
NE Mora-via	LBK phase Ia	Kladníky	22.4		0.8			65.6				11.2
	LBK phase II	Přáslavice-Kocourovec	9.4	0.7	0.4			76				13.5

Table 5. Raw material provenance (in percent) during the LBK in selected regions of Moravia and Lower Austria.

By contrast, in the early phase of the LBK raw materials are dominated by:

a) In Lower Austria – Bakony radiolarites
b) In northern Moravia – Krakow Jurassic silicites

5) In the Körös culture, too, imported raw materials predominate: obsidian, limnosilicites and Banat silicite; in this case, however, the preponderance of imported raw materials is related to a lack of local raw materials.

6.1.2. The end of phase I and the middle phase of the LBK

The situation here was somewhat different to that in the earliest phase of the LBK; it is possible to trace a general trend in the use of raw material sources closer to hand, and in the orientation towards particular types of raw material. At almost all sites, raw materials of local origin or imported from the north and north-east gradually came to predominate (**table 5**; **map 12**).

At Brunn I in the Vienna Wood region, dated to the end of phase I of the LBK, only a very small number of chipped stone artefacts were found, in contrast to the earlier settlements at Brunn IIa and Brunn IIb. The assemblage displays a marked decline in Transdanubian radiolarites, the proportion of which falls to a mere 12.5 % in favour of local Mauer radiolarites. A single long distance import from Little Poland appears – a tool made from Krakow Jurassic silicite (**table 57**).

A development similar to that in the Vienna Wood was also followed further up the Danube in Waldviertel. At the settlement at Mold, founded earlier than the very beginning of phase II, the proportion of Bakony radiolarite – the only raw material of south-eastern or eastern origin – is less than 3 %; Krumlovský Les chert predominates, with a significant presence of siliceous weathering products of serpentinites of Japons type

and other varieties of siliceous weathering products of serpentinites, probably also of local origin (**table 68**).

At the cemetery at Kleinhadersdorf, dated to the transitional phase I/II of the LBK, the situation was different to that at the settlements. Here, the majority of the chipped stone artefacts, dominated by blades and trapezoidal forms, were made from raw material imported over considerable distances (Krakow Jurassic silicites and Szentgál radiolarite; **table 61**). A similar situation is known from the contemporary cemetery at Vedrovice (see below).

In Moravia, changes were not as radical as in the Danubian region of Lower Austria, but certain differences are nevertheless observable. The sites analysed here are somewhat younger than those in Lower Austria; most can be assigned to the period of the developmental apex of the middle phase ('*Notenkopfkeramik*') of the LBK; by contrast, the Lower Austrian sites rather date to the end of phase I and the beginning of phase II.

Only the cemetery at Vedrovice "Široká u lesa" can be dated to the same period. Like that at Kleinhadersdorf, it exhibits a preponderance of imported raw materials (Krakow Jurassic silicites, Szentgál radiolarites) despite a source of Krumlovský Les chert in its immediate vicinity (**table 282**). In contrast, at the settlement at Vedrovice "Široká u lesa" (**table 266**) local Krumlovský Les chert is the primary raw material, while raw materials imported over great distances, such as Szentgál radiolarite, Krakow Jurassic silicites, erratic silicites and Olomučany chert, occur only in insignificant quantities. Although the features in which Transdanubian radiolarites were found have yet to be dated, it is assumed that the settlement was occupied as early as phase Ib of the LBK, and that it is partially contemporary with the cemetery (Lech 1983a, 51–52; Mateiciucová 1992; 1997b; 1998; Podborský 2002, Tab. 5; T. Berkovec, pers. comm.).

As at the Vedrovice "Široká u lesa" settlement, other Moravian sites of this period are also characterised by an orientation to one particular type of raw material, which is either local or supra-regional in nature and which often forms up to 90 % of the raw material assemblage.

At Nové Bránice, no raw materials other than local chert from the Krumlovský Les upland region were identified (**table 181**). At Těšetice, beyond the exploitation zone, the same raw material predominated, with only a 6 % presence of local siliceous weathering products of serpentinites; raw materials from further afield were represented by a few artefacts made from Krakow Jurassic silicites and erratic silicites. Other than an artefact from contentious limnosilicite, no other raw materials of south-eastern origin were identified (**table 224**).

At the edge of the Brno Basin, at Brno-Nový Lískovec, dated to the end of phase I, there is a preponderance of local Jurassic chert and Krumlovský Les chert. Several artefacts made from Krakow Jurassic silicites also appear, along with one made of erratic silicites.

At Kuřim there is a heavy predominance of local Olomučany chert, with Krumlovský Les chert and other Moravian Jurassic cherts appearing in negligible quantities; there are also several artefacts made from spongolite, which is absent in the earliest phase of the LBK despite being used a great deal in the Mesolithic. The long-distance imports identified were Krakow Jurassic silicites and erratic silicites (**table 166**).

Northern Moravia is part of the region supplied by Krakow Jurassic silicites imported from Little Poland. These predominate even in the small assemblage from Žopy II (**table 308**).

A similar situation is known from the settlement at Přáslavice-Kocourovec, where Krakow Jurassic silicites were preferred to the local erratic silicites (**table 200**). Two examples of KL I chert were also recovered from the site, along with a single artefact of Szentgál radiolarite (feature 26a – dated to LBK phase IIb; Mateiciucová 1997a).

At this time, Krakow Jurassic silicites also predominated at the sites of Bylany and Močovice in east Bohemia, as well as in Lower Silesia at Skoroszowice and Niemcza (Lech 1989a; Pavlů 1998a, 56).

The general characteristics of the raw material supply at sites of the music note phase of the LBK can be summarised as follows:

1) Bakony radiolarites, along with other raw materials of south-eastern origin, sharply decline to the point of almost total absence
2) There is a preponderance of imports of north-eastern and northern origin
3) Sites are oriented towards a single raw material type, in most cases either of local or supra-regional origin, a strategy in line with a settled lifestyle and well-organised exchange system; other raw materials appear only in very minor quantities
4) In Lower Austria and in south Moravia, raw materials of local origin predominate
5) In northern Moravia, as well as in eastern Bohemia and Lower Silesia, Krakow Jurassic silicites predominate
6) Emphasis is placed on the quality of raw materials; the raw materials from gravels used in the earliest phase of the LBK are abandoned

6.1.3. The late phase of the LBK and the Middle Neolithic

Only the assemblage from Asparn-Schletz in Weinviertel has been classed as belonging to the later phase of the LBK. In the case of this settlement, it is not possible to completely rule out the possibility that some of the artefacts might also have come from the middle phase.

Given that a comparable assemblage is missing from Moravia, chipped stone assemblages from neighbouring regions will instead be used for comparison here. In Moravia, there is a whole series of sites with settlement dating to the late phase of the LBK, but unfortunately these are sites that have not as yet been studied in detail and which were occupied for a longer period within the LBK, so that it is difficult to assign them to any single chronological phase (Mohelnice, Nová Ves u Oslavan).

As already noted, the Asparn-Schletz settlement probably came to an end through a violent attack, during which the majority of its inhabitants were killed. While the diversity of the raw materials from this site clearly attest long-distance contacts, the markedly worn artefacts indicate that the settlement was to a certain extent isolated (**table 16**). The supply of stone raw material was probably interrupted for some reason at the end of the LBK. The diversity of the raw materials employed was obviously also influenced by the absence of raw material sources nearby (**map 13**). Traditionally, this region maintained a close relationship particularly with south-western Moravia, from where Krumlovský Les chert was transported during the whole Neolithic period (e.g. Friebritz, Falkenstein-Schanzboden: A/MPW I); this material also predominated at the Asparn-Schletz settlement, immediately followed by Krakow Jurassic silicites. From the far north-east, and a distance of some 435 km, came a single blade of Spotted Świeciechów silicite. As in LBK phase I, Bakony radiolarite appears, particularly the Szentgál type. Its occurrence is probably connected to more intensive contacts with south-eastern and eastern areas, also attested by the appearance of Želiezovce ceramics. One blade is made of obsidian, and its presence demonstrates links to the Szakálhát group of the middle Tisza, again confirmed by the ceramic material (Windl 1996, 16–17). In addition to siliceous raw materials, pieces and fragments of polished stone were also chipped, probably deliberately. The majority of these pieces are made from green schist, the closest known source of which is at Želešice, south of Brno.

The entire assemblage is extremely diverse, and the sizes of the artefacts also seem bizarre. Especially the fluctuation of artefact size is striking, above all when comparing the cores, which are in fact miniature and often hardly reach 20 mm, and the relatively large regular blades. It is as if a situation arose when the regular supply of the settlement with raw materials or finished blanks ceased to function normally, and it was necessary to scrabble among abandoned cores and other raw material wastage. Thus, on the one hand the already finished tools continued to be utilized and were probably highly valued and curated, as shown by the considerable traces of wear, and on the other hand at least some tiny flakes could still be obtained by splintering technique from the already abandoned cores. As I mentioned above, even abandoned polished artefacts were chipped and various lower-quality local cherts were also collected. One flake chipped off a polished artefact was even used as a sickle insert, as evidenced by the sickle gloss on its surface. The appearance of uniform blades of Krumlovský Les chert, often with sickle gloss, is striking. This type of blades had been manufactured in the settlement of Nové Bránice, from where the finished products were exported. Extremely similar sickle blades, also made of Krumlovský Les chert, have been found in the settlement at Kuřim. It seems likely that these blades reached Asparn in form of finished products, and they apparently come from the same chronological horizon (probably from the middle phase) as at the settlements in Nové Bránice and Kuřim (see chapter 6.5.).

At the end of the LBK, a development similar to that at Asparn-Schletz can also be observed in other regions. It probably relates to an overall crisis in Early Neolithic society associated with conflicts and cultic death rites (Spatz 1998; 2003, 583; Farruggia 2002) and connected with a population decline or even the depopulation of several areas. An attendant phenomenon of these developments was a collapse of the distribution network, and a replacement of the high-quality raw material often imported from long distances with a less valuable one, frequently collected from gravels. In Moravia, the raw material from gravels continues to be utilized by the Stroke-Ornamented Ware culture of the Middle Neolithic. In the Rhineland, for example, the Rijckholt silicites which had predominated in settlements of the middle phase of the LBK declined at the end of that culture and were replaced by raw materials obtained from gravels (Zimmermann 1995, 16). In the same way, the proportion of Krakow Jurassic silicite at Bylany also shrank, to be replaced by the erratic silicite that would later predominate in the Stroke-Ornamented Ware culture.

In Moravia, the raw materials coming from gravels also continue to be utilized further by the Stroke-Ornamented Ware culture (Oliva 1996; Čižmář & Šmíd 1997; Kazdová 1998; Kazdová, Peška & Mateiciucová 1999; Čižmář & Oliva 2001). Although

in south Moravia, for example, the Krumlovský Les cherts were still used during the Stroke-Ornamented Ware period, the fine-grained KL II variety began to dominate. It had already been used more frequently in the Mesolithic, and is collected from among gravels rather than being extracted (Oliva, Neruda & Přichystal 1999, 269, 306). In the Stroke-Ornamented Ware culture, Krumlovský Les chert was also used at more distant sites, and in central Moravia partially displaced Olomučany chert (Kuřim, Vyškov, Křižanovice near Vyškov; Mateiciucová 2001b). The extent of the distribution of Olomučany chert did not change overall. The collapse of the previous distribution network is particularly notable in those areas previously supplied with Krakow Jurassic silicites; in this period such raw materials were replaced in particular by erratic silicites (e.g. at Určice-"Záhumení", Olomouc-Slavonín, Cholina, Náměšť na Hané-"Valník"; Čižmář & Šmíd 1997; Kazdová, Peška & Mateiciucová 1999, fig. 34). Compared to the middle phase of the LBK, however, the late phase and the Stroke-Ornamented Ware culture in Moravia saw an increase in the proportion of imported raw materials. In addition to raw materials of south-eastern origin (obsidian, Bakony radiolarites), which are related to Želiezovce and Bükk influences at the end of the LBK and the formation of the Lengyel complex, there is an ever increasing occurrence of raw materials of western provenance, such as north-west Bohemian quartzite and Bavarian striped Abensberg-Arnhofen chert (Kazdová, Peška & Mateiciucová 1999, figs. 35, 36).

In Lower Austria, the situation with regard to particular raw material types and their provenance is unfortunately not yet mapped out in detail.

The general characteristics of the raw material supply at sites of the late phase of the LBK and Stroke-Ornamented Ware culture can be summarised as follows:

1) The raw materials employed are mainly of local or regional origin (**map 13**)

2) Within settlements, there continues to be a predominance of just one kind of raw material, but the orientation towards it is no longer as clear-cut as was the case in the middle phase of the LBK

3) More easily accessible, often lower quality, raw materials are used

a) The mass transfer of Krakow Jurassic silicites to more distant areas ceases; this change is compensated for by the use of more accessible erratic silicites

b) Of the Krumlovský Les cherts, the KL II variety predominates; it has probably been obtained by selection from gravels rather than by extraction/mining.

4) At the end of the Middle Neolithic, Krumlovský Les chert penetrated further to the north, apparently in conjunction with the movement of its users, the Stroke-Ornamented Ware culture, pushed north by the users of Moravian Painted Ware (cf. Kazdová 1998, 153–173)

5) Imports from greater distances are of more diverse provenance and comprise a greater proportion of assemblages than was the case in the middle phase:

a) Imports of south-eastern origin begin to appear again (Bakony radiolarites, obsidian). They are associated with Želiezovce and Bükk influences at the end of the LBK and with the formation of the Lengyel complex

b) Raw materials of western provenance appear (north-west Bohemian quartzite, Bavarian striped Abensberg-Arnhofen chert), linked to the penetration and formation of the Stroke-Ornamented Ware culture

6.2. Production of blanks

6.2.1. The technique of regular blade production

In the LBK, the production of blanks was oriented towards the production of regular blades. Setting aside Upper Palaeolithic blade industries, the first regular blades in Europe appear at the end of the Early Mesolithic and are regarded as the first indication of influences from the Near East.

S. K. Kozłowski (1987) suggests that the production of regular blades and other "pre-Neolithic" (proto-Neolithic) elements (such as trapeze production), originating in the Near East and central Asia, was taken up locally by European Mesolithic and Epi-Palaeolithic populations. In the Mediterranean, the Pontic regions, around the Paris Basin and in southern Germany, a discontinuity in the development of chipped stone industry can be observed between the Early and Late Mesolithic; this is expressed in a complete change in the technology of blank production and was also accompanied by a transformation in the typological range of tools. On the other hand, Kozłowski presumes a continual development in these areas from the Late Mesolithic to the Early Neolithic.

By contrast, in central Europe and the low-lying regions of Europe (the "lowland model"), development from the Early to Late Mesolithic is essentially uninterrupted. The chipped stone industry of the Mesolithic was enriched by several "pre-Neolithic" elements, which did however not come to predominate; a complete change only came about in the period of the ceramic Neolithic. This model thus assumes that the chipped stone industry of the Early Neolithic in

southern Europe is a continuation of the pre-Neolithic or Late Mesolithic tradition in this region. Further north, setting aside certain individual elements, these pre-Neolithic components spread in connection with the Starčevo-Körös complex and then also with the LBK. S. K. Kozłowski sees the origin of the chipped stone industry accompanying the LBK, as well as that of the Starčevo-Körös complex, in the pre-Neolithic chipped stone industry of the Mediterranean region (S. K. Kozłowski 1987).

J. K. Kozłowski's view is somewhat different. As with S. K. Kozłowski's model, it is assumed that there was a "hiatus" between the Early and Late Mesolithic in the Mediterranean and Pontic regions, expressed in the appearance of a new technology of blade production. The rise of this new technology is, however, seen in the migration of a new population from the Near East – while S. K. Kozłowski rather advocates an acculturation process, whereby knowledge of the new technology was adopted and adapted by the original Mesolithic population. Only in certain parts of southwest Europe, and on the basis of analyses by D. Binder (1984; 1987), does J. K. Kozłowski assume the continuous development of the Early Neolithic chipped stone industry from the original Early Mesolithic, uninfluenced by Late Mesolithic technological innovations. By contrast, further north in the Balkan/Danubian region, the Late Mesolithic chipped stone industry builds on the Early Mesolithic tradition. A developmental turning point came only with the beginning of the ceramic Neolithic, when knowledge of the new technology of blank production permeated into the Balkan/Danubian regions in conjunction with the migration of a new Neolithic population. Similarly, J. K. Kozłowski links the origin of the LBK chipped stone industry to the Early Neolithic cultures of south-east Europe, from where populations migrated further north (J. K. Kozłowski 1989a). Both scholars agree that the chipped stone industry of the eastern branch of the LBK (AVK) is a direct continuation of the traditions of the Körös culture, while the chipped stone industry of the Transdanubian branch of the LBK originated under the influence of contact with the Vinča culture; unlike the Vinča culture, however, the LBK was better adapted to loess environments (Kozłowski & Kozłowski 1986, 104–105; S. K. Kozłowski 1994, 30–32).

M. Kaczanowska also sees a close relationship between the chipped stone industry of the Vinča culture and that of the LBK; on the other hand, she also points out the pronounced differences between the chipped stone industry of the Starčevo-Körös complex and that of the LBK, for which she does not rule out the possibility of local Mesolithic roots (Kaczanowska 1989, 129–130).

The new blade technology meant the production of regular, long blades. Using the narrower definition, it is understood that these blades were made by pressure technique (S. K. Kozłowski 1987, 9; Perlès 1987, 28; J. K. Kozłowski 1989a). The origin of this technology in Europe, as follows from the models presented above, lies in the production methods used previously in the Late Palaeolithic and the Pre-Pottery Neolithic of the Near East and central Asia.

More broadly, all blades with parallel edges are termed regular blades. This is an essential part of the universally applicable definition of a blade (Ginter & Kozłowski 1990, 34; Zimmermann 1988, 580), according to which a blade is any flake the length of which is at least twice its width and which has parallel sides. W. Taute (1974/75, 76) defined the Late Mesolithic as the period when the production of blanks was oriented towards the production of regular blades. The production of regular blades then continued on into the Neolithic. The connection between the Neolithisation of Europe, the appearance of regular blades and the spread of trapezes was first formulated in 1958 by G. Clark.

The new technology of blank production first appeared in Europe in the south-east, from where it spread across the entire Mediterranean during the Late Mesolithic and penetrated as far as the Paris Basin; it also reached southern Germany (S. K. Kozłowski 1987). At several sites in southern Europe there was a conspicuous technological change in the production of chipped stone artefacts in the Late Mesolithic, while at other sites the first discernible signs of change appeared only later, at the beginning of the ceramic Neolithic. In the Franchthi cave in southern Greece, for example, the first, albeit less obvious, changes were observed in the course of the Late Mesolithic; it was in this period, too, that regular blades began to appear and that obsidian from the Aegean island of Melos was used far more often. The first conspicuous changes in the technology of blade production came at the beginning of the Neolithic (previously termed the "Aceramic Neolithic") – long, regular blades appear that were most likely produced by pressure technique. The production of chipped stone artefacts in the Franchthi cave is seen as continuous from the Late Palaeolithic to the Early Neolithic (Perlès 1987; 2003; Gehlen & Schön 2003, 258).

At the Odmut cave, too, no major technological changes in chipped stone industry were observed during the Mesolithic; here, developmental continuity persisted into the ceramic Neolithic. The production of long, regular blades began slowly through their lengthening and the gradual replacement of the raw materials used. In the Iron Gates region at Lepenski Vir, the Late Mesolithic also continued with-

out interruption from the Early Mesolithic; conspicuous change only came with the onset of phase III, when local raw materials were replaced by imported ones and long, regular blades began to be produced (J. K. Kozłowski 1982; Kozłowski & Kozłowski 1984; Kaczanowska & Kozłowski 1984–85; S. K. Kozłowski 1987; J. K. Kozłowski 1989a; Kozłowski, Kozłowski & Radovanović 1994).

In north-eastern Italy, however, changes between the Early Mesolithic (Sauveterrian) and Late Mesolithic (Castelnovian) are clearly discernible. Long, regular blades began to be produced in the Castelnovian, and this trend continued uninterrupted into the ceramic Neolithic.

Similarly, in southern France there is a discontinuity between the Early Mesolithic and the Castelnovian, when regular blades of the Montbani type were produced. An interruption in stone tool development between the Early Mesolithic (Sauveterrian) and the Late Mesolithic can also be documented in south-western France. Further development then continued without major changes into the Early Neolithic. According to Binder, in some parts of south-west Europe the technology of producing Early Neolithic blades is linked more to the tradition of the Early Mesolithic Sauveterrian than to the Castelnovian, which would imply that at least in some places the Neolithic originated through the acculturation of the local population (Binder 1984; J. K. Kozłowski 1989a).

Likewise, an interruption has been observed in the development from the Early to Late Mesolithic in the Pontic region, while on the other hand there is a fluid transition from the Late Mesolithic to the Early Neolithic. Long, regular blades began to be produced here as early as the Late Mesolithic, which itself appears very early in this region (J. K. Kozłowski 1989a).

These examples serve to demonstrate that changes in chipped stone technology linked to the arrival of Near Eastern influences in southern Europe did not follow the same pattern everywhere, and that this subject is far more complex than it might at first appear. In some areas it is possible to trace continual development from the beginning of the Mesolithic right through to the Early Neolithic; elsewhere there was a pronounced change in technology in the Late Mesolithic, and subsequent development was continuous, while there are also sites where the first changes in chipped stone technology only appear at the beginning of the Neolithic, if not later still.

Most southern European Late Mesolithic cultures are characterised by the production of long, regular blades, which it is presumed were produced by pressure technique, although the punch technique has also been suggested. The production of regular blades then continues on into the ceramic Neolithic. This means that some time around the end of the Boreal and the beginning of the Atlantic period either a new population began to move into the Mediterranean region from the Near East, or – thanks to contacts with the latter region – local Mesolithic and Epi-Palaeolithic populations in the Mediterranean began to change their technology of chipped stone artefact production.

It is in the phenomenon of regular blades that the majority of scholars have sought support for the idea of a developmental continuity from the Late Mesolithic to the Early Neolithic in the Mediterranean region. In contrast, the discontinuity of developments in the Balkan and the Danube area is often emphasised. A whole series of researchers have concluded that the Early Neolithic in these latter areas – the Starčevo-Körös complex and the LBK – did not grow out of the local Late Mesolithic, but that Neolithisation occurred thanks to the expansion of a new population from the south-east (Vencl 1982; 1986b; S. K. Kozłowski 1987; J. K. Kozłowski 1989a). On the other hand, and particularly in recent years, some investigators have rather tended towards an autochthonous development of the LBK (Whittle 1996; Zvelebil 2002); regular blades have again been one of the main arguments used in considering the autochthonous or allochthonous development of the LBK (Tillmann 1993; Gronenborn 1997; Kind 1998). Supporters of an allochthonous development hold that regular blades appear in the Balkans and central Europe only with the beginning of the ceramic Neolithic (J. K. Kozłowski 1989a), and also argue that virtually no Late Mesolithic is known in these regions. Those who prefer the notion of autochthonous development, or at least a partial acculturation of the indigenous Mesolithic population, seek out similarities in blade production technology at Late Mesolithic sites, in particular in southern Germany (Tillmann 1993; Gronenborn 1997; Kind 1998), Poland[16] (Kowalczyk 1969, 20–23; Balcer 1986, 104–105) and Switzerland (Nielsen 2003, 294).

In most cases, however, it is impossible to determine whether in formulating their hypotheses of continuity or discontinuity scholars understand the term 'regular blade' in the narrower sense as meaning a blade produced by pressure technique, or in the broader sense as meaning simply any regular blade that might also have been produced by punch technique. Usually the technologies are not differentiated,

16 In Poland during the 1980s, for example, B. Balcer (1986, 104–105) considered the possible close links between the Mesolithic Janisławice culture and the chipped stone industries of the LBK. In this case, his hypothesis was based on the earlier theoretical work of J. Kowalczyk (1969, 20–23).

or the term 'regular blade' is understood differently by different researchers. This therefore leads to a confusion of different production techniques.

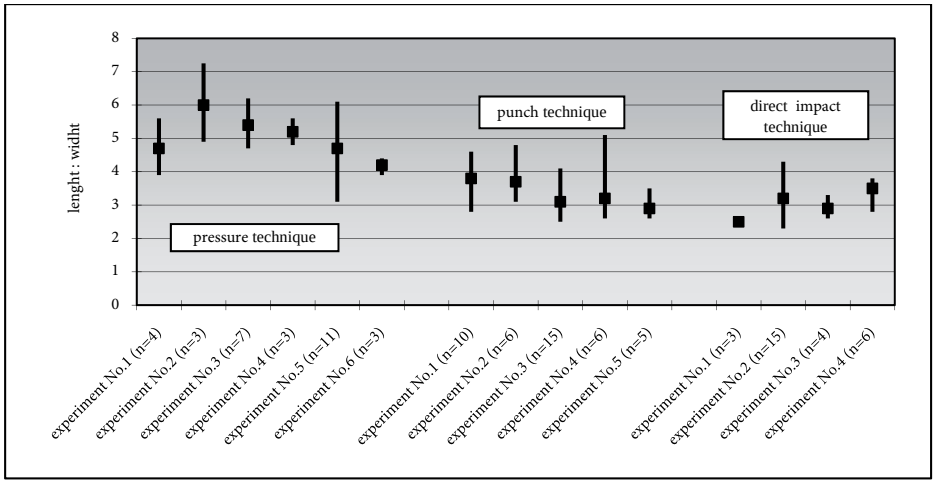
6.2.1.1. The use of experimental archaeology

In order to compare the various blade technologies of the Mesolithic and the Earliest and Early Neolithic, I first attempted to establish a series of basic criteria by listing the typical indicators that repeatedly appeared during the use of particular technologies on the basis of the analysis of experimentally produced blades and the relevant data available from the literature (Tixier, Inizan & Roche 1980; Weiner 1985; 1987).[17] The necessary experiments were undertaken over a period of around five years by W. Migal of the State Archaeological Museum in Warsaw (**figs 3–6**). Because on the one hand it is mostly possible to differentiate the use of direct percussion from that of pressure technique and/or punch technique, and on the other most of the indicative characteristics of the latter two techniques are the same, it was also decided to compare the indices of length and width[18] **(graph 1)** and of length, width and thickness **(graph 2).** For the blades produced by pressure technique, the index values were markedly higher (the indices of length/width fall between 4–6 and of length/width/thickness between 1–3) than those for blades produced by the punch technique or direct percussion, for which the index values were similar (length/width falls between 2–4 and length/width/thickness is less than 1)[19].

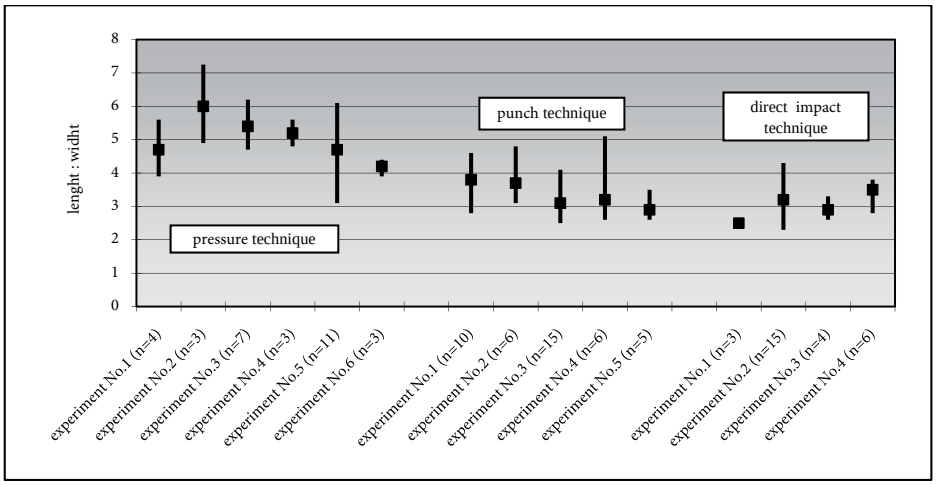
Several of the indicators given below may apply to more than one technique (for example, both to pressure and punch techniques). In assessing blades, it is therefore important not to take the criteria separately, but rather to consider them in combination; in this way, they may provide more detail on the blade production technique employed. Indicators are grouped for blades made from a single-platform core.

Blades made by pressure technique (**figs 3–5**):

1) The platform remnant is most often prepared by primary faceting, with or without dorsal



Graph 1. Length/width indices of experimentally manufactured blades.



Graph 2. Length/width/thickness indices of experimentally manufactured blades.

17 For critical comments on particular techniques, I thank Wulf Hein (Archäo-Technik, Dorn-Assenheim, Germany) and Leif Steguweit (University of Erlangen, Germany).

18 Generally, it would be sufficient to determine only the length/width/thickness indices. But the length/width indices have been added to also enable work with sources containing no information on blade thickness.

19 All of the experimentally produced blades fall within this scheme, with only one exception: blades produced by pressure technique in experiment 4 **(graph 2).** The crested blades from the initial exploitation of the core are relatively crude, and their length/width/thickness index shows similar values to those of blades made by direct percussion or by punch technique.

reduction; the plain or punctiform platform remnant may also appear. The platform remnant is relatively small, sometimes with a gabled roof-like angle, and it can shift slightly to the side of the blade axis.

2) The platform remnant angle of the blade ranges from 85–95˚. Similarly, for cores the striking platform angle also falls between 85–95˚.
3) The bulb tends to be flat.
4) The apex of the bulb of percussion is not as clear as it is for blades made by punch technique.
5) The blade thickness is even. In the terminal part, the blade is no thicker than in the basal and medial parts.
6) Both edges and the edges of negatives left by previous blades are mutually parallel.
7) Blades are uniform, and their dimensions vary only slightly.
8) The length/width indices fall between 4–6; the length/width/thickness indices are in the range 1–3, because blades produced by pressure technique are slimmer than those made by direct impact or punch techniques.
9) In profile, the blades are straight or slightly and evenly bent. S-shaped profiles and more pronounced arching in the terminal parts, as found among blades made by punch technique, do not occur.
10) Pre-cores are very carefully prepared by cresting, which either serves to create a guiding edge or also to fix the core (for example into a wooden frame), so that it does not slip during blank production (Hahn 1993, 144–146).
11) Cores have a single platform and are typically conical, or later cylindrical. Blades, however, may be made either from semi-conical or flat cores (Tixier, Inizan & Roche 1980, 57).
12) The negatives remaining on the core after the blade has been struck off are generally very shallow.

Blades made by punch technique (**figs 6 & 7**):

1) The platform remnant is prepared by primary faceting, without dorsal reduction. Alternatively, the platform remnant may also be plain, and the ideal angle for placing the punch is then achieved by dorsal reduction.
2) In addition to primary facetted and plain platform remnants, a punctiform platform remnant may also appear, comprising only the apex of bulb of percussion.
3) The platform remnant is generally quite large, and there are commonly notches at the edge with the dorsal side of the blade (the platform remnant edge).
4) On the platform remnant, at the edge with the ventral side of the blade, the apex of bulb of percussion is usually well visible.

Fig. 3. *Experimental production of blade blanks by pressure technique, undertaken by W. Migal. Photo by I. Mateiciucová.*

Fig. 4. *Experimental production of blade blanks by pressure technique – detail, undertaken by W. Migal. Photo by I. Mateiciucová.*

5) The platform remnant angle of the blade, as well as the platform angle of the core, varies from 80–95˚.
6) Conspicuously raised, semi-circular bulbs appear more commonly among blades with primary facetted platform remnants without dorsal reduction than among other blades.
7) Blades are broader than those made by pressure technique.

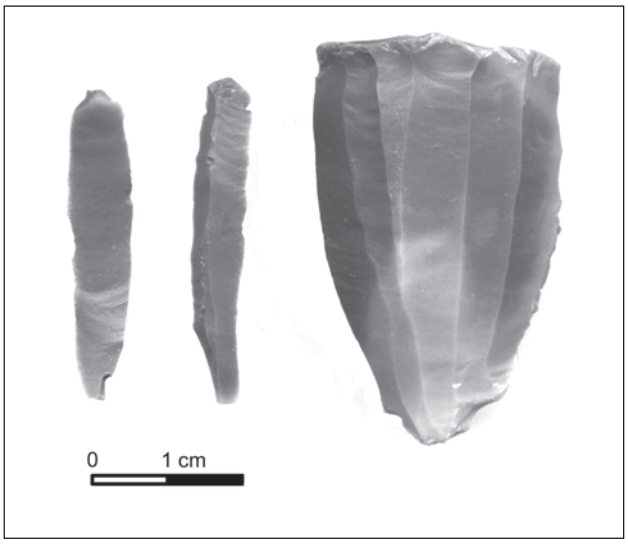


Fig. 5. *Radiolarite core and blades manufactured by pressure technique. Photo by I. Mateiciucová.*

8) Blade thickness is not even across the whole length of the blade, as is the case with those produced by pressure technique. Blades may be thicker at the terminal than at the basal part.[20]
9) The length/width indices are in the range 2–4; the length/width/thickness indices are < 1, i.e. far lower than for blades made by pressure technique and similar to the indices for blades made by direct percussion.
10) Blade arching concentrates in the terminal parts. Blades without dorsal reduction are often S-shaped in profile.
11) Pre-cores are in most cases prepared with crests, which served to produce a guiding edge for the striking off of the first blade (= crested blade). The preparation is not as careful as it is for the pre-cores of the pressure technique.
12) Cores have a single platform and are semi-conical to prismatic in shape.
13) The negatives left after the striking of blades are deeper and less parallel than those on cores from which blades were removed by pressure technique.
14) If the core striking platform is prepared by faceting without dorsal reduction, then the platform edge is formed by irregular notches, as if nibbled. These notches are also visible on the blade platform remnant edge (see point 3 above).

20 In this case, I do not mean the rejuvenation flake from a core's base.

Fig. 6. *Experimental production of blade blanks by punch technique – detail, undertaken by W. Migal. Photo by I. Mateiciucová.*

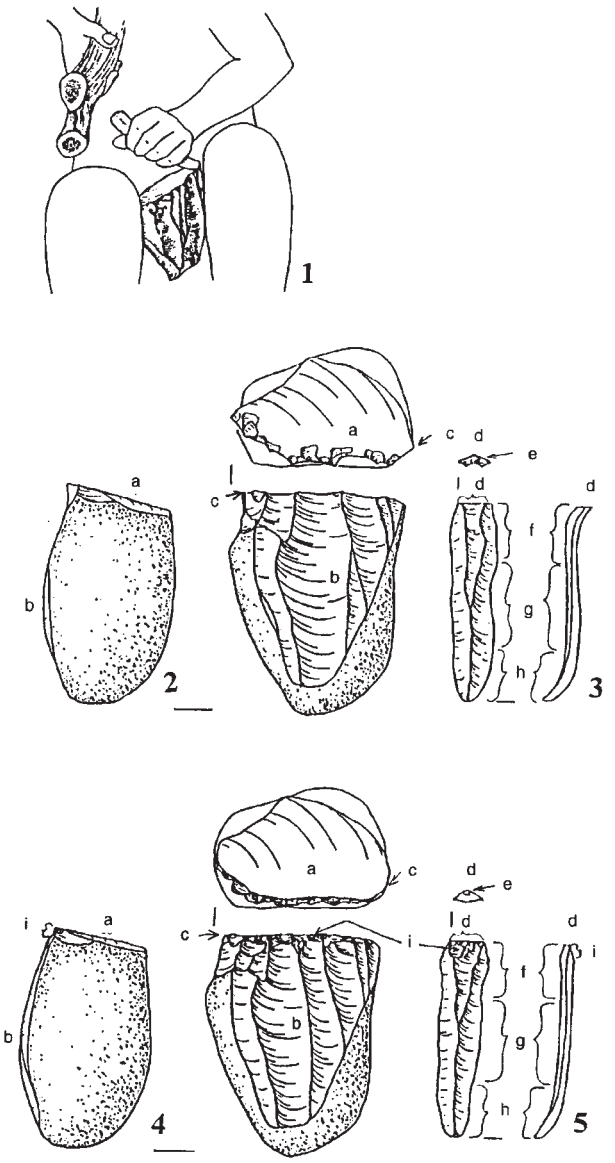


Fig. 7. *Punch technique. 2 – core with facetted striking platform, 3 – blade with primarily facetted platform remnant, 4 – core with plain striking platform and dorsal reduction, 5 – blade with plain platform remnant and dorsal reduction, a – striking platform, b – knapping surface, c – platform edge, d – platform remnant, e – apex of the bulb of percussion, f – basal part, g – mesial part, h – terminal part, i – dorsal reduction.*

Blades made by direct percussion[21]:

1) The platform remnant is most often plain with obvious dorsal reduction, or with abrasion (see chapter 10.2.3.5.)
2) The platform remnant is smaller than for blades made by punch technique. It is ellipsoid to linear in shape and may also be punctiform.
3) The platform remnant angle of the blade and the platform angle of the core are less than 80˚.
4) On the platform remnant, at the edge with the ventral side of the blade, traces (scars) of the hammerstone blow can sometimes be seen.
5) The edge between the platform remnant and the ventral side often forms a lip.
6) Blades are broader and less regular than those made by pressure technique; they are also less regular than blades made by punch technique.
7) Blade thickness is not as even along its length as is the case for blades made by pressure technique. Blades are often as thick or thicker at the terminal part as at the basal part.
8) The length/width indices are in the range 2–4; the length/width/thickness indices are < 1. Both indices are very similar in value to those of blades made by punch technique.
9) In profile the blades are slightly to markedly bent, with the arching concentrated on the mesial part of the blade; S-shaped profiles, such as those occurring among blades made by punch technique, do not appear.[22]

6.2.2. Blade blank production in the early phase of the LBK in comparison with that in the Mesolithic and in neighbouring regions

In order to characterise the blade production technology in the earliest phase of the LBK, the following questions were asked:

a. Is the blade production technology of the early phase of the LBK similar in all areas?
b. Does the blade production technology of the LBK have anything in common with the production of blanks in other Early Neolithic cultures (Starčevo-Körös, La Hoguette)?
c. Is there any relationship between blade production technology in the early LBK and in the local Mesolithic *milieu*?

First, blade production in the earliest phase of the LBK in the study area of Moravia and Lower Austria is characterised; this is followed by a comparison with neighbouring regions and the local Mesolithic *milieu*.

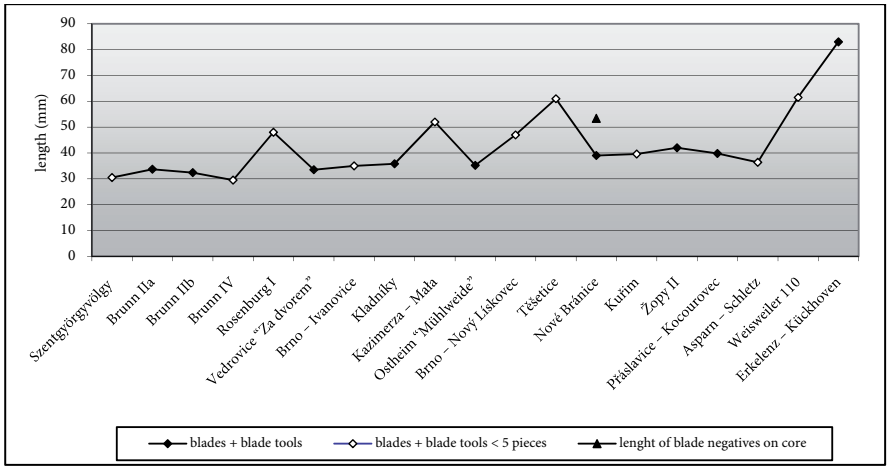
In the Lower Austrian Danube Basin, small blade blanks varying from 25–35mm (**graphs 3,4 & 5**) were the most common tool made at the sites of Brunn IIa, Brunn IIb, Brunn IV and Rosenburg I. Blades were for the most part obtained from single platform cores that were prismatic to semi-conical in shape. Prior to exploitation the core was prepared with crests, which were often situated in the area of the future knapping surface and which formed a guiding edge making the striking of the first blade easier. This method of working is indicated by finds of crested and secondary crested blades and flakes. Core striking platforms were most often worked by faceting, as is also shown by the primary, facetted platform remnants on blade blanks (**graph 6**). Dorsal reduction virtually never appears **(graph 7)**. The platform angle of cores, like the platform remnant angle of blades, in most cases meets at a right angle. Blades are often S-shaped in profile. The length/width index of the blades varies from 2.7 to 3.3 **(graph 8)**, and the length/width/thickness index from 0.8 to 1.2 **(graph 9).** These indicators suggest that most of blade blanks at these sites were obtained using the punch technique[23].

A similar situation is known from Moravia; here too, the settlements at Vedrovice "Za dvorem" (**fig. 14: 3–7, 9**), Brno-Ivanovice (**fig. 15: 4, 5**), Žopy I (**fig. 39: 7 & fig. 40: 1, 2, 6**) and Kladníky (**fig. 16: 3, 6 & fig. 17: 1–9**) had blade blanks made from single-platform cores with facetted striking platforms. Only rarely do cores with plain platforms and dorsal reduction appear. With the exception of those from Žopy, cores and pre-cores were made from local raw materials. At the Kladníky settlements there was a predominance of imported Krakow Jurassic silicites, but all of the cores (three pieces) came from local erratic silicites. As a rule, cores are prismatic in shape, and have a roughly right platform angle. Blades are regular and relatively small, even where the settlement concerned did not suffer from a lack of raw materials; they generally have an S-shaped profile. The platform remnant is most often worked by primary faceting without dorsal reduction **(graphs 6 & 7)**; plain or punctiform platform remnants also appear, but rarely. The index of blade length to width does not exceed

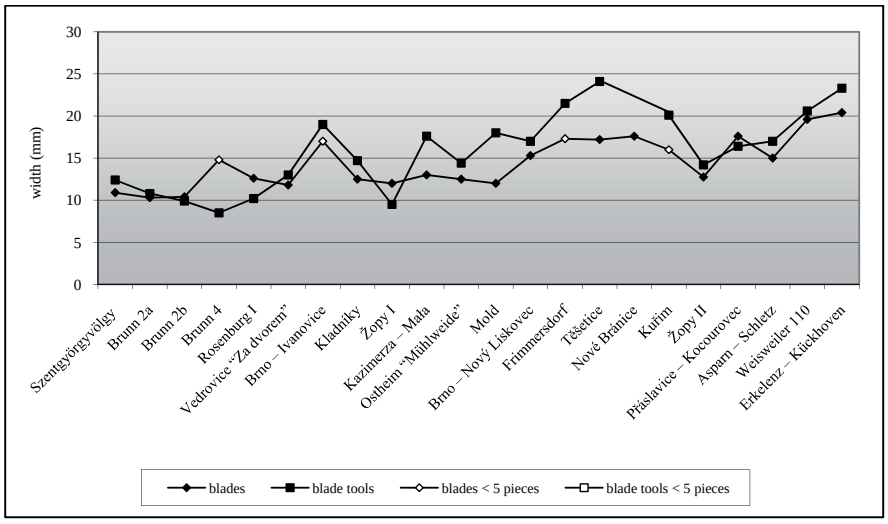
21 I mean direct soft-hammer percussion, although hard hammers can also soften through use (Witek Migal – pers. comm.).

22 S-shaped profiles occur among blades without dorsal reduction (see *Blades made by direct percussion* above).

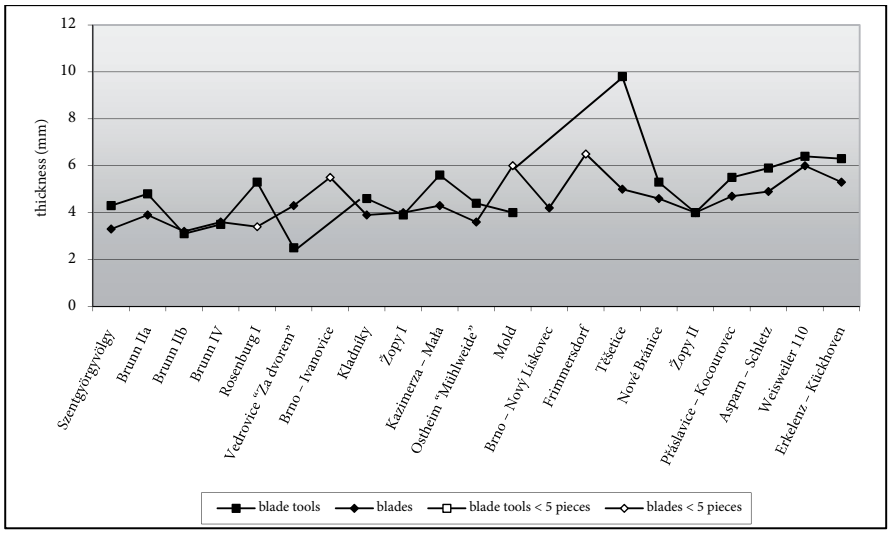
23 The indices of some blades from Brunn IIa and Brunn IIb scatter quite widely and in some cases they could also indicate the use of a different technique, although this probably relates to the raw material utilized. Unfortunately, I had no opportunity to study the production technology of blade blanks from these sites in detail, as the material is being analysed by W. Antl-Weiser.



Graph 3. Average length of blades and blade tools at LBK sites in Moravia, Lower Austria and adjacent regions.



Graph 4. Average width of blades and blade tools at LBK sites in Moravia, Lower Austria and adjacent regions.



Graph 5. Average thickness of blades and blade tools at LBK sites in Moravia, Lower Austria and adjacent regions.

a value of 3 **(graph 8)**, while the average index of length, width and thickness is < 1 **(graph 9)**. It seems, then, that in Moravia blades were also made by punch technique.

What, though, was the situation in neighbouring regions?

The chipped stone artefacts from the Early Neolithic site at Szentgyörgyvölgy-Pityerdomb in western Transdanubia were made from Bakony radiolarite, and are of exactly the same character as those from Early Neolithic sites in the Danube Basin of Lower Austria. Cores are small, and often markedly exhausted. Among the blades there is a predominance of platform remnants worked by primary faceting without dorsal reduction (**fig. 41: 1–3**; **graphs 6 & 7**). At the settlements of Neckenmarkt in Burgenland and Strögen in Waldviertel – where again there is a predominance of Bakony radiolarites – the character of the chipped stone industry is also similar to that from comparable sites in the Danube Basin of Lower Austria. Single platform cores with facetted striking platforms with no dorsal reduction predominate, and are matched by the blade blanks (Gronenborn 1997, Tab. 1.1, 1.2, 2.1). The length/width **(graph 8)** and length/width/thickness **(graph 9)** indices are similar to those from the sites mentioned above.

Further up the Danube, at Langenbach-Niederhummel, Mintraching, Enkingen and Schwanfeld in Bavaria, the single-platform cores with facetted striking platforms also appear regularly or predominate. In addition to prismatic or semi-conical forms, however, there are also conical cores. Blades with primary facetted platform remnants and with-

out dorsal reduction are dominant (Tillmann 1993, Tab. 1). In addition to small blade blanks similar to those from more easterly regions, some are relatively long and narrow (Gronenborn 1997, Tabs 3.1, 4.1, 5.1, 5.2). The length/width and length/width/thickness indices are surprising **(graphs 8 & 9)**, their values being close to those of the indices for pressure knapping blades. From the illustrations, many blades seem to be almost straight or only slightly, evenly arched.

Similar blades also come from the site of Bruchenbrücken in Hessen, where some scholars believe that some of the blade blanks were made by pressure technique (Gronenborn 1997, 80, note 139, Tab. 7.1). At Bruchenbrücken, however, yet another means of making blades has been recognised. D. Gronenborn has determined that several blades have plain or punctiform platform remnants, are dorsally reduced and, above all, include acute platform remnant angles. Similar blades have also been recorded at Goddelau. Both sites are at the western periphery of the LBK culture, in a region where La Hoguette ceramics also appear. The bearers of La Hoguette pottery are regarded as having been the original Mesolithic inhabitants of western Europe, who adopted some of the contrivances of the Mediterranean Neolithic. Given finds of blades with plain platform remnants, dorsal reduction and acute platform remnant angles at Late Mesolithic sites in north-western Europe and at sites with La Hoguette ceramics (Stuttgart-Bad Cannstatt, Loschbour, Bavans), Gronenborn and others believe that at Bruchenbrücken and Goddelau a local, Mesolithic tradition was applied in the production of blade blanks, which the occupants of the early LBK settlements then adopted from the makers of La Hoguette ceramics (Tillmann 1993, 165–166; Gronenborn 1997, 85, 132–133).

In the same region, another settlement dated to the early phase of the LBK has recently been investigated at Nidderau-Ostheim, a few kilometres north of Frankfurt am Main. So far, it is at this settlement that Transdanubian Szentgál radiolarite has been found at the greatest distance from its source. The blades are small and very similar to the blade blanks from sites further to the east; notably, longer and narrower blades were not found here. In comparison to other sites, however, the proportion of dorsal reduction was greater **(graph 7)**, but cannot be placed in direct relation to plain platform remnants and acute platform remnant angles **(graph 6)**. Blades from the settlement at Steinfurth display similar features (Gronenborn 1997, Tab. 8.1). I am inclined to the view that the blades at both sites were made by punch technique. Should it be confirmed that some of the blades from early LBK sites at the south-western periphery of the distribution of the earliest LBK phase were really made by pressure technique, and that some of the blades at Bruchenbrücken and Goddelau were made by direct percussion, then this would mean that three different traditions were recognisable in this peripheral zone, which might be described as follows:

1) the Early Mesolithic, linked to the production of blades by direct percussion;
2) the Mediterranean proto-Neolithic and Early Neolithic, associated with blades made by pressure technique; and
3) the 'Danubian', associated with the production of blades by punch technique.

Unlike Gronenborn, I understand the Danubian tradition as having been the original Late Mesolithic tradition, which came into being in the south-eastern parts of central Europe and perhaps in the Balkans as a local reaction to the innovations and new currents coming from the Near East and later from the Mediterranean. I term these adaptations 'variations on a Mediterranean tradition'. The intention is not, of course, to claim that the production of blades by punch technique was completely unknown in the Mediterranean and the Near East. Moreover, it is sometimes very difficult to distinguish certain variants of blades made by punch technique from those made by pressure technique, and at the same time the possibility that both methods were used contemporaneously cannot be ruled out. Unlike the situation in the Mediterranean, however, pressure technique was not practised in central Europe, with only a few exceptions (Bruchenbrücken; Gronenborn 1997, 80). Gronenborn sees the Danubian tradition as linked to the appearance of regular blades with primary facetted platforms with no dorsal reduction, and does not distinguish the techniques by which these were made. He traces the roots of this phenomenon to the Near East and central Asia (Gronenborn 1994; 1997). A. Tillmann, like me, understands the appearance of regular blades in the southern parts of central Europe as having been caused by the introduction of new currents and requirements into earlier, traditional Early Mesolithic technologies (Tillmann 1993, 165); unlike Tillmann, however, I believe that in several regions the movement of population groups and individuals from areas practising a food-producing economy had a decisive influence on the spread of the Neolithic.

The problem of the various traditions will be considered later. Initially, however, it is necessary to consider blade production technology in the earliest phase of the LBK in other regions, as well as in areas settled by other Early Neolithic cultures. At the same time an effort will be made to enquire into the production of blanks by Mesolithic foragers.

Let us now move across Slovakia, northwards into Little Poland and along the Vistula to the north-

ernmost borders of the distribution of the earliest LBK. To date, no large chipped stone assemblages dating to the earliest phase of the LBK have been found in south-west Slovakia (Kaczanowska 1985, 25; 2001, 216; Cheben 1987). In eastern Slovakia, the earliest phase of the Eastern LBK sees the appearance of generally small blades, which in their dimensions approach those of Moravia and Lower Austria; in addition to these small blades, however, there are also more robust examples. The length/width index of the blades generally varies between 2 and 4. As a rule, they have primary facetted platform remnants lacking dorsal reduction (J. K. Kozłowski 1989a; Kaczanowska & Kozłowski 1997). From their overall appearance I conclude that they were made by punch technique.

In Little Poland, at Kazimierza Mała, single platform cores with facetted striking platforms also predominate. Among the blade blanks, relatively long blades appear very sporadically[24]. Their length/width/thickness index (**graph 4**) does not suggest production by pressure technique. Other blades are rather small (**graphs 3, 4 & 5**). In northern Poland, at Boguszewo 43a and Boguszewo 41 in the Chełmno-land, blades are also rather smaller, with primary facetted platform remnants. The cores were originally single-platform, with facetted striking platforms (Małecka-Kukawka 1992).

In lower Silesia, at Gniechowice 2 and Stary Zamek 2A on the upper Oder, the situation is similar. The small assemblages contain cores with altered orientations and which were originally single-platform cores for the production of blade blanks. Blades have platform remnants worked by primary faceting, in most cases without dorsal reduction. Both chipped stone collections were made mainly from local silicites of glaciogenic origin. The sizes of the platform remnant angles were not, unfortunately, recorded, but from the drawings of the cores published it may be assumed that a right angle predominated (Lech 1985). The length/width and length/width/thickness indices, together with the preparation of the platform remnants, most closely accord with the production of blades by punch technique. Bylany in east Bohemia, too, matches these characteristics (Popelka 1991a).

The blade platform remnants from the small early LBK assemblages at Eitzum and Klein Denkte in Lower Saxony are primary facetted without dorsal reduction. The blades were struck from single-platform cores, with striking platforms worked by facetting (Gronenborn 1997, Tab. 9.1). The dimension indices suggest the manufacture of blades by punch technique. By contrast, there is a predominance at the settlement at Eilsleben of blades with plain and punctiform platform remnants, most likely struck from cores employing an acute platform angle (Kaczanowska 1990; Wechler 1992, Tab. 14). According to Tillmann, these characteristics have their roots in the local Mesolithic (Tillmann 1993, 168).

Blade production technology in the Balkans should also be considered. Drawings of blades from Romanian sites dated to the Starčevo-Criş phase generally show regular blades, which are for the most part relatively large and wide. At the sites of Cuina Turkului-Dubova layers I-III, Valea Raii-Rimnicu Vilcea, Leţ, Ostrovu Banului (Golu), Divostin, Anzabegovo, Lepenski Vir III and Gologut there are blades that, according to the published illustrations, are large and regular. The manufacturing technique used cannot be established with certainty, but at least some of the blades seem to have been pressure flaked (**graphs 10 & 11**); it is, however, also possible that they were made by punch technique. J. K. Kozłowski and M. Kaczanowska regard the blade industry of the Starčevo as having been highly developed, and do not rule out the pressure technique method (Kozłowski & Kozłowski 1984, 274–275; Kaczanowska & Kozłowski 1984–85; J. K. Kozłowski 1987, 561; Kaczanowska 1989; Ginter & Kozłowski 1990, 64). Similarly, at sites of the Körös culture – and particularly in the southern part of its range – large, very regular blades appear or predominate; these are made of Banat silicite, the source of which is not as yet precisely known but which is presumed to lie somewhere in the Banat region of Romania. Similar blades are sometimes made from limnosilicites or obsidian. The dimensions of the blades from Battonya-Landesmann dülö and Szentpéterszeg-Körtvélyes fit the criteria of typical blades made by pressure technique; this supposition is also supported by isolated finds of cores (Bacskay 1975; Bacskay & Siman 1987).

In addition to these large, regular blades, some sites of the Körös culture and late phase of the Starčevo culture (Gellénháza-Városrét and Vörs-Máriaasszonysziget) have also yielded small, regular blades (Bacskay & Siman 1987; Kalicz, Virág & Biró 1998, 163–168; Biró 2002, 122–124; Biró & Simon 2003, 122–123). At the Ecsegfalva 23 settlement, small blades made from obsidian or limnosilicite predominate (**figs 43 & 44**); they often have primary facetted platform remnants without dorsal reduction, and are bent at their terminal parts. The length/width index is 2.4 (Mateiciucová 2007). These blades are very similar to the blade blanks of the earliest phase of the LBK in Lower Austria and eastern Slovakia (Kaczanowska & Kozłowski 1997). I believe that they were made using the punch technique. This would mean that there are two different technologies for the produc-

24 It cannot be ruled out that the chipped stone assemblage from Kazimierze Małe contains later (Lengyel culture?) intrusions (J. Lech, pers. comm.).

tion of blade blanks within the Körös culture, as has been suggested previously (J. K. Kozłowski 1987, 561; Kaczanowska 1989, 124). While both served to produce regular blades, the methods and final appearances were different[25].

In the south of central Europe, contact between the bearers of the Mediterranean Early Neolithic and those of the LBK was hindered by the Alpine Massif. The Impresso/Cardial tradition of blade manufacture developed from the Castelnovian in many places in southern and south-western Europe. This means that in the Early Neolithic, these areas saw the production of long, very regular blades, probably made by pressure technique. During the Late Mesolithic and Early Mediterranean Neolithic, this means of making blades permeated into the Alps, where it was also adopted by the local foraging population. Regular blades were produced at a whole series of sites dating to the Late and Final Mesolithic in southern Germany and Switzerland; some of these are very reminiscent of the production technologies known from the Mediterranean. At other sites, however, it is rather a case of the conscientious copying of fashionable trends and their adaptation to local conditions, where instead of pressure technique punch technique was used to make blades.

From the drawings of the blades and cores from Jägerhaushöhle layers 7 and 6, I conclude that blade production was by means of punch technique (Taute 1971, Tab. 13–20). The blade proportions, too, seem to favour this possibility. Some researchers are willing to allow production by pressure technique as well (Bauche 1987, 57). Similarly, the blades and cores from the Late Mesolithic surface sites at Feuerbichl bei Horn, Forggensee 2 and Forggensee 6 in the eastern part of the Allgäuer Alps (Gehlen 1988; 1999, Fig. 15, 27) are reminiscent of the early LBK chipped stone industries of eastern central Europe. Some of the blades, however, may well also have been made using the pressure technique. The pressure technique is deduced by C. J. Kind at the Late Mesolithic site of Henauhof Nord II near the Federsee in upper Swabia (Kind 1992, 342). The Late Mesolithic horizon II at Rottenburg-Siebenlinden 3 in south-western Germany has also yielded regular blades, more than half of which have platform remnants worked by primary faceting (Kind 1997, 26). The site of Sarching 4 near Regensburg is regarded as a transitional horizon, in which regular blades with primary facetted platform remnants begin to appear (Gronenborn 1997, 129).

Further to the west and south-west, Late Mesolithic sites in Switzerland regularly contain a substantial proportion of Montbani type blades with primary facetted platform remnants lacking dorsal reduction. According to E. Nielsen, Montbani blades are absent from southern Germany, a fact which may be interpreted either chronologically or culturally (Nielsen 1997a, 70). Blades from the Late Mesolithic sites of Nenzlingen--Birsmatten-Basisgrotte (horizons 1 & 2), Liesberg--Liesbergmühle VI and Röschenz-Tschäpperfels in the Bir valley of north-west Switzerland (Nielsen 1991, 66–69; 2003, 281–283) are in the main straight or slightly and evenly bent. The platform remnant often diverges to one side from the main axis of the blade. While primary facetted platform remnants lacking dorsal reduction are the norm, plain or punctiform platform remnants, generally lacking dorsal reduction, do occur, sometimes being of an almost gabled roof-like shape (dihedral platform remnants). The assemblages contain few cores, most of which have been markedly exhausted; semi-conical to flat cores with regular blade negatives do, however, occur[26]. On the basis of these indicators, I feel that at least some of the blade blanks were made by pressure technique; the use of pressure technique in the production of Montbani blades has also been deduced by other authors (Ginter & Kozłowski 1990, 64). At the same time, the length/width indices of several blades from the Late Mesolithic station at Fällanden ZH-Usserriet not far from Zürich are comparable with those resulting from the experimental use of the pressure technique (Nielsen 1997a, 63, 65).

The pressure technique was certainly used to make blade blanks in the Late Mesolithic Janisławice culture (Dęby 29), the bearers of which settled in what are now the eastern half of Poland, south-western Belarus and northern Ukraine (**graphs 10 & 11**). According to L. Domańska, there were close relations between the Janisławice culture and the Pontic region, in particular with the Kukrek culture, which were also expressed in the technological production of very regular, straight blades. Conical, or in more advanced stages of working cylindrical, cores are typical (Domańska 1990a 49–52; 1990b; 1991a, 78). This hypothesis of links between the Janisławice culture and the Pontic zone has been heavily criticised by S. K. Kozłowski (1991; reply in Domańska 1991b), but a number of scholars nevertheless regard it as likely

25 Unfortunately, in most cases the literature does not give the dimensions of the blades presented, and from the drawings it is not possible to determine whether they are whole blades or merely fragments; it is therefore somewhat difficult to obtain the true proportions of the artefacts. I nevertheless believe that some of the large blades of the Körös culture need not have been made by pressure flaking, but were rather created by punch technique.

26 I am indebted to E.H. Nielsen (Bern University) for making possible the examination of the chipped stone industry from this site.

(Czerniak 1994, 11–16). The discovery of limnosilicite artefacts at Bear Cave near Ružín (see below) also seems to support the hypothesis (Bárta 1990, 21). It is interesting that the very mature blade technology recorded at the site of Dęby 29 in the Kujavia region does not appear in this area during the LBK. According to Domańska, the LBK blades from Podgaj 32 and Krzywosądz 3 are rather reminiscent of the blade blanks from Mesolithic sites of the Kolankowo type (Kolankowo, Nowa Wieś Wielka), which are related to the Late Mesolithic of north-western Europe. No continuity is apparent even from the point of view of raw material usage: while in the Janisławice culture chipped stone industry was almost exclusively manufactured from chocolate silicites, the chipped stone artefacts from settlements dated to the early phase of the LBK were made either from local erratic silicites or from Krakow Jurassic silicites from southern Poland (Domańska 1991a, 70–74; Czerniak 1994, 57–58, fig. 43; Bednarz 2001, 34).

In recent years, new Mesolithic stations have been discovered in north Bohemia (Svoboda, Cílek & Jarošová 1998; Svoboda *et al.* 2003). In addition to numerous Early Mesolithic sites, three Late Mesolithic stations have also been found at Bezděz, Pod Zubem and Dolský Mlýn. According to the radiocarbon dates, these belong to the very late Mesolithic, comparable to the 'Final Mesolithic' of southern Germany[27] (Kind 1992; 1997, 22). Trapezes commonly appear among the chipped stone artefacts, and the site of Dolský Mlýn in particular has yielded an assemblage of regular blades. Unfortunately, the published illustrations and descriptions of the artefacts do not include any more detailed information on the appearance of the blades (Svoboda *et al.* 2003; 117–119, 213–216, 238–240, Fig. 19.10.).

In Hungary it was only recently, during the 1990s, that stratified Mesolithic settlements could be identified at the sites of Jászberény I and Jásztelek I in the northern part of the country, between the Tisza and the Danube. Several surface sites are known from the same region.

The chipped stone blanks from Jászberény I layer C, which is dated to the same chronological horizon as Smolín (Kertész *et al.* 1994, 22), may be described as small, irregular blades and flakes made by direct percussion. Rarely, regular blades also appear, but they also seem to have been produced by direct percussion. Layer B and feature 1 from Jásztelek I may be similarly described and are probably of similar age (**graphs 10 & 11**). Layer A (topsoil) at Jásztelek I has been dated to the beginning of the Atlantic; here, too, there is a preponderance of irregular, small blades, with plain or punctiform platform remnants and dorsal reduction. In addition to the irregular blades, however, the later horizon (layer A) also contains regular blades with platform remnants worked by primary faceting, accompanied by trapezes. Imported raw materials – Bakony radiolarites and obsidian – also occur frequently. A higher proportion of regular blades with primary facetted platform remnants has also been identified at the surface sites of Jászberény II and Jászberény III; some are even highly reminiscent of the blades from the Early Neolithic sites of Brunn am Gebirge and Szentgyörgyvölgy-Pityerdomb. Unfortunately, several fragments of LBK pottery were recovered at Jászberény II, and it therefore seems that in this case at least the chipped stone industry is Early Neolithic. Further convincing and more abundant evidence of Mesolithic and mainly Late Mesolithic settlement in Hungary is lacking (Dobosi 1972; Kertész 1991) – which does not mean that such settlement did not exist. The question remains as to how many Mesolithic settlements lie covered by river alluvium, and whether, given the very similar chipped stone industries of the Late Mesolithic and Early Neolithic, we are unable to recognise surface sites.

In Transdanubia, Late Mesolithic settlement has been identified at the surface site of Kaposhomok (Kertész 1993, 89; Marton 2003); here the chipped stone artefacts were made from Transdanubian radiolarite, and several are very similar to artefacts from Brunn IIa and IIb.

The Mesolithic of south-eastern Slovakia is represented in particular by the sites of Košice-Barca I and Bear Cave (Medvedia jaskyňa) near Ružín. Barca I rather dates to the Early Mesolithic (Bárta 1981, 295), but the limnosilicite artefacts discovered at Bear Cave comprised very regular, narrow and straight blades, which are characteristic of the Late Mesolithic and Early Neolithic in the northern Black Sea and Crimean regions (Bárta 1990, 21, figs. 6 & 7). From the published illustrations of these items and the lengths and widths given, it seems very likely that they were made by pressure technique (**graphs 10 & 11**).

Known Mesolithic settlements in south-western Slovakia are relatively abundant, and S. K. Kozłowski places them into the Sauveterrian, along with finds from Šakvice in Moravia (S. K. Kozłowski 1981, 305). Settlement concentrates mainly in the valley of the Váh. The stratified finds from the site of Sereď I-"Mačanské vŕšky" are regarded as the most significant. At both

27 The Dolský Mlýn site has yielded four C^{14} dates between 6720 ± 120 BP and 7770 ± 70 BP. Bezděz has provided a single date of 6930 ± 120 BP (Svoboda 2003a, 312; Svoboda et al. 2003, Tab. VIII.2.).

Sereď I and Dolná Streda relatively regular, mainly small blades appear among the blades illustrated in the literature (Bárta 1959, Tab. I; Bárta 1981, Abb. 2).

In Moravia, the largest assemblages of Mesolithic chipped stone industry come from Smolín and Přibice; that from Smolín is stratigraphically documented. The production of blanks at both sites is very likely. Blades are generally irregular with plain or punctiform platform remnants, acute platform remnant angles and dorsal reduction. They are made from single-platform cores, but double-platform cores with a single knapping surface also occur. Both sites have been dated to the end of the Boreal (see chapter 4.5.) (Valoch 1981, 54). All the indications are that the blades were made using direct percussion. The situation is also similar at Mikulčice (Škrdla, Mateiciucová & Přichystal 1997).

A relatively large chipped stone assemblage has been recovered from Dolní Věstonice-"Písky" and again contains symmetrical trapezes. At this site, too, there is a preponderance of blades with flat or punctiform platform remnants. In contrast to Smolín and Přibice, however, the proportion of blades with a right platform remnant angle is higher, while the number of examples with dorsal reduction is lower. It is notable that at this site the use of coarse-grained Krumlovský Les I chert, which vastly predominated in the LBK, began to increase[28]. It is not possible to securely ascertain whether some of the blades were made by punch technique, but this cannot be ruled out.

In Lower Austria, only a few sites dated to the same horizon as the Moravian sites are known. They can similarly be classified typologically into the Beuron-Coincy sequence (S. K. Kozłowski 1981, 301). At Kamegg, Limberg-Mühlberg, Burgschleinitz and Wien-Bisamberg blades were made by direct percussion. At all of these stations there is a predominance of blades with flat or punctiform platform remnants and dorsal reduction. The platform remnant angle is almost always acute. The blades are most often made from local or regional raw materials (mainly Krumlovský Les chert).

Summary

Given the archaeological source material and information on the manufacturing technology of blanks available today, it is not possible in either Moravia or Lower Austria to securely demonstrate continuity of development from Mesolithic to Neolithic chipped stone industries, but neither can such continuity be ruled out. It is, however, striking that the Early Neolithic industry in these regions differs from the Neolithic chipped stone industries known from more southerly regions in the Balkans and along the Mediterranean, where in most cases there is a preponderance of large, regular blades or narrow, regular blades.

The area of the Carpathian Basin appears important, as it is here that the Mediterranean tradition of blade production mixes with the production technique characteristic of both Lower Austria and Moravia. Can this other technique be regarded as evidence for continuity between the Late Mesolithic and Early Neolithic in the south-eastern parts of central Europe? In addition, the following questions also remain to be answered:

Is the production technology of blades within the early phase of the LBK culture similar in all areas of its distribution?

To what degree is it affected by the technologies of other Early Neolithic cultures (Starčevo-Körös, La Hoguette)?

Is there any manifestation of a local Mesolithic background?

In Moravia and Lower Austria, the blade blanks resemble each other (**graphs 8 & 9**). In other regions in eastern central Europe (Bohemia, Slovakia, Hungary, Poland), significant differences similarly could not be detected. The features on blade blanks and cores correspond with the production technique of indirect percussion. Similar blades also occur in areas further to the west, in the Danube and Main Regions (Ostheim, Schwanfeld).

In the Körös and Starčevo cultures, above all in settlements dating from the later phase and occurring at the northern periphery of their distribution, some smaller blades resembling the blades of the earliest phase of the LBK also appear. Similar regular blades, still scattered but increasing in number, also occur at Mesolithic sites in eastern central Europe (Dolní Věstonice, Sereď I, Dolná Streda, Kaposhomok, Jászberény II and III, Jásztelek I). Although so far no sites with a significant ratio of regular blades are known, it is likely that the production of blades by indirect percussion familiar in the LBK culture has its roots in the local Mesolithic of this region.

Besides tiny blades, large regular blades obviously manufactured by pressure technique also occur in the Körös and Starčevo cultures. This second tradition is

28 In addition to the Mesolithic settlement, Dolní Věstonice-"Písky" also yielded pottery of the Stroke-Ornamented Ware, Bell Beaker, Únětice and Horákov cultures (Klíma 1953, 298; Šebela 2002). For this reason, it is impossible to exclude the possibility that some of the chipped stone may have come from the *milieux* of these latter cultures. On the other hand, no blade industry comparable to that of Neolithic cultures appears in these Late Eneolithic and post-Neolithic cultures.

typical for the Early Neolithic Balkan sphere of the cultures Starčevo – Kremikovci – Karanovo – Körös. The origin of LBK blade technology has also been derived from the Starčevo-Körös complex (J. K. Kozłowski 1987, 561). However, in the study area of Lower Austria, Moravia and the investigated sites in Hungary and Poland, I could not yet discover any large regular early LBK blades which are comparable to those of the Starčevo-Körös culture. Therefore, I suggest that the production technique of blade blanks used in the earliest phase of the LBK culture more likely relates to local Mesolithic traditions[29].

After all, local Mesolithic traditions are also detectable at the western and south-western periphery of LBK distribution. The first Mesolithic tradition with blade production by direct percussion can be designated as the original north-west European tradition. In the Early Neolithic, it is associated with the makers of La Hoguette pottery. It was also detected at the earliest LBK settlements of Bruchenbrücken and Goddelau. The second tradition, production of blades by pressure, can be associated with the first proto-Neolithic impulses from the Near East. In the Mediterranean area, these spread as early as in the Late Mesolithic in form of a new production technology for narrow regular blades. The new technology was also adopted by some hunter-gatherer communities in the Alpine Foreland (Switzerland, south Germany), from where it spread into LBK territory (Bruchenbrücken, Mintraching, Enkingen and maybe also some blades in Schwanfeld).

Conclusions:
Three separate traditions can be distinguished in earliest LBK blade production technology:
1) the Danubian, associated with the manufacture of blade blanks using the punch technique;
2) the Mediterranean (proto-Neolithic and Early Neolithic), characterised by the production of blade blanks by pressure technique; and
3) the Early Mesolithic, associated with the production of blade blanks by direct percussion.

The Danubian tradition[30] has been identified across the entire territory encompassed by the earliest phase of the LBK. Along with the Mediterranean tradition, this method of production has also been recognised at several sites of the Starčevo-Körös complex. The Starčevo-Körös-Criş cultural sphere is linked to the Mediterranean tradition by a kind of blade production the origins of which must be sought in the Epi-Palaeolithic and proto-Neolithic cultures of central Asia and the Near East.

The Mediterranean tradition of blade production has not been identified in northern Transdanubia, Moravia or Lower Austria.

The roots of the Danubian tradition probably lie in the local Late Mesolithic background of south-eastern central Europe. Several Late Mesolithic sites (Sereď I, Kaposhomok, Jásztelek I, Jászberény II, Jászberény III, Dolní Věstonice) showing an observable trend towards the manufacture of regular blades may be evidence for this link.

The Mediterranean tradition of blade blank production is known from several Late Mesolithic cultures of southern Germany and Switzerland. The Mediterranean tradition can also be demonstrated at the south-western and western fringes of earliest LBK distribution (Bruchenbrücken, Mintraching?, Enkingen?).

The original Early Mesolithic tradition of blade production by direct percussion – which in north-western and western Europe persisted into the Late Mesolithic – has been identified at the western and perhaps also the northern periphery of earliest LBK distribution. It may be assumed that those who continued this tradition included the bearers of La Hoguette pottery, who accepted economic innovations from the western Mediterranean region. La Hoguette ceramics, along with blades made by direct percussion, also appear at some earliest LBK sites (Bruchenbrücken).

It may be assumed that a detailed study of blade production technology at the northern and western fringes of the earliest LBK, just like a detailed study of retouched tools (e.g. Löhr 1994), would also show the survival of the Early Mesolithic tradition at other early LBK sites (Goddelau?, Eilsleben?).

29 In my view, the local Mesolithic traditions from which the chipped stone industry of the earliest phase of the LBK culture developed are located in the regions of Transdanubia, Burgenland and apparently also south-west Slovakia. However, it is likely that local Mesolithic traditions also played a certain formative role in other areas of earliest LBK distribution.

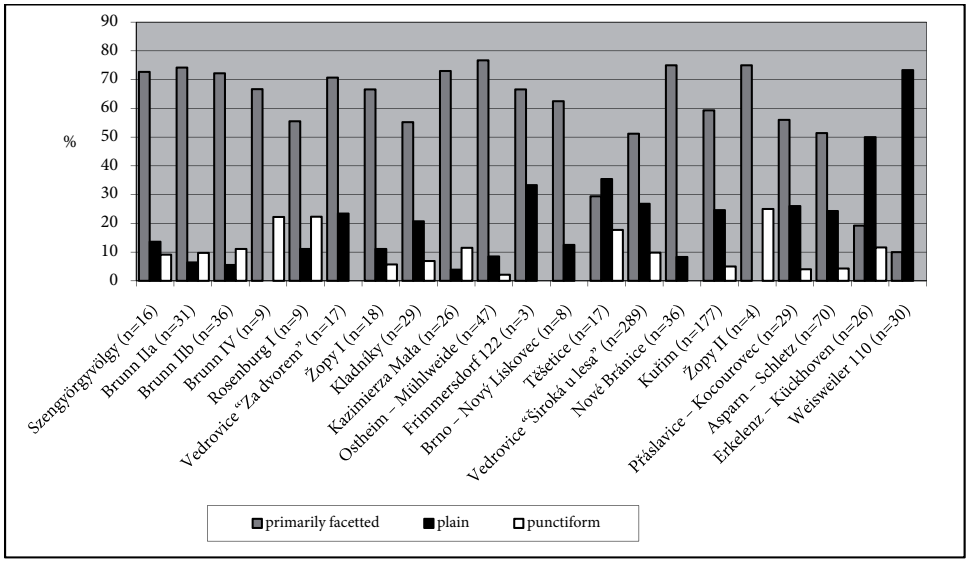
30 This term does not coincide with the 'Danubian tradition of blade blank manufacture' used by Gronenborn (1997, 80). For Gronenborn, the term includes all regular blades, and he does not distinguish between those made by punch technique and those produced by pressure flaking (Gronenborn 1997, 80). In contrast, I understand the Danubian tradition to be specifically bound up with the production of regular flakes by punch technique, and class blades made by pressure flaking as part of the Mediterranean tradition. The pressure flaking of blades was a technique that spread into the Mediterranean from the Near East; it was taken up in southern areas of Europe as early as during the Late Mesolithic, and it is also linked to the Early Neolithic cultures of the Mediterranean region (the Early Neolithic of south-eastern Europe, the Impresso/Cardial culture complex).

The distinction of various traditions within the earliest LBK territory shows that:

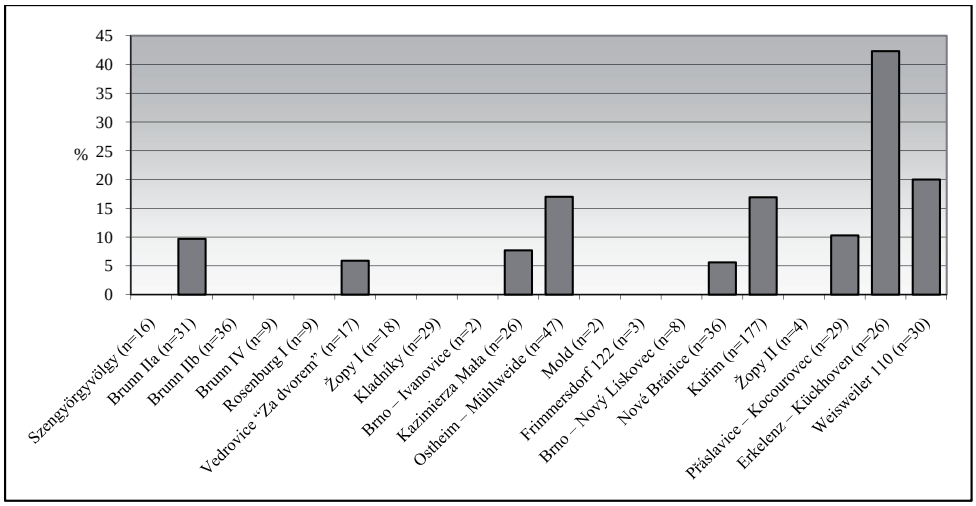
- the process of Neolithisation in central Europe was not unified;
- in some regions the indigenous Mesolithic population, which was gradually acculturated, played an important role;
- the Balkan cultural complex (including the Starčevo and Körös cultures) most likely contributed to the Neolithisation of central Europe through mediation, the transfer of information and the medium of contacts relating to the exchange of raw materials, products and partners;
- the local Mesolithic population contributed to the formation of the Körös culture, and perhaps also the Starčevo culture, at least in some regions;
- the Danubian tradition of blade manufacture originated as a local response to technological changes in Mediterranean areas (a 'variation on a Mediterranean tradition').

6.2.3. Blank production at the end of phase I and the in the middle phase of the LBK

In this period the production of blades started to become more standardised. Blades are broader, larger and more regular than in the preceding period (**graphs 3,4 & 5**). This is also reflected in the more careful selection of raw materials; raw materials from gravels disappeared, and higher quality raw materials were used ever more often. At most sites there was a dominant orientation towards a single type of raw material. In south Moravia, Krumlovský Les chert is predominant at this time; in the areas north of Brno it is Olomučany chert, and in the north-eastern and eastern parts of Moravia, Krakow Jurassic silicites. In the Vienna Wood region of Lower Austria, local Mauer radiolarites were principally used, while in Waldviertel, Krumlovský Les chert and siliceous weathering products of serpentinites predominated at this time.



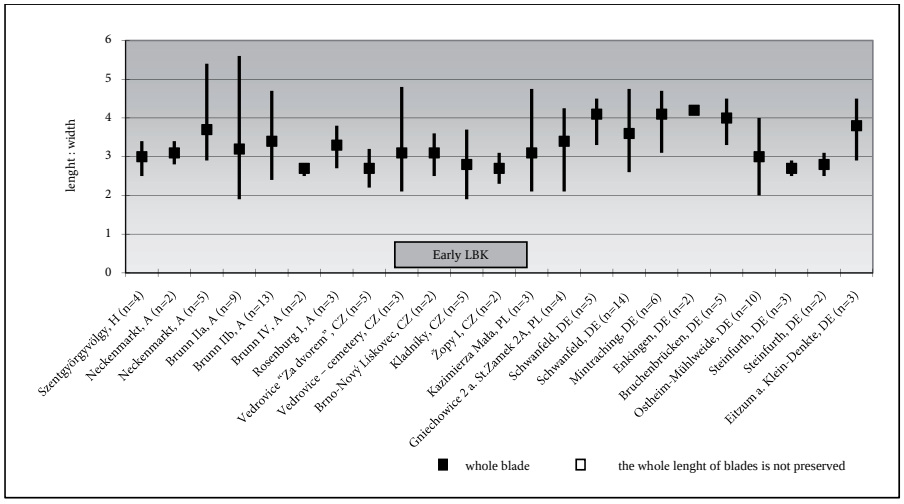
Graph 6. Platform remnants of blades and blade tools at LBK sites in Moravia, Lower Austria and adjacent regions.



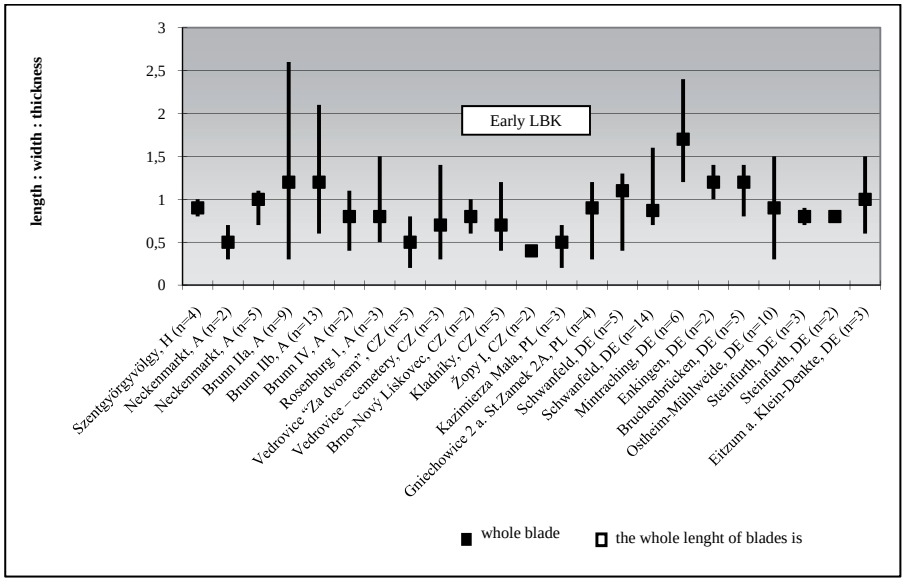
Graph 7. Dorsal reduction on blades and blade tools at LBK sites in Moravia, Lower Austria and adjacent regions.

At the settlement at Mold, from the end of phase I of the LBK, there was still a preponderance of smaller blades with platform remnants that were most often worked by primary faceting without dorsal reduction. This is matched by the smaller, single-platform cores that are most often prismatic in shape. The blade blanks from the settlement at Brunn I, which is dated to the same chronological horizon, are similar in appearance.

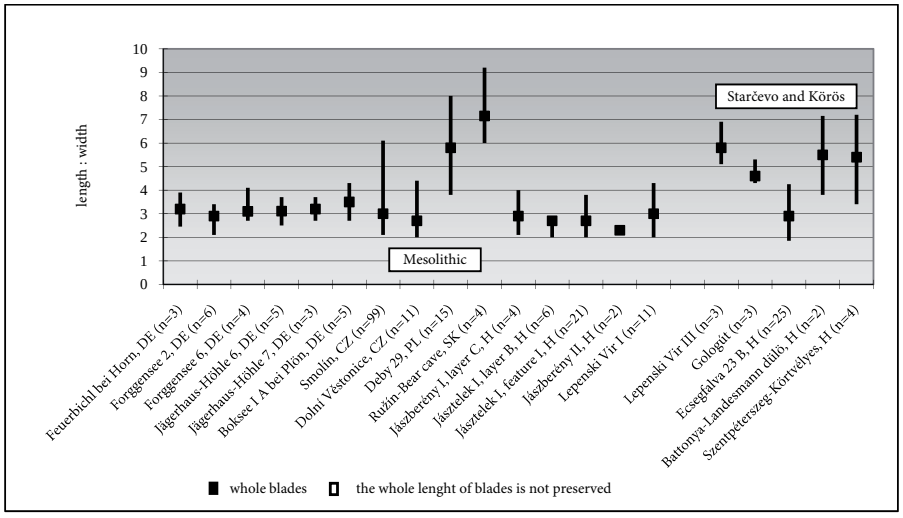
Changes first take place in the middle phase. At the settlements at Těšetice, Vedrovice "Široká u lesa" and Nové Bránice there is a predominance of blanks made from Krumlovský Les chert. Although all of these settlements used the



Graph 8. Length/width indices of blades at early LBK sites in Moravia, Lower Austria and adjacent regions.

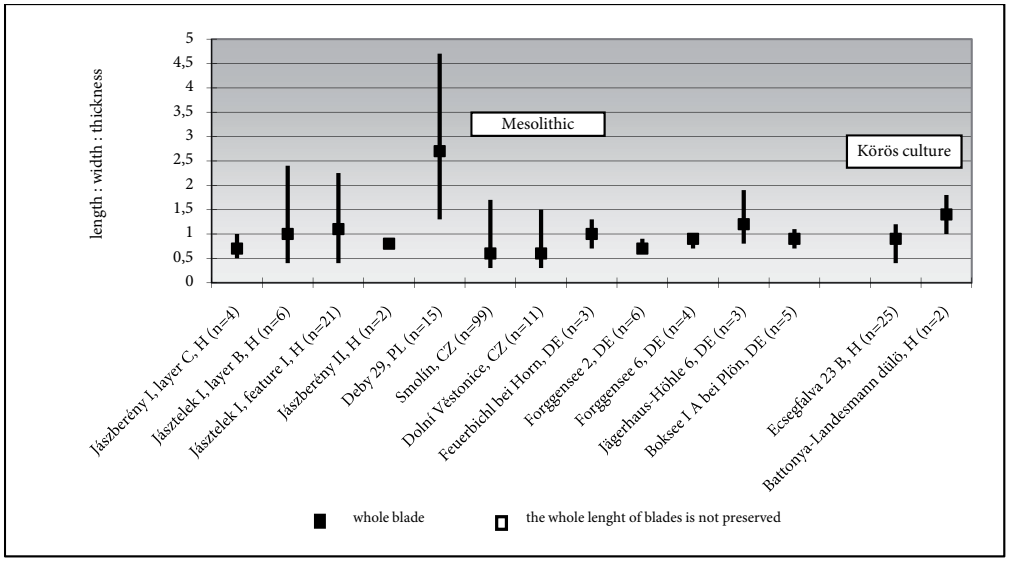


Graph 9. Length/width/thickness indices of blades at early LBK sites in Moravia, Lower Austria and adjacent regions.



Graph 10. Length/width indices of blades at Mesolithic sites and sites of the Starčevo and Körös cultures.

same type of raw material, there are differences between them: at Vedrovice "Široká u lesa" and Těšetice, single-platform prismatic cores with platforms worked by faceting predominate, but plain platforms with dorsal reduction also appear relatively frequently. There is also a corresponding increased proportion of plain and punctiform platform remnants on blade blanks (**graph 6**). The platform angles of the cores and the platform remnant angles of the blades are most often right. In comparison to those from the nearby site of Nové Bránice, the cores from Vedrovice "Široká u lesa" are less regular, more exploited, and relatively often also yielded flake blanks. Nevertheless, I believe that the blades were made by punch technique (**graphs 12 & 13**). The Nové Bránice collection consists of very similar single-platform mostly blade cores of regular prismatic shape, which shows that regular, relatively broad blades were produced here. The core platforms and blade platform remnants were generally worked by faceting, and the right platform angle indicates that the blade blanks were produced by punch technique. The high proportion of cores at Nové Bránice does not, however, match the number of blade blanks, which are almost entirely absent; only irregular and small – perhaps failed – blade fragments, in short: debitage, remained at the site (**graph 14**). The basal parts of blades predominate among the fragments, while there are no long blade pieces or whole blades. This means that the blades produced must have been taken somewhere else. Unfortunately, very little can be said about the site, as the trenches did not locate any cut features. Finds of fine ware sherds and polished stone do, however, support the idea that a settlement was located here.



Graph 11. Length/width/thickness indices of blades at Mesolithic sites and sites of the Starčevo and Körös cultures.

Finds from the site were collected over many years, and a huge collection (of several thousand pieces) of chipped stone has been assembled, comprising cores and flakes in particular. By contrast, at the Těšetice-Kyjovice and Vedrovice "Široká u lesa" settlements, whole blades and longer blade fragments are common. This would imply that in the case of Nové Bránice, one is dealing with a settlement that specialised in the production of blade blanks (Mateiciucová 1997b; Oliva, Neruda & Přichystal 1999, 258). Although the question of specialisation in the LBK period has yet to be clearly answered (Zimmermann 1995, 69, 89), this assertion is also supported by finds of blades made from Krumlovský Les chert, often with sickle gloss, at other settlements dated to the middle phase of the LBK; these appear without cores and could have been exchanged as whole blade blanks.

An almost identical situation has been revealed at a settlement at Kuřim, where a relatively extensive occupation area has been uncovered along with at least eight longhouses. At the south-eastern edge of the site, outside the residential area, pits literally stuffed with chipped stone were uncovered; in the residential area, on the other hand, there were only a few chipped stone artefacts. As at Nové Bránice, there was a massive predominance of flakes and regular blade cores were conspicuous; once again, the blades made from them are absent, with only debitage and blade fragments remaining. From the negatives on the cores, it is clear that regular, relatively broad blades very similar to those from Nové Bránice were made here. The chipped stone artefacts were made almost exclusively from Olomučany chert. Single-platform cores with platforms worked by facetting predominate, but there are also cores with plain platforms. The platform angles are usually right; this is matched by blades with primary facetted platform remnants (**graph 6**). Blades with plain platform remnants also occur regularly, some of them with dorsal reduction. However, dorsal reduction is not only linked to blades with plain or punctiform platform remnants, but also occurs on blades with primary facetted platform remnants. On the basis of all these indicators, the blades from Kuřim were made by punch technique. The concentration of chipped stone in a number of pits outside the domestic area indicates that this was the workshop part of the settlement, where amongst other activities the production of chipped stone artefacts took place. Judging from the uniformity of the cores and the absence of blades, it may be assumed that this settlement, much like Nové Bránice, specialised in the production of blade blanks that were subsequently distributed to surrounding communities. This is also indicated by finds of sickle blades made from Olomučany chert at other settlements from the same period. It does not seem likely that the blades were simply moved from the production area to the domestic part of the settlement; this would not fit with the small number of chipped stone artefacts in the latter. On the other hand, it should not be forgotten that settlement finds are only a partial, unintentional selection of the original inventory, and that necessary items, tools and raw materials could have left with their owners.

Kuřim and Nové Bránice could have been settlements with central place functions. Langweiler 8 in the Aldenhovener Platte region is also regarded as a central place, from where the occupants of the neighbouring "daughter" settlements of Langweiler 2 and Langweiler 9 obtained some of their blade blanks and finished tools (Zimmermann 1995, 92–96).

At Vedrovice "Široká u lesa" and Těšetice, however, it would seem that blank production merely met the needs of the settlements' occupants. Further to the north-east, at Žopy II and Přáslavice-Kocourovec, where imported Krakow Jurassic silicites predominate, blades are also not as standardised as they are at Nové Bránice and Kuřim

(Mateiciucová 1997a; 1997b). As at Vedrovice "Široká u lesa" and Těšetice, there is a preponderance of whole blades or longer blade fragments (blades with broken basal or terminal parts) among both the blanks and the tools at Žopy II and Přáslavice-Kocourovec. In contrast, only small blade fragments (basal fragments, terminal fragments, mesial fragments) are present at Kuřim and Nové Bránice, along with small, somewhat irregular blades that probably did not meet the standard.

The situation as a whole can perhaps be characterised as follows:

1) During the transition from phase I to phase II of the LBK, the production of small, regular blades similar to those of the earliest LBK phase predominates.
2) In the middle phase, the overall size and in particular the width of blades increases. These changes may be associated with an orientation towards better quality raw materials, with a single type of raw material dominant in most instances, and in some cases with a certain degree of specialisation in the production of blade blanks.
3) The orientation towards a single type of high quality raw material is probably linked to raw material extraction (the extraction must have been at least partially organised, with larger numbers of people contributing).
4) In the middle phase, two types of settlement existed in areas where stone raw material occurred:
   a) those that produced blade blanks for their own needs, probably with individual households making enough blanks for their own use; and
   b) those that specialised in the production of blade blanks that were then distributed to neighbouring settlements and regions. This specialised activity was probably bound up with the actual procurement of raw materials, i.e. with extraction, in a far more complex manner.
5) It will probably also be possible to divide these two types of settlement chronologically. This means that the settlements at Kuřim and Nové Bránice may fall into the period of the apex of LBK development. At this time, the greatest settlement density and a relatively well functioning network of contacts between individual villages and regions can be assumed. This settlement type probably fulfilled the role of a centre organising raw material extraction and the distribution of cores and blanks. The settlements at Vedrovice "Široká u lesa" and Těšetice-Kyjovice seem to be older, or may date to a period outside the developmental peak. However, it cannot yet be ruled out that both settlement types existed contemporaneously.
6) In terms of blade production technology, the production tradition of phase I of the LBK persisted in Moravia and in Lower Austria, i.e. blades were made by punch technique.
7) The proportion of blades with plain platform remnants increases in comparison to phase I of the LBK, and dorsal reduction also occurs more often. However, these two phenomena do not always occur contemporaneously. Together with the preponderance of a right-platform angle, they indicate certain changes in core preparation which does, however, remain linked to the production of blade blanks by punch technique. Given the current state of knowledge, it is impossible to know whether or not this relates to the remnants of the local Mesolithic tradition of production or to the influence of western regions.

What, then, was the situation in other areas within the LBK distribution?

In the western part of Germany, on the left bank of the Rhine, differences between blades of the Flomborn phase (the LBK phase Ib according Tichý) and of the later LBK can be traced. At Frimmersdorf 122, dated to the Flomborn phase, there is a preponderance of small blades with platform remnants worked by primary faceting without dorsal reduction. These blades are comparable with those identified in settlements of the earliest LBK (Ostheim-Mühlweide).

By contrast, at Erkelenz-Kückhoven, which mostly dates to the middle and late phases of the LBK, there are uniform, broad, robust blades (**fig. 42: 5–8**); unlike the blades from Frimmersdorf 122 these mainly have plain platform remnants (**graph 6**) and often show dorsal reduction (**graph 7**). At Langweiler 8 in the Aldenhovener Platte region blades with a plain platform remnant also predominate (Zimmermann 1988, 662). The platform remnants of the blades from Erkelenz-Kückhoven and Langweiler 8 are relatively broad, with a visible point of percussion. The bulbs are generally conspicuous. Blades are bent at their terminal parts. The platform angle ranges from right-angled to acute. It seems that blades of this kind were made by punch technique. Unlike blades made by direct percussion, where dorsal reduction removes all of the unwanted notches and the unevenness on the surface of exploitation, dorsal reduction here was rather used to correct the platform angle (Kazdová, Peška & Mateiciucová 1999, fig. 41, 146–148).

In addition to these blades, the settlement at Erkelenz-Kückhoven also yielded long, thin, almost straight blade (Zü 90/44–1592–5/2) made from Obourg flint (**fig. 42: 11**), the source of which

is in western Belgium, some 180 km from the site (Cahen, Caspar & Otte 1986, 6). The length/width and length/width/thickness indices and other indicators place this blade among those made by pressure technique. It is interesting that its dorsal side is covered by the original surface, which means that the knapping on the core began with the striking of this blade (primary blade)[31]; cores prepared for blade production by pressure technique, however, generally have a knapping surface that is carefully prepared by cresting. It is therefore not certain which technique was used in this case. The pressure technique is, however, suggested by the raw material: Obourg flint was often used in the Blicquy group, which again is part of the Bandkeramik sphere; within this group, blades were made by pressure technique (Cahen, Caspar & Otte 1986, 59–60).

The western areas of the LBK are comparable in their developmental trends to the eastern part of central Europe. Here, too, uniform blades (comparable to those from Kuřim and Nové Bránice), very probably made using the punch technique, appear from the middle phase onwards. In contrast to those from Moravian sites, however, they are far more likely to have plain platform remnants. Does this method of working have its roots in the local Mesolithic?

The region west of the Rhine was settled by the LBK only in the Flomborn phase. Prior to the LBK settlement of the area, the local Late Mesolithic and post-Mesolithic cultures (the bearers of La Hoguette and Limburg ceramics) persisted and continued to produce blades by direct percussion. At sites of the earliest LBK, there have also been isolated examples of blades made by direct percussion alongside blades with primary facetted platform remnants; these, too, have been associated with the indigenous Mesolithic cultures (see above).

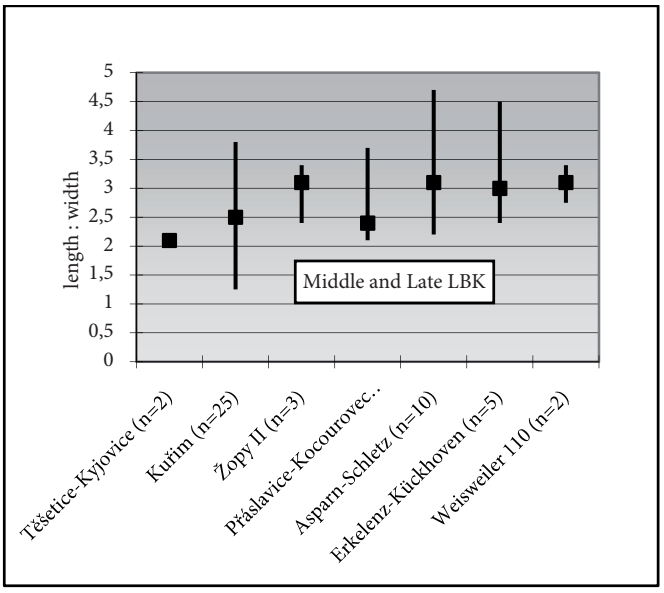
In the middle phase of the LBK there are changes in the sites west of the Rhine. In this period, blades with plain platform remnants and often with dorsal reduction appear, but these are made by punch technique, not by direct percussion. Furthermore, the same sites yield blades with the primary facetted platform remnants characteristic of the earliest LBK and the Flomborn phase, albeit much more rarely.

Several questions therefore arise: did a new method of blade production by punch technique, which was different from the Danubian tradition of production by punch technique, develop in the western part of the LBK range? Did this develop from the local Mesolithic background and under the influence of the Danubian tradition (see chapter 6.2.2.)?

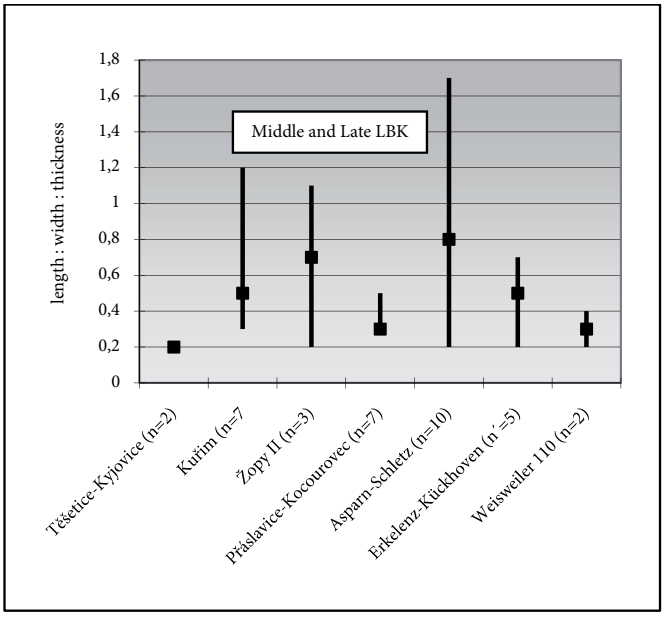
Blades made by pressure technique found in the Blicquy group and occasionally in the *milieu* of the LBK can also be seen as evidence for the influence of the Late Mesolithic and Early Neolithic Mediterranean tradition.

6.2.4. Blank production in the late phase of the LBK

The only late LBK chipped stone assemblage to have been analysed in the study area is that from the enclosed settlement at Asparn-Schletz in Lower Austria. Part of



Graph 12. Length/width indices of blades at middle and late LBK sites in Moravia, Lower Austria and adjacent regions.



Graph 13. Length/width/thickness indices of blades at middle and late LBK sites in Moravia, Lower Austria and adjacent regions.

31 But no cores of this raw material were found at Erkelenz-Kückhoven. I am grateful to A. Zimmermann, C. Mischka, D. Mischka and N. Kegler-Grajewski (University zu Köln) for the possibility to study the material from Erkelenz-Kückhoven and Weisweiler 110 and to E. Claßen for the possibilty to study the material from Frimmersdorf 122.

the chipped stone also comes from pits dated to the end of the middle phase of the LBK, but the assemblage was studied as a single whole. The blades and blade tools form a relatively large proportion of the total. The blade platform remnants are most commonly worked by primary faceting without dorsal reduction, but plain platform remnants also appear relatively frequently (**graph 6**). The blades most often have a right platform remnant angle. In addition to small blades, more robust examples also appear (**graphs 3, 4 & 5**). The blades were struck from single-platform cores. The technique by which the blades were separated from the core is, however, difficult to determine, as essentially all of the cores are in a very exhausted state. From the similarities to blades from other LBK settlements, however, it would appear that they were made by punch technique (**graphs 12 & 13**). There is a strikingly high proportion of splintered pieces, the raw material of which was exploited down to the smallest possible flake which the splintering technique allows (see chapter 10.2.3.4.1.).

The more frequent appearance of the splintering technique in the late phase of the LBK, which is linked to the limited access to stone raw material and to the more abundant use of raw materials from gravels, also affected other areas within the LBK. To the best of my knowledge, however, there is nowhere else with forms like those from Asparn-Schletz, whose inhabitants came to a tragic end.

The A. Gottwald chipped stone collection at the Olomouc Museum comprises material from the late LBK settlement with Šárka ceramics and Stroke-Ornamented Ware at Nová Ves near Oslavany. The collection contains smaller and larger blades with primary facetted platform remnants lacking dorsal reduction. The striking platform remnant angle is a right angle. In profile these blades are most often bent at their terminal parts. All of this indicates that it is highly likely that these blades were made by punch technique.

At Strachów in Lower Silesia, dated to the Šárka phase of the LBK, there is a predominance of small blades with primary facetted platform remnants and lacking dorsal reduction, with a right platform remnant angle. These were struck from single-platform cores. Strachów, like other sites in Lower Silesia from the same period, was supplied with Krakow Jurassic silicites from Little Poland, these being complemented by local erratic silicites (Lech 1981, Map 6). As at Asparn-Schletz, there is a massive preponderance of splintered pieces (Lech 1997, 255–256).

In contrast, at Weisweiler 110 in the Aldenhovener Platte region, which dates to the late phase of the LBK (Zimmermann *et al.* 2004, 57), broad blades with plain platform remnants prevail, much as at Erkelenz-Kückhoven. Splintered pieces also dominate at Weisweiler 110.

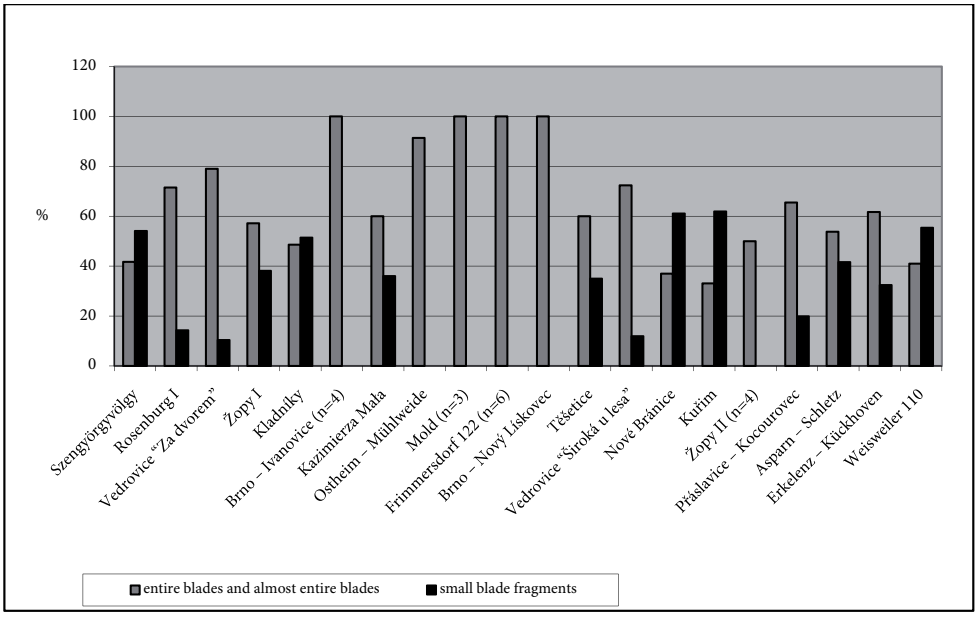
The following, then, can be said of blank production in the late phase of the LBK:

1) The characteristics of the blade blanks indicate that they were made by punch technique, as in the preceding period.
2) Uniform blade cores, known from several sites of the middle phase of the LBK and linked to the specialist production of blade blanks, disappear.
3) Cores for the most part appear in a markedly exhausted state. This thorough exploitation of raw material was achieved by using the splintering technique, as documented by the abundant occurrence if not outright predominance of splintered pieces.

6.3. Tools

6.3.1. Endscrapers and truncated blades

The basic rule is that in chipped stone assemblages where endscrapers predominate the propor-



Graph 14. Frequency of blades and blade fragments at LBK sites in Moravia, Lower Austria and adjacent regions.

tion of truncated blades is lower, and *vice versa* **(graphs 15 & 16**). The function of endscrapers and truncated blades was, however, different. Endscrapers were particularly used for the working of skins, even if other uses were also possible (Małecka-Kukawka 2001; Korobkowa 1999, 26–34). Truncated blades, on the other hand, often appear in combination with sickle gloss. They were sometimes used to engrave wood. End retouching often served only to trim the end of the blade to a certain length, and only its edge was used to, for instance, cut meat (Małecka-Kukawka 2001; Korobkowa 1999, Ryc. 29–10, 15, Ryc. 206)[32].

A comparison of the frequency of endscrapers and truncated blades reveals certain differences in the various areas into which the earliest phase of the LBK spread. In the settlements at Brunn on the edge of the Vienna Woods and at Szentgyörgyvölgy-Pityerdomb in Transdanubia, truncated blades appear often. A relatively even proportion of endscrapers and truncated blades has been presented by D. Gronenborn (1997, 102) at the Neckenmarkt settlement in Burgenland. At Rosenburg and in Moravia, by contrast, endscrapers are more numerous (Vedrovice "Za dvorem", Žopy I): only at Kladníky is there a predominance of truncated blades. In Little Poland, too, endscrapers appear most often at settlements dated to the early phase (Nowa Huta-Bieńczyce, Mogiła 62, Samborzec, Zofipole, Kazimierza Mała; Kaczanowska 1971, 11; 1989, 125). Endscrapers are also more common in the north along the Lower Vistula (Chełmnoland; Małecka-Kukawka 1992, 39), in the very modest assemblages from Lower Silesia (Stary Zamek, Gniechowice; Lech 1985, 79) and in east Bohemia (Bylany I; Popelka 1991a, 302–03).

Endscrapers also predominate in the Danube Basin at Mintraching and Enkingen in Bavaria, as well as being more frequent at Goddelau on the right bank of the Rhine. In contrast, at the more northerly sites along the Main (Bruchenbrücken, Ostheim, Steinfurth and Schwanfeld) there is a prevalence of truncated blades. At Eilsleben in northern Germany there is a preponderance of endscrapers (Kaczanowska 1990, 36).

In the later phases of the LBK, endscrapers come to dominate in both the eastern and western parts of the LBK range – sometimes very markedly. The preponderance of endscrapers, particularly on blades, over truncated blades is related at least in part to an increase in blade width, which is visible in particular in the later phases of the LBK. In addition to Moravia and Lower Austria, endscrapers predominate in south-west Slovakia, in Poland, in Bohemia, in Germany, in Belgium and in the Netherlands (J. K. Kozłowski 1970, Tab. II; Davis 1975, 51, 67–91; Löhr, Zimmermann & Hahn 1977, 264; Kaczanowska 1985, 41–42; Kaczanowska, Kozłowski & Zakościelna 1987, 102, 107, 113; Zimmermann 1988, 669; Caspar, Kaczanowska & Kozłowski 1989, 165–78; Popelka 1991a, tab. 19; 1999; Małecka-Kukawka 1992, 39; Langenbrink 1996, tab. 14). A dominance of truncated blades[33] is the exception (Pleszów 17–20, Strachów; Kaczanowska, Kozłowski & Zakościelna 1987, 102; Lech 1997, Tab. 14).[34] It would seem that in the eastern part of the LBK distribution, truncated blades retained a significant position in the later phases; by contrast, in the western part of the culture's extent endscrapers predominate almost entirely.

What then was the situation in the Early Neolithic of south-eastern central Europe?
At several Körös culture settlements (Ecsegfalva 23, Dévaványa 26 and Méhtelek-Nádas) truncated blades predominate (Bacskay & Siman 1987, 121; Starnini 1993, 38). Blade blanks, as shown above, are somewhat smaller at some sites from this culture, and are similar to the blade blanks of the early phase of the LBK. By contrast, at other Körös culture settlements (Hódmezővásarhely-Kotacpart, Tiszacsege) and at sites of the early phase of the Eastern LBK (Slavkovce, Zalužice, Zbudza) it is endscrapers that are more abundant (Bacskay & Siman 1987, 118–19, 121; Starnini 1994; Kaczanowska & Kozłowski 1997, 180, 191–92, 204). At sites of the Starčevo culture, both endscrapers and truncated blades are rather rare phenomena (Kaczanowska & Kozłowski 1984–85; Gronenborn 1997, 103). In Vinča culture settlements there is a preponderance of endscrapers (Kaczanowska & Kozłowski 1986; Kaczanowska 1989, 130).

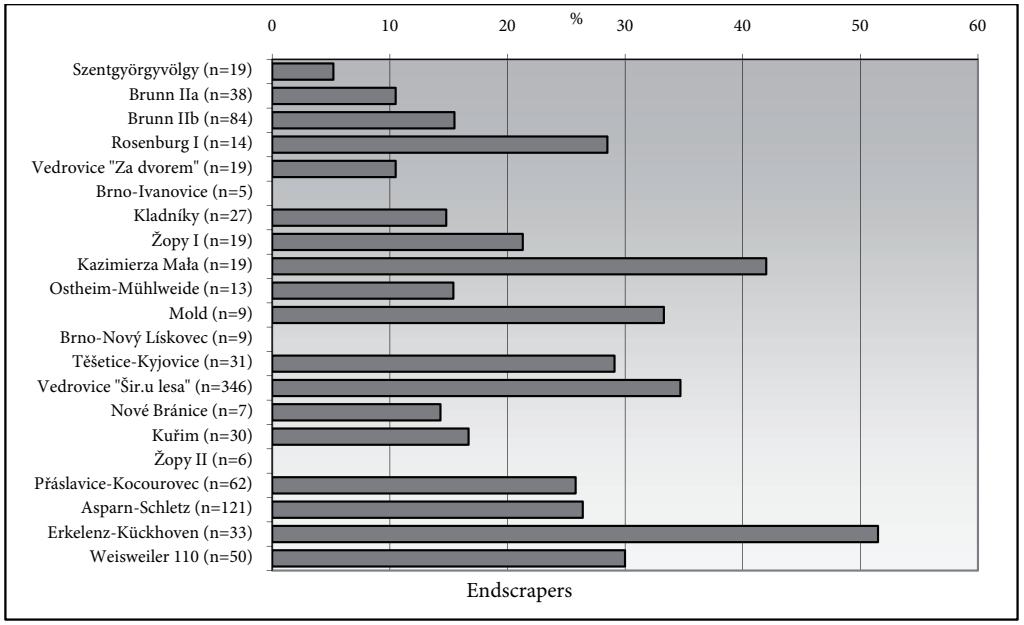
6.3.1.1. Blades with ventral truncation

Several truncated blades are retouched on the ventral side. These blades are sometimes comparable to the Upper Palaeolithic Kostěnki type blades (J. K. Kozłowski 1974, 20; Kaczanowska 1989; Ginter & Kozłowski 1990, 97, Tab. XXX.4, 5). Within the framework of the study period this phenomenon cannot as yet be defined either geographically or chronologically. Nevertheless, it does seem that the appear-

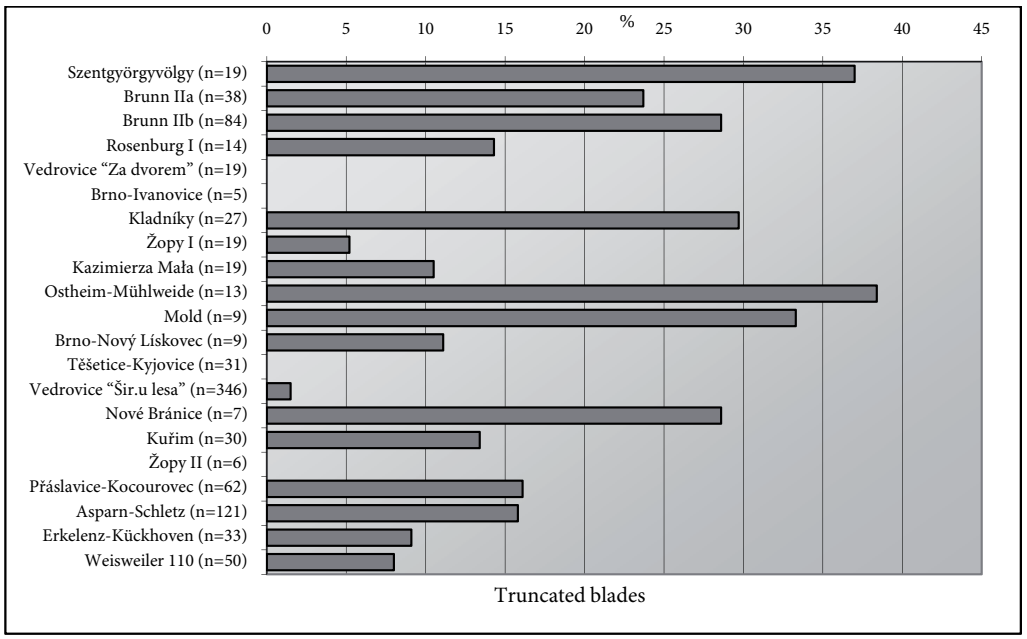
32 Trasological analyses conducted in recent years on LBK artefacts at Chełmno-land have shown that a considerable part of the truncated blades was also used for processing skins, and that in contrast the endscrapers were used not only for working skins but also often as sickle inserts (Małecka-Kukawka 2001, 33–50).

33 Some scholars unfortunately classify truncated blades together with blades with sickle gloss, and it is thus difficult to ascertain the true and comparable proportions of truncated blades as such.

34 The small assemblages of chipped stone artefacts from Transdanubia do not allow a comparison (Biró 1987).



Graph 15. Proportion of endscrapers in the category of tools at LBK sites in Moravia, Lower Austria and adjacent regions.



Graph 16. Proportion of truncated blades in the category of tools at LBK sites in Moravia, Lower Austria and adjacent regions.

ance of blades with ventral truncation concentrates mainly in the south-eastern part of the area covered by the earliest phase of the LBK, in the Starčevo-Körös cultural sphere and in the Late Mesolithic of southern Germany and Hungary.

Ventrally retouched blade ends have been identified at the settlements of Brunn IIa, Brunn IIb and Brunn IV[35]. In Moravia, the terminal ventral retouch is known only from the settlements at Kladníky and Mohelnice (Tichý 1962, figs 9 & 11; Mateiciucová 2000). In eastern Slovakia it has been found at Zemplínské Kopčany in pit 9 and at Zalužice, both dated to the early phase of the eastern Slovakian LBK (the Kopčany phase; J. K. Kozłowski 1989b, Pl.II.21,25; Kaczanowska & Kozłowski 1997, Pl.VI-27.7).

In Hungary, the blades with ventral truncation appear both in the Transdanubian LBK (Szentgyörgyvölgy--Pityerdomb) and in the late Starčevo (Gellénháza-Városrét[36]), as well as at Körös culture sites (Ecsegfalva 23 – **fig. 43: 5, 6, 10**; Méhtelek-Nádas, Battonya; Bacskay & Siman 1987, Pl. I.-3; Kaczanowska 1989, 124; Starnini 1993, Figs 9.20 & 12.4). This tool type has also been recognised at the Mesolithic station of Jásztelek I[37] in northern Hungary, and at Lepenski Vir I in the Iron Gates region of Yugoslavia (Kozłowski & Kozłowski 1984, Pl.2–14, 15).

Blades with ventral truncation occur not just in Hungary and the Iron Gates, but also in the Late Mesolithic of southern Germany (Jägerhaushöhle 7,

35 Because at Brunn IIa, Brunn IIb and Brunn I, I was only responsible for identifying the raw materials used, I gained only an orientational overview of the artefact production technologies and tool types; several tool types thus do not form part of the published analysis.

36 At Gellénháza-Városrét, which lies west of Lake Balaton, a settlement of the late phase of the Starčevo culture and of the Sopot-Bicske culture was identified. I am indebted to K.T. Biró (National Museum in Budapest) for access to the material.

37 I am grateful to R. Kertész (Szolnok Museum) for making it possible to study the material from the Mesolithic sites in the Jászság area.

Forggensee 2 and Forggensee 6; Taute 1971, Taf. 19–24, 25; Gehlen 1988, 269, 322). By contrast, this type does not appear at the sites of the Earliest LBK published by Gronenborn (1997). Trapezoidal blade fragments found in graves at the cemeteries of Kleinhadersdorf and Vedrovice "Široká u lesa" and interpreted as arrowheads have also been known to bear ventrally retouched ends, which means that they fulfilled a similar function. Both cemeteries have probably been founded in the early LBK (phase Ib).

In later phases of the LBK, blades with ventral truncation appear in Hungary at the sites of Vászoly and Bakonyjakó (Biró 1987, Fig. 4), as well as in Moravia at Kuřim, at the Erkelenz-Kückhoven settlement in western Germany and in Little Poland (Olszanica, Pleszów). An example from Kormanice I in south-east Poland (J. K. Kozłowski 1974, 20; Milisauskas 1976, Fig. 24. H; Kaczanowska, Kozłowski & Zakościelna 1987, Pl. VI. 20) may also be related.

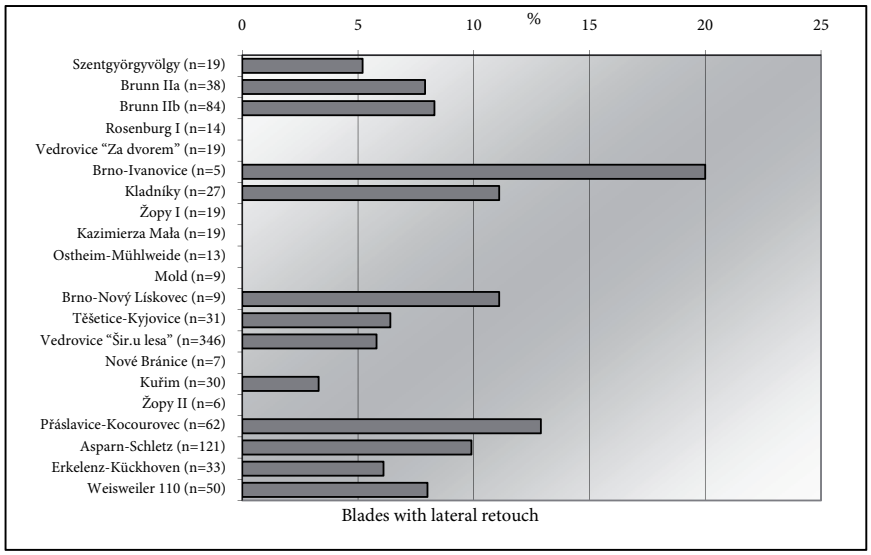
6.3.2. The transversal and other burins

At the Late Mesolithic site of Jägerhaushöhle 7, at the late Starčevo settlement of Gellénháza-Városrét and at the Brunn IIa and Brunn IIb settlements, ventral truncation occurs together with transverse burins (Taute 1971, Taf. 19–24). The transverse burin most likely served to divide blades. It has been identified at sites dated to the earliest phase of the LBK – at Brunn IIa, Brunn IIb (**fig. 10: 17 & fig. 11: 3,6,16–18**), Neckenmarkt, Mogiła 62, Schwanfeld, Enkingen, Mintraching, Bruchenbrücken and Goddelau (Kaczanowska, Kozłowski & Zakościelna 1987, Pl. I. 12; Gronenborn 1997, Taf. 1.1–8, 9, Taf. 3.1–8, 10, Taf. 4.1–8, Taf. 5.2–14, 15, Taf. 5.3–22, Taf. 6.1–7, 10, Taf. 7.1–12). However, the transverse burin also appears in the Late Mesolithic of Hungary (Jásztelek I) and southern Germany (apart from Jägerhaushöhle 7 and at Forggensee 6; Taute 1971, Taf. 19–6; Gehlen 1988, 322). In Hungary, it occurs at settlements of the Starčevo culture (Gellénháza-Városrét), the Körös culture and the Alföld LBK (Endrőd 6, Tiszacsege, Méhtelek-Nádas; Starnini 1994, Figs 5–10, 25–1,2; Starnini & Szakmány 1998, Fig. 29–2), just like ventral truncation. In eastern Slovakia it has been identified at the site of Slavkovce, dated to the Szatmár phase, and at Zemplínske Kopčany in pit 9 (J. K. Kozłowski 1989b, Pl.II.16, Pl.V.5; Kaczanowska & Kozłowski 1997, Pl.VI.-2.11).

In south-west Slovakia, the transverse burin appeared at the site Štúrovo, dated to the middle and Želiezovce phase (Kaczanowska 1985, Taf. 15, 16). A single example has been identified from Moravia, at the Přáslavice-Kocourovec settlement (Mateiciucová 1997a). In Bohemia, along the Lower Vistula (Chełmno-land) and in Lower Silesia, this artefact treatment has yet to be recognised (Kaczanowska 1971; Lech 1985; Małecka-Kukawka 1992; Popelka 1991a; 1999). However, this is possibly due to the fact that it has not hitherto attracted any great attention.

Otherwise, burins appear only very rarely. In the earliest LBK phases they appear in isolated cases at the Szentgyörgyvölgy-Pityerdomb, Vedrovice "Za dvorem" (**fig. 14: 15**), Kazimierza Mała, Mintraching and Ostheim settlements (Gronenborn 1997, Taf. 3, 2–1). A single burin has also been identified at the Körös culture site of Ecsegfalva 23. Most are burins on break, on a natural plateau or side facetted. Burins appear far more commonly at the Late Mesolithic station of Jásztelek I in northern Hungary; at the latter site, however, all of the mentioned types are outnumbered by wedge-shaped burins.

Burins are often mentioned also in connection with the late phase of the Starčevo culture and with the Transdanubian LBK culture (Biró 1987; 2002). On the basis of published illustrations as well as according to the fact that they do not even occur in the settlements of Brunn am Gebirge, which are closest to the Transdanubian LBK culture, I remain sceptical of their classification as burins and suspect that in many cases they could be pseudo-burins.



Graph 17. Proportion of retouched blades in the category of tools at LBK sites in Moravia, Lower Austria and adjacent regions.

6.3.3. Laterally retouched blades

Laterally retouched blades are neither a significant nor a conspicuous category (**graph 17**). In both the earliest and the later phases a small amount of regular retouching is most common, in most cases not stretching along the whole length of the blade, and which in part probably originated only through use of the artefact. The regular, continuous lateral retouching so typical of the Starčevo-Körös-Criș culture complex and of other Early Neolithic cultures of the Anatolian/Balkan sphere has yet to be found in either Moravia or Lower Austria (Kozłowski 1982; Kozłowski & Kozłowski 1984; Kaczanowska & Kozłowski 1984–85; Bacskay & Siman 1987; Paunescu 1987; Kaczanowska 1989). In the LBK of Transdanubia, too, retouched blades (regular, continuous, in most cases bilaterally retouched blades) are essentially absent (Biró 1987). They are also absent in the Mesolithic of northern Hungary (Kertész *et al.* 1994). They appear more often in the pre-Neolithic horizons in the Iron Gates region (Kozłowski & Kozłowski 1982; 1984) and in the eastern Slovakian LBK (Kaczanowska & Kozłowski 1997).

6.3.4. Borers, perforators and becs

Another tool group comprises borers, perforators and becs (**graph 18**). Borers and perforators appear both at sites dating to the earliest phase of the LBK and in later phases (**graph 19**). They most often have their points worked as perforators (see chapter 10.2.3.4.). The most common shapes are small, slim perforators and borers with a *weakly* distinguished point; they are sometimes classed together with the borers and perforators with a *well* distinguished point. Borers and perforators with a long, well distinguished point are regarded as a characteristic tool type of the Danubian Neolithic, and their appearance in the LBK is taken as evidence for its south-eastern origin (Tichý 1962, 297; Vencl 1971, 91). It was in this context that they were first published by R. Tichý from the settlement at Mohelnice, where they were found[38] in feature 051 together with trapezes and "ancient pottery" (Tichý 1962, Obr. 9.3–5, 269). Tichý sought analogies in the pre-pottery Neolithic of Thessaly and the Near East at Jarmo (Tichý 1962, 297). J. K. Kozłowski, too, regards this type as characteristic of the earliest Neolithic in the Anatolian/Balkan zone (J. K. Kozłowski 1970, 74). A collection of very conspicuous perforators with a long, well distinguished point (type Vedrovice) was found in feature 098 at the settlement at Vedrovice "Široká u lesa"; this pit also contained ceramics with music note decoration (Ondruš 1975/76). Borers/perforators with a long, well distinguished point of this type have not been identified at other earliest LBK sites studied here. Similarly, this type is absent at other sites dated to the earliest phase of the LBK (Biró 1987; J. K. Kozłowski 1989b; Małecka-Kukawka 1992; Gronenborn 1997; Kaczanowska & Kozłowski 1997) – the only exceptions perhaps being a few fragments from Rosenburg I and Brunn II, a point fragment from Bylany and two examples from Goddelau (Popelka 1991a, Fig. 5.6; Gronenborn 1997, Taf. 6.2–12, 13; Mateiciucová 2001a, Abb. 2: 31, Abb. 3: 2). Other contentious examples, whole or fragmented, come from settlements of the music note and late phase of the LBK at Bylany, Těšetice, Olszanica and Asparn-Schletz (Caspar, Kaczanowska & Kozłowski 1989, Pl. 2. 14; Popelka 1991a, Fig. 13. 7). Most of them could be classified as *slim* perforators/borers with a *well* distinguished point, rather than perforators/borers with *a long, well* distinguished point of the Vedrovice type.

In contrast to the earliest phase of the LBK, borers/perforators with a long, well distinguished point are abundant in the later phases, and particularly in the Stroke-Ornamented Ware and Rössen cultures. Their occurrence is concentrated above all in southern Germany and Switzerland, with isolated instances from the same period in the Rhineland (Davis 1975, 91–93; Zimmermann 1988, 700). In Switzerland, borers/perforators with a long, well distinguished point are hidden behind the term *Dickenbännli-Spitze*, but do not occur here in the Mesolithic (Taute 1974/75, 88–89; Davis 1975, 75–76; Nielsen 1991, 88; 1997a, 60). In the case of Mohelnice, F.D. Davis does not exclude the possibility that feature 051 might include an admixture of later date, which has since been confirmed (Rad. Tichý – pers. comm.). A single borer with a long, well distinguished point was also found at Mohelnice in a feature containing ceramics of the middle phase (Davis 1975, 86). Similarly, a small borer found at Přáslavice-Kocourovec might be classifiable as a borer with a long, well distinguished point (**fig. 25: 1**); this would, however, mean that this could not be considered a type characteristic solely of the earliest phase of the LBK and the Early Balkan Neolithic (Gronenborn 1997, 90–91), but rather as a shape accompanying the whole Neolithic (i.e. the Early and Middle Neolithic in the western European chronology), its occurrence peaking in the Middle Neolithic (after western European chronology) in south-western parts of central Europe. Nevertheless, it seems likely that borers/perforators with a long, well distinguished point first appeared in central Europe at the beginning of the Neolithic.

By contrast, the *slim* perforators with a *weakly* distinguished point are the original type known

38 Judging from the illustrations, this seems to be a perforator.

from even the Early Mesolithic of northern Europe and the north African Epi-Palaeolithic (Tixier 1963; Heinen 1998, 135). In central Europe they remained until recently an unknown type; only a few years ago were they recognised at a range of Early to Late Mesolithic sites in southern Germany, Austria, Switzerland, France, Belgium and Italy (Heinen 1998, 135). Perforators with this shape appear in the literature as 'Mèche de fôret', but may also be found under the name "awl" or even on occasion transformed into Sauveterrian points (Heinen 1998).

In south-western Europe this shape of perforator has been identified in the Early Neolithic Cardial culture and in the earliest LBK phase at Rottenburg a. N. (Heinen 1998, 144).

The slim perforator with a weakly distinguished point or 'Mèche de fôret' is also a typical form occurring in the eastern part of central Europe, where it is again known from as early as the Mesolithic. A single example has been identified in south Moravia at Šakvice, and another in a Late Mesolithic context at the Jásztelek I site in northern Hungary (Klíma 1953, Obr. 130; Kertész 1996a, Plate 6:42; Mateiciucová 2001a, Abb. 2: 13). It is likely that further examples are to be found in the Mesolithic assemblages of south-west Slovakia[39].This type has also been recognised at Lepenski Vir I in the Iron Gates region (Kozłowski & Kozłowski 1984, Pl.4.4).

'Mèche de fôret' perforators appear far more frequently in the LBK, especially in its earliest phase, than in the Mesolithic. Unlike the Mesolithic, however, in addition to points in the shape of perforators, i.e. retouched on both edges from the same (both on dorsal or both on ventral) side, borer shapes with alternate retouches – dorsal on one edge and ventral on the other – also appear in the LBK. 'Mèche de fôret' perforators/borers are relatively common at the sites of Brunn IIa, Brunn IIb (**fig. 11: 19–26**), Rosenburg I (**fig. 13: 4,7,8,12,13**) and Neckenmarkt (Gronenborn 1997, Taf. 1.2–13,14). Working material into the shape of a perforator remained more common than producing the shape of a borer. In Moravia 'Mèche de fôret' perforators have been identified at the settlements at Vedrovice "Za dvorem" (**fig. 14: 6**) and Kladníky. In addition to Moravia and Lower Austria, in this period these objects also appeared in Little Poland (Kazimierza Mała, Mogiła 62; Kaczanowska 1971, Ryc. 3.9), Chełmno-land (Boguszewo 41; Małecka-Kukawka 1992, 65, Tab. 3.6,7) and Germany (Schwanfeld, Goddelau and Ostheim – **fig. 42: 2**; Gronenborn 1997, Taf. 5.4.-1–5, Taf. 6.2.-9, 11,14). Perforators of this type also appeared in eastern Slovakia (Zalužice; Kaczanowska & Kozłowski 1997, Pl. VI-26. 11). By contrast, no characteristic example has yet been found in the Körös culture (Starnini 1993; Starnini & Szakmány 1998; Mateiciucová 2007). Slim perforators/borers with weakly distinguished points matching the 'Mèche de fôret' type occur in the Usoye culture of north-eastern Bulgaria, which is contemporary with the Dudeşti culture of Romania and the Vinča culture. It is presumed that the roots of the manufacturing tradition of the blanks and tools of the Usoye and Dudeşti cultures are interwoven in the Epi-Palaeolithic (Gatsov 1987; 48–49, Pl. V.; J. K. Kozłowski 1987, 561).

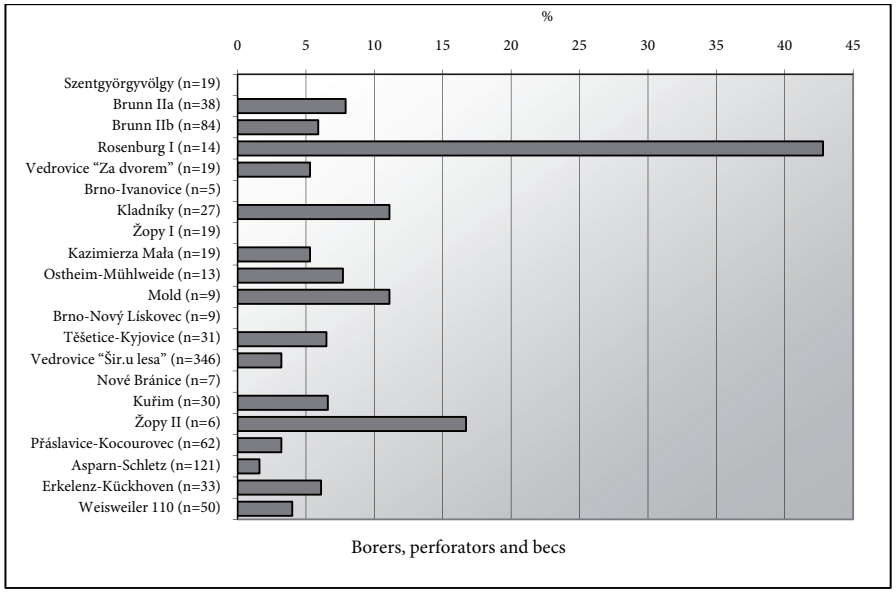
Borers and perforators of this type also appear in the later phases of the LBK. It seems that in this period borers were more frequent. One example, a perforator, was found at the settlement at Mold. A small borer with a weakly distinguished point was found at the settlement at Asparn-Schletz. In Moravia, borers of this type appeared at the site of Kuřim. An example from Přáslavice-Kocourovec (**fig. 25**) should probably rather be classed as a borer with a well distinguished point (see above); similar tools are also known from Bylany, although in this case it is not possible to state with certainty whether these were perforators or borers on the basis of the illustrations provided (Popelka 1991a, Fig. 13.8,9). This type also appears in Poland during this period; its size does not, however, increase in comparison to the earlier period (Olszanica, Mogiła 62, Pleszów, Niemcza; Milisauskas 1976, Fig. 24. C; Kaczanowska, Kozłowski & Zakościelna 1987, Pl. XIII.12,13,16; Caspar, Kaczanowska & Kozłowski 1989, Pl.2.12, Pl.3.19,20; Lech 1997, Ryc. 1.h). Slim perforators with weakly distinguished points also occur in the north-western parts of central Europe, in the areas west of the Rhine, where, however, they are much larger than borers and perforators of the 'Mèche de fôret' type from more easterly areas (Zimmermann 1988, 699, Taf. 68–71). Large types are mentioned by M. Heinen (1998, 137) in the Mesolithic of north-western Europe. It would certainly be interesting to investigate whether any closer relationship exists between the two traditions, such as has been recognised in the continuation of the Mesolithic tradition of asymmetrical triangular and trapezoid points in the same region (Löhr 1994).

The function of borers/perforators

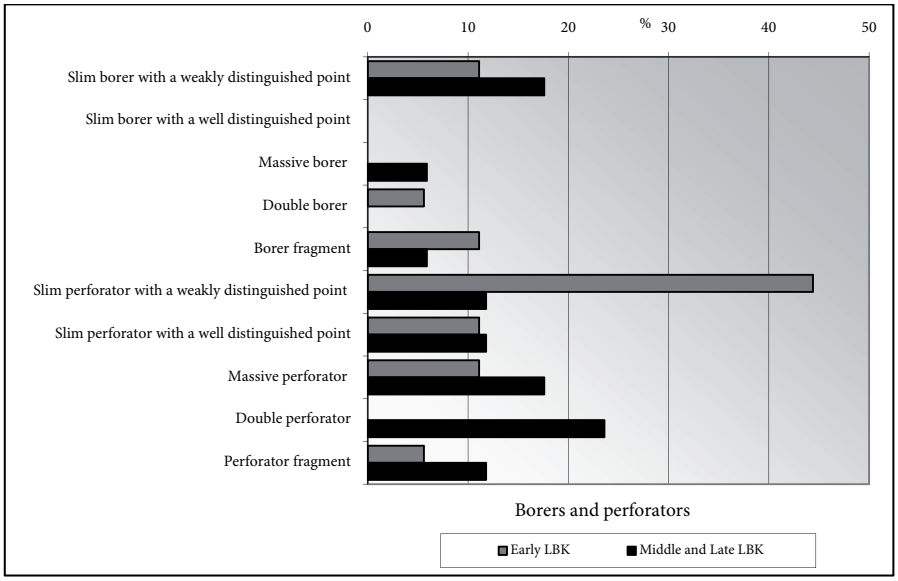
Trasological functional analyses of borers and perforators reveal that in the main they were used for drilling and piercing bone, horn, antler, wood, skin, shells and ceramics. Rarely, traces have been found of the boring of harder materials such as sandstone, shale, lime-

39 A look through a selection of material from the Late Mesolithic station at Forggensee 2 also yielded a single 'mèche de foret' perforator. A further four pieces have been recognised at the neighbouring station of Feuerbichl bei Horn (Heinen 1998, 140).

stone or marble (Heinen 1998, 138; Korobkowa 1999, 90–100). Indeed, it is point borers/perforators and similar types with slender points that were most likely used to drill the limestone and marble beads that occur in large numbers in Neolithic graves (Nadler 1985; Nieszery 1995, 160–61; Ondruš 2002). Six perforators were found at Rosenburg I which, given the low number of tools overall, formed more than 1/3 of all the implements recovered. All are very small and made from Krumlovský Les I chert (**fig. 13: 4, 7, 8, 12, 13**). As noted above, one or perhaps two examples might originally have been point-shaped perforators. Traces of limestone were found on the points of three of the perforators (**fig. 13: 4, 7, 8**)[40]; it is thus highly probable that they were used to drill limestone or marble, and might have been used in bead production. Similarly, I. Mrázek is of the opinion that the point borers found in large numbers in feature 098 at the Vedrovice "Široká u lesa" settlement were used for the drilling of stone beads. Mrázek compared the thickness of the points of these borers and the extent of the macroscopically visible working traces on the points with the holes in the marble beads found in large numbers in grave 9 at the Vedrovice "Za dvorem" cemetery, and found that they agreed (Mrázek 1989). Of course, whether the perforators and borers from Rosenburg and Vedrovice really served this purpose will be revealed only by full trasological analysis.



Graph 18. Proportion of borers and perforators in the category of tools at LBK sites in Moravia, Lower Austria and adjacent regions.



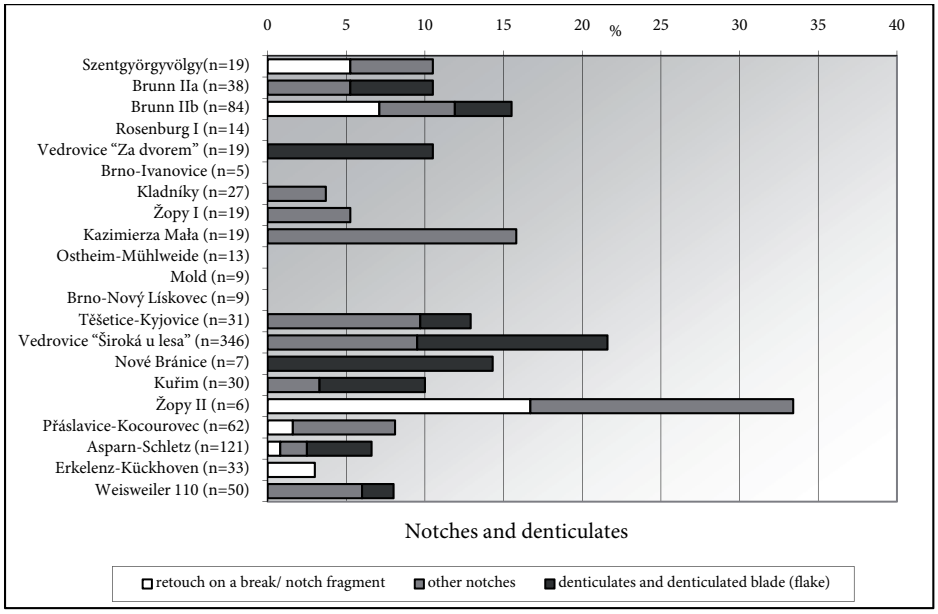
Graph 19. Borers and perforators. Frequency of particular types at sites dating to the early phase and at those dating to the middle and late phases of the LBK.

6.3.5. Notches and denticulates

Notches and denticulates form a common part of chipped stone artefact assemblages (**graph 20**). The most common types are retouched notches, which most often appear on blades. A striking example is provided by notch fragments that indicate a certain manner of dividing the blade, whereby the notch was retouched on the blade and the blade was then broken at the notch site; W. Taute terms this the '*Kerb-Bruch-Technik*' and regards it as typically Neolithic (Taute 1973/74, 81).

Notch fragments have been identified at the early LBK settlements of Szentgyörgyvölgy-Pityerdomb and Brunn IIb. This method of blade division has also been identified at Kladníky (**fig. 17: 9**). On the series of trapezes and trapezoidal shapes from the Vedrovice "Široká u lesa" and Kleinhadersdorf cemeteries, it is in a number of cases also possible to interpret retouching on breaks as notch fragments (Mateiciucová

40 I am indebted to A. Přichystal (Brno University) for the identification.



Graph 20. Proportion of notches and denticulates in the category of tools at LBK sites in Moravia, Lower Austria and adjacent regions.

1998, 84). Notch fragments have also been identified at the Körös culture settlement of Ecsegfalva 23 and in the Alföld LBK at Ecsegfalva 18; by contrast, notch fragments do not appear on the Late Mesolithic sites of northern Hungary (Jászberény II, Jásztelek I), even though simple, retouched notches are common.

At Brunn IIb, the '*Kerb-Bruch-Technik*' is complemented by a method of blade division during which the blade was divided at the notch site by a blow from the dorsal or ventral side – but this is not the classic microburin technique. As the Brunn sites are currently being analysed, and for the purposes of comparison, only a small sample of the chipped stone artefacts have been studied from a morphological point of view. Greater attention will be paid to this phenomenon in future studies.

In the later phase of the LBK, notch fragments appear only in isolated cases; single examples are known from the settlements at Žopy II, Přáslavice-Kocourovec and Asparn-Schletz.

Irregular denticulates, and sometimes whole denticulated blade or flake edges, are fairly common throughout the duration of the LBK, but do not form a characteristic tool type. Denticulates most often appear in settlements concerned with primary processing of chipped stone, which apparently led to their creation by chance.

6.3.6. Trapezes and trapezoidal shapes

Trapezes made on regular blades are a phenomenon characteristic of the Late Mesolithic and Early Neolithic. Indeed, it is the presence of trapezes at Mesolithic stations that is usually regarded as an indicator allowing the Mesolithic settlement to be classified into the later chronological horizon. Together with regular blades, trapezes are regarded as evidence of the first influences entering Europe from the Near East, thus announcing the onset of the Neolithisation process by their presence (Taute 1974/75; S. K. Kozłowski 1987; Gronenborn 1997).

Trapeze occurrence

The trapezes from Smolín (Valoch 1978; S. K. Kozłowski 1980) are regarded as among the earliest, but are made on irregular blades. In Moravia, the first trapezes on regular blades appear at the Mesolithic stations at Dolní Věstonice, Mikulčice and Šakvice (Klíma 1953; Škrdla, Mateiciucová & Přichystal 1997); they also appear in Kůlna cave in layer 3, dated to the Epi-Magdalenian, but the upper part of which is regarded as Mesolithic due to the presence of trapezes (the "Final Palaeolithic": Valoch 1988, 21–22, Abb. 1–10, 11). In Lower Austria, trapezes have been identified in Mesolithic contexts at the stations at Wien-Bisamberg, Burgschleinitz and Horn-Mühlfeld (Leitner 1984; Antl-Weiser 1986). In Hungary, they are so far known from Kaposhomok in Transdanubia (Dobosi 1972, Abb. 2: 35–38; Bánffy 2000; 175) and from northern Hungary – the sites of Jászberény I (layer B), the surface station of Jászberény III and the Late Mesolithic horizon of Jásztelek I (Kertész *et al.* 1994). In Slovakia, trapezes have been identified at the Late Mesolithic stations of Sereď and Dolná Streda[41] (Bárta 1959; S. K. Kozłowski 1981). They also appear in Mesolithic assemblages from north Bohemia (Bezděz, Máselník, Dolský Mlýn, Stará skála and Okrouhlík I; Novák 2003, 70).

In the LBK of Moravia and Lower Austria, trapezes appear almost exclusively in the earlier phase I and at the turn of phase II (**graph 21**). Only exceptionally do they occur in phase II proper. The settlement at Kuřim yielded a single, atypical trapeze. The single example identified at the Vedrovice "Široká u lesa"

41 Because Lengyel ceramics, which can also be associated with trapezes, are present at the Dolná Streda-"Vŕšky" station, the latter cannot simply be classed as a Mesolithic settlement (Bárta 1959).

settlement probably comes from an earlier horizon. At Asparn-Schletz, where even settlement traces datable to the earliest phase of the LBK were recorded, two trapezes were found. The greatest numbers of trapezes were identified at Brunn IIa and Brunn IIb, and at the Vedrovice "Široká u lesa" cemetery.

Trapezes did not appear at the early LBK sites at Kladníky, Brno-Ivanovice and Rosenburg I[42].

Until recently it was the case that trapezes were absent from the basins of the Vistula and Oder (Kaczanowska & Lech 1977, 14); new archaeological research, however, has provided evidence of trapezes along the Vistula (Kazimierza Mała, Boguszewo 41; Małecka-Kukawka 1992, Tab. 6.10). In Bohemia they are rare in the LBK. At Bylany only a single trapeze was found, in a context dated to the later or final phase (Popelka 1991a, Fig. 13. 10). By contrast, these objects are relatively abundant in Austria and the German Danube Basin, as well as at the western periphery of the earliest LBK; they are also to be found at sites of the earliest phase in Saxony (Klein Denkte and Eilsleben; Tillmann 1993, 162–163; Gronenborn 1997). Their occurrence is still recorded in the later phases (Flomborn, Sondershausen, Müddersheim; Behrends 1973, Abb. 4; Fiedler 1979, 88–89).

In south-west Slovakia trapezes are known from later contexts onwards. A single transverse arrowhead was found at the late LBK settlement at Štúrovo (Kaczanowska 1985, Taf. II. 8). In Hungarian Transdanubia trapezes are again rare, which is probably a result of the small numbers of chipped stone collections from the earliest phase of the LBK (Biró 1987; Makkay, Starnini & Tulok 1996); a single example has been identified in an investigated sample of chipped stone from Szentgyörgyvölgy-Pityerdomb in western Transdanubia.

Trapezes form a relatively large proportion of finds from the Körös culture sites of Ecsegfalva 23 and Méhtelek-Nádas (Starnini 1993; J. K. Kozłowski 1989b, 396; Mateiciucová 2007). In other sites dated to the Körös, they do appear (Ecsegfalva 23, Dévaványa-Réhely düló; Bacskay & Siman 1987, Pl. II. 10), but are not as numerous as many maintain: they are absent from a whole series of sites associated with this culture (Bacskay & Siman 1987; Starnini 1994; Starnini & Szakmány 1998). On the other hand, it seems that they are far more numerous in eastern Slovakia, where in recent years a number of new sites from the earliest phase of the Eastern LBK have been investigated (Slavkovce, Zalužice, Zbudza; J. K. Kozłowski 1989b; Kaczanowska & Kozłowski 1997).

Rich collections of trapezes are known from sites of the Starčevo-Criș cultural sphere and from Early Neolithic Greece (J. K. Kozłowski 1982; Perlès 1987, Fig. 4, Fig. 6; Paunescu 1987, Figs 2,4,5, 7).

Trapeze types and trapezoidal retouched and unretouched shapes

In dividing trapezes into long (AA), short (AZ) and broad (transverse dart – AC) categories, I have retained the descriptions and definitions of S. K. Kozłowski (1980, 16, figs 28–32). Trapezoidal retouched and unretouched blade fragments, found in graves as part of funerary equipment at the cemeteries at Kleinhadersdorf and Vedrovice, were assessed alongside the trapezes; depending on their proportions, they too were classed into one of three types, AC, AZ or AA (**table 6**).

Short trapezes (AZ) predominated at the sites studied. They are also predominant at other sites of the early phase of the LBK in Austria and Germany (Gronenborn 1997). This shape further occurs preferentially along the Vistula, as well as in eastern Slovakia in the Eastern LBK and in the Körös culture in Hungary (Małecka-Kukawka 1992, tab. 6.10; Starnini 1993; Kaczanowska & Kozłowski 1997).

The short trapezes are immediately followed by the broad trapezes (transverse arrowheads) of class AC, which dominate the cemeteries at Kleinhadersdorf and Vedrovice "Široká u lesa". Similar broad trapezes have been recovered from the settlement at Brunn I, dated to the same horizon as both cemeteries. Broad trapezes have further been found at the settlements at Vedrovice "Za dvorem", Vedrovice "Široká u lesa", Asparn-Schletz and Kazimierza Mała. They are also common in the Körös culture (Méhtelek-Nádas, Dévaványa-Réhely düló; Bacskay & Siman 1987, Pl. II.10; Starnini 1993) and in the Eastern LBK (Kaczanowska & Kozłowski 1997). In Germany they have been recovered at Schwanfeld, Goddelau, Bruchenbrücken and Müddersheim, and from the cemeteries at Flomborn and Sondershausen (Behrends 1973, Abb. 4; Fiedler 1979, 88–89; Gronenborn 1997). The shape of the broad trapeze from Bruchenbrücken (Gronenborn 1997, 237) is more similar to the north-west European types.

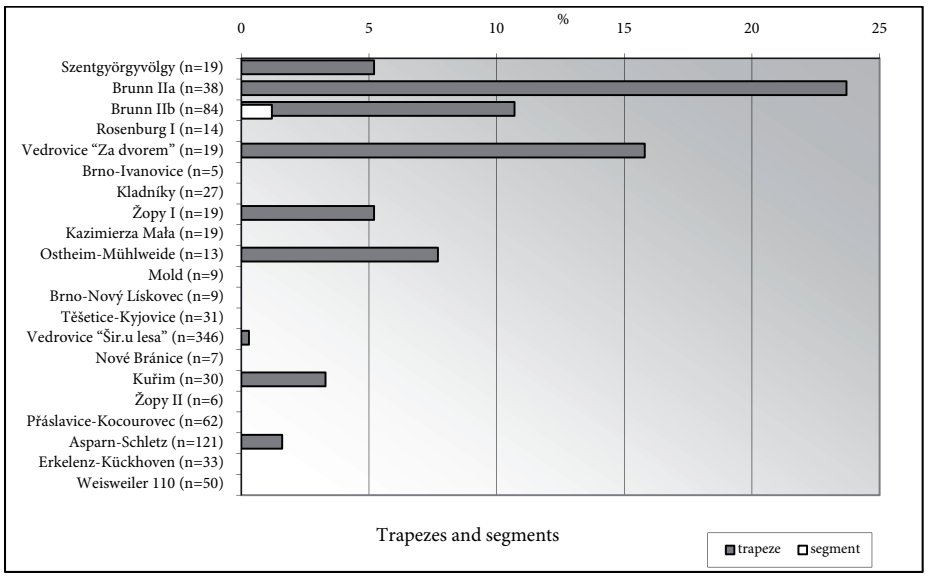
Broad trapezes are also known from the Mesolithic stations at Dolní Věstonice and Mikulčice (Klíma 1953; Škrdla, Mateiciucová & Přichystal 1997, Abb. 3.6.).

Long trapezes (AA) are less common in the LBK; indeed, they are essentially absent from Moravia. They

42 In a paper given at a symposium held at Szolnok in 1996, I described a blade fragment with oblique truncation from Rosenburg I as a trapeze. At the other end of the fragment, a fine retouch was visible, which I would now rather regard as a pseudo-retouch originating mechanically. For these reasons, this artefact has not been retained in the class of identified trapezes (Mateiciucová 2001a).

appear most abundantly at the settlements at Brunn IIa and Brunn IIb and in the graves found there. In Germany two examples have been recovered from the settlement at Schwanfeld and one from Steinfurth (Gronenborn 1997). They have also been identified in the Eastern LBK at the Zbudza settlement, and in the Körös culture in the Ecsegfalva 23 and Méhtelek--Nádas settlements.

Long trapezes also appear at Mesolithic stations. That at Kaposhomok in Transdanubia has yielded two pieces (Dobosi 1972; Bánffy 2000; 175), while a single example was recovered from the Late Mesolithic context of Jásztelek I (Kertész *et al.* 1994, Taf. III.1; 2002, Fig. 7:7). They also appear in the pre-Neolithic horizons at Vlasac and at Lepenski Vir I (Kozłowski & Kozłowski 1982, 96, Pl. IX.17, Pl. XXIV.6; 1984, 270, Pl. 4.10). Two long trapezes have also been found at Mikulčice in south-east Moravia (Škrdla, Mateiciucová & Přichystal 1997, Abb. 3), and one in the Kůlna cave (layer 3) in the Moravian Karst (Valoch 1988, Abb. 1–11).



Graph 21. Proportion of trapezes and segments in the category of tools at LBK sites in Moravia, Lower Austria and adjacent regions.

Retouch methods on trapezes and evidence for trapeze production

In essence, the great majority of trapezes from the study area are dorsally retouched. This kind of retouching massively predominates at the settlements of Brunn IIa and Brunn IIb (**fig. 10 & fig. 11: 1–10**).

At the Vedrovice cemetery trapezes showed dorsal, ventral and dorso-ventral retouching (tabs. XXVI–XXIX inclusive). Ventrally or alternately (dorsal + ventral) retouched trapezes also appear at other LBK sites (Brunn I, Brunn IIa, Neckenmarkt, Goddelau, Bruchenbrücken and Flomborn; Fiedler 1979, Abb. 10–4; Gronenborn 1997, Taf. 1.2–6, Taf. 6.2–8, Taf. 7.2–6,8). Ventrally and dorsal-ventally retouched trapezes have also been found at the sites of Méhtelek-Nádas and Ecsegfalva 23 (Körös culture) and even at the Mesolithic station at Jászberény I (layer B). According to W. Taute (1974/75, 81), ventrally, dorso-ventrally and alternately retouched trapezes are absent from the south German and Austrian Mesolithic. Dorso-ventrally retouched trapezes have been identified at Méhtelek, Brunn II and Schwanfeld (Gronenborn 1997, Taf. 5.3–5).

Certain sites have a relatively regular occurrence of trapezes with retouching on just one half, with a visible break on the other, either at one or, rarely, both ends (Žopy I, Brunn IIa, Brunn IIb, Vedrovice "Za dvorem", Kazimierza Mała, Strögen, Schwanfeld and Bruchenbrücken; Gronenborn 1997). They appear most abundantly at the Vedrovice "Široká u lesa" cemetery (Mateiciucová 1998). The half retouch could arise from two methods and is evidence for the blade division technique. Either the blade from which the trapeze was made was simply broken, and the break created partially retouched (the method Taute termed the '*Bruch-Technik*'), or a notch on the blade was first retouched and the blade broken at the notch site, in the '*Kerb-Bruch-Technik*' (Taute 1974/75). The latter would mean that the half retouch on the trapeze is actually a notch fragment; this technique may also be indicated by "notch fragments" on blades (**graph 20**; Szentgyörgyvölgy-Pityerdomb, Kleinhadersdorf, Žopy II, Asparn-Schletz and Flomborn; Fiedler 1979, Abb. 10–5). Similarly, the dorso-ventral retouch on trapezes might originate in the over-retouching of a notch from the other side.

Taute regards both techniques for blade breaking as being characteristic of the Neolithic, while the '*Kerb-Schlag-Technik*' (*microburin technique*) is regarded as typical of the Mesolithic (Taute 1974/75, Abb. 6). The latter does not appear in the study area in Neolithic contexts.

At Brunn IIa and Brunn IIb, transverse burin blows were used to divide blades and produce trapezes.

Trapezes and trapezoidal shapes				
Site	Dating	broad	short	long
Jászberény I, layer B	Early/Late Mesolithic		3	
Jászberény III	Late Mesolithic			
Jásztelek I	Early/Late Mesolithic		1	1
Kaposhomok	Late Mesolithic		2	2
Sereď	Late Mesolithic		4	
Mikulčice	Early Mesolithic ?and Late Mesolithic	1	5	2
Kůlna , upper part of layer 3	Late Mesolithic ?		1	1
Dolní Věstonice "Písky"	Late Mesolithic ?	1	3	
Šakvice	Late Mesolithic		1	
Ecsegfalva 23	Körös culture		4	2
Dévaványa 26	Körös culture	1		
Méhtelek-Nádas	Körös culture	1	2	1
Slavkovce	Szatmár group	2	4	
Zbudza	early phase of the Eastern LBK	1	7	1
Zalužice	early phase of the Eastern LBK		1	
Zalužice – younger features	middle phase of the Eastern LBK	1	3	
Szentgyörgyvölgy	Early LBK		1	
Neckenmarkt	Early LBK		7	
Brunn IIa and Brunn IIb	Early LBK	1	23	16
Brunn II – settlement burials	Early LBK		2	4
Brunn III	Early LBK		1	
Brunn IV	Early LBK		1	
Brunn I	LBK phase I/II	2		
Strögen	Early LBK		2	
Asparn-Schletz	Early to Late LBK	1	1	
Kleinhadersdorf – cemetery	LBK phase I/II+II	9	3	
Vedrovice "Za dvorem"	Early LBK	1	2	
Vedrovice "Široká u lesa" – cemetery	LBK phase I/II+II	33	15	
Vedrovice "Široká u lesa" – settlement	LBK phase I/II+II	1		
Kuřim	Early LBKI		1	
Žopy I	Early LBK		1	
Mohelnice	Early LBK			
Kazimierza Mała	Early LBK	1	1	
Boguszewo 41	Early LBK		1	
Mintraching	Early LBK		2	
Langenbach-Niederhummel	Early LBK		1	
Enkingen	Early LBK		2	
Schwanfeld	Early LBK	2	20	2
Schwanfeld – burial in the settlement	Early LBK	1	6	
Goddelau	Early LBK		5	
Bruchenbrücken	Early LBK	1	7	
Steinfurth	Early LBK			1
Ostheim "Mühlweide"	Early LBK		1	
Klein Denkte	Early LBK		1	
Flomborn – cemetery	LBK phase I/II (phase Flomborn)	2		
Müddersheim	LBK	2		
Sondershausen – cemetery	LBK phase I/II (phase Flomborn)	1		

Table 6. Occurrence of trapezes and trapezoidal shapes on selected Mesolithic and Early Neolithic sites.

The similarity of trapezes and trapezoidal shapes

A glance at **graph 28**, which shows the proportion of symmetrical trapezes at sites in Hungary, Austria, Moravia, Poland and Germany (Gronenborn 1997, 213–218), reveals the sites whose material essentially falls between the trapezes from the Vedrovice cemetery and those from the settlements at Brunn IIa and Brunn IIb. The trapezes from Brunn II are most often long (AA) or short (AZ). The proportion of short trapezes is close to that of the long trapezes. Very similar long trapezes have been identified at the sites of Steinfurth and Schwanfeld. By contrast, the trapezes from the Vedrovice cemetery, which are often almost right-angled in shape, are dominated by the broad (AC) trapezes (transverse arrowheads); the proportion of short trapezes is similar. The blade fragments (sometimes with retouching) found alongside the trapezes, and which could thus presumably have had a similar function, are similar in their size and proportions to the broad trapezes (AC). Very similar dimensions to the objects from Vedrovice are observable in the trapezoidal shapes from the Kleinhadersdorf cemetery and the trapezes from Brunn I. Trapezes from other sites are most often morphologically short trapezes (AZ), but among these differences are also apparent.

Data on the various types may be summarised as follows:

<u>Broad trapezes (AC)</u>

a) Broad trapezes with an almost right-angled shape predominate and concentrate in southwest Moravia, Weinviertel and in the Vienna Woods (Vedrovice "Široká u lesa", Vedrovice "Za dvorem", Kleinhadersdorf, Asparn-Schletz, Brunn I).
b) Similar trapezes also appear in the earliest phase of the LBK at Mohelnice, at the Kazimierza Mała settlement in Little Poland, at Schwanfeld in Bavaria, in the Eastern LBK (Slavkovce, Zalužice, Zbudza) and in Körös culture settlements (Méhtelek-Nádas, Dévaványa 26).
c) Broad trapezes also appear in the Moravian Mesolithic (Dolní Věstonice, Mikulčice).

d) A single example from the Vedrovice cemetery (grave 79) and a single broad trapeze from Bruchenbrücken in Hessen are more than doubled in width.

Long trapezes (AA)

a) Within the study region, long trapezes with rather acute angles appear only at the settlements of Brunn IIa and Brunn IIb and in the graves from these sites. Outside the study region, they have been identified at sites of the earliest phase of the LBK at Steinfurth in Hessen and Schwanfeld in Bavaria, as well as in the Körös culture settlement of Ecsegfalva 23 in eastern Hungary.
b) In Mesolithic contexts, long trapezes with acute angles are known from Mikulčice and Kůlna cave in Moravia, the station at Kaposhomok in Transdanubia and the Iron Gates, where they appear in the pre-Neolithic horizon at Vlasac.
c) Long trapezes with slightly acute angles appear in eastern Slovakia in the Eastern LBK (Zbudza), in the Körös culture (Méhtelek-Nádas) and at Lepenski Vir I in the Iron Gates region.

Short trapezes (AZ)

a) At Brunn IIa and Brunn IIb, the majority of the short trapezes are rather longer than usual, so that morphologically they are similar to long trapezes. They also have more acute angles.
b) By contrast, the short trapezes from Brunn III and Brunn IV are somewhat shorter, with less acute angles, and are reminiscent of the trapezes from Weinviertel and south-west Moravia.
c) The short trapezes from Moravian sites and from other sites in Lower Austria and Burgenland dated to LBK phases I and I/II are close to being right-angled in shape.
d) The short trapezes from the Mesolithic stations at Dolní Věstonice and Mikulčice are similar to the LBK trapezes from these areas.
e) The short trapezes from Mesolithic stations from Kaposhomok in Transdanubia (Bánffy 2000, Fig. 2; Marton 2003) and from the Körös culture settlement of Ecsegfalva 23 are most similar to those from Brunn II.
f) The short trapeze from Šakvice had a highly acute angle and concave terminal shaping retouch. It is very like the trapezes from the Mesolithic layers in the Franchthi cave (Perlès 1984, Pl. 2.32,33).

Summary

The trapezes from the investigated parts of Moravia and Lower Austria form two conspicuous morphological groups:

1) The sites represented in the first group are those where long trapezes (AA) appear. Even the short trapezes that occur here are somewhat longer. The trapezes are characterised by rather acute angles. This group contains in particular the settlements at Brunn IIa and Brunn IIb and finds from the graves at these sites.

2) The second group brings together those sites at which broad trapezes and shorter short trapezes predominate, their shape almost right-angled. These types occur in particular at the Vedrovice "Široká u lesa" cemetery, Kleinhadersdorf and Brunn I. They also appear at cemeteries in Germany from the same chronological horizon (Flomborn, Sondershausen).

3) It must be stressed that the trapezes from the Mesolithic station at Kaposhomok in Transdanubia are similar to those from Brunn IIa and Brunn IIb, which on the basis of radiocarbon dating are regarded as the earliest settlements of the LBK in Austria. The carbon-14 dates from the Szentgyörgyvölgy-Pityerdomb settlement with conspicuous Starčevo culture elements are later (Stadler *et al.* 2000) and are contemporary rather with Brunn III and Brunn IV.

It seems that these two groups can be divided chronologically: the first group contains sites dated to the earliest phase of the LBK and the second sites datable towards the close of LBK phase I. The trapezes from the settlements at Szentgyörgyvölgy-Pityerdomb, Brunn III, Brunn IV, Neckenmarkt and Strögen are similar to other trapezes from the Danube and Main Basins in Germany (Gronenborn 1997), and are probably somewhat later than those from Brunn IIa and Brunn IIb.

6.3.7. Segments

A broad segment (DE – **fig. 11: 11**; Mateiciucová 2002b) was found at the Brunn IIb settlement, while a single broad segment appeared at Brunn IIa[43]; another has been identified at Neckenmarkt (Gronenborn 1997, Taf. 1.2–1). All of these segments were made from Szentgál radiolarite.

Segments appear in central Europe from the Early Mesolithic onwards. In the Late Mesolithic of the southern and south-western parts of central Europe, segments are absent and their functional role is taken up by trapezes (Tillmann 1986; Hahn 1991, 263–264; Nielsen 1991, 77, 84). In contrast, segments are known from the Late Mesolithic stations in the south-east of central Europe in Moravia and Slovakia, where they

43 This tool type is not part of the published analysis.

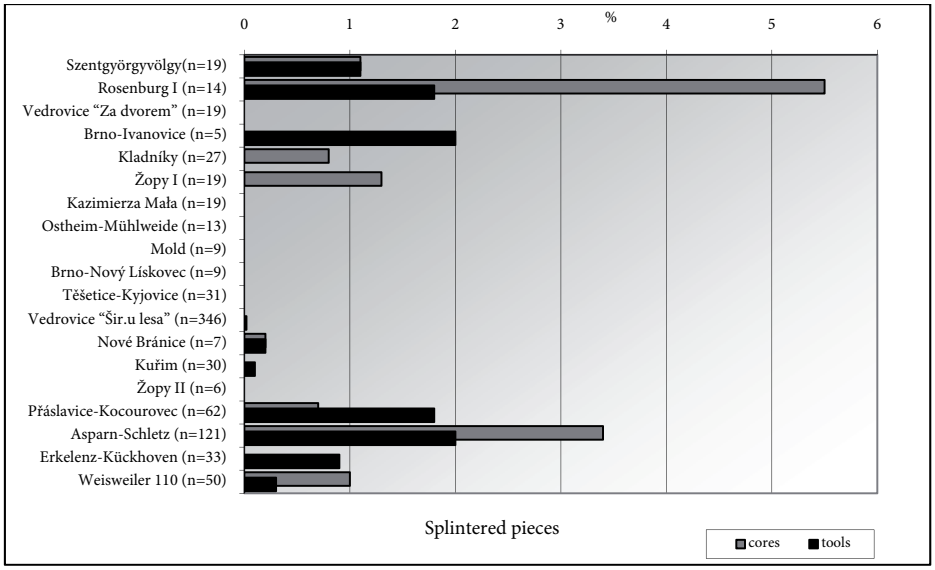
appear together with trapezes (Dolní Věstonice, Šakvice, Mikulčice, Dolná Streda, Sereď; Klíma 1953; Bárta 1959; 1981; Škrdla, Mateiciucová & Přichystal 1997). Segments also occur at the Mesolithic station of Jásztelek I (Kertész *et al.* 1994, Taf. III.1,2,4); one was made from Szentgál radiolarite. Special attention should be paid to the collection of four very symmetrical segments from Šakvice, three of which had double-sided retouch. These have a regular, partial retouch and were made of dark red radiolarite with black mottling and remains of the pebble surface. The raw material may come from the local Miocene gravels (see chapter 6.1.1.), but appears, like the artefacts as a whole, somewhat exotic. The closest known analogies come from the Early Neolithic in the western Mediterranean, where they are termed the Betey type (Ginter & Kozłowski 1990, 167, Tab. LIII. 16; S. K. Kozłowski 2001, 269; Mateiciucová 2001a, 289)[44]. They are somewhat similar to the segments known from the Natufian in the Near East (S. K. Kozłowski 2001, 269). Segments also appear in pre-Neolithic and Early Neolithic contexts in Transdanubia (Vörs-Máriaasszonysziget, Gellénháza-Varosrét), northern Hungary (Mezőkövesd-Mocsolyás – AVK I), the Iron Gates region (Cuina Turkului-Dubova) and southern Greece (Perlès 1987, Tab. III; Gronenborn 1994, 144; 1997; Kalicz, Virág & Biró 1998, 166; Biró 2002, Table 9).

The appearance of segments in the earliest phase of the LBK (in only the south-eastern part of its distribution), in the Starčevo-Körös-Criş cultural complex, in the Late Mesolithic of Hungary, south-west Slovakia and south Moravia, and in pre-Neolithic and Early Neolithic horizons in the Balkans may attest to the survival of originally pre-Neolithic traditions in these regions.

6.3 8. Splintered pieces (cores and tools)

Splintered pieces (see chapter 10.2.3.4.1.) occur at sites of both the early phase of the LBK and in later phases (**graph 22**). They are most numerous at the Asparn-Schletz settlement (33 pieces). With the exception of Přáslavice-Kocourovec, where seven pieces have been identified, they usually occur in frequencies of below five. Splintered pieces that took on the role of cores appear mainly at settlements that obtained their raw materials from distant sources. By contrast, at settlements located close to raw material sources splintered piece/cores are almost entirely absent. At the same time, splintered pieces classified as tools are found in particular at those settlements using stone raw material imported over long distances. This means that the presence of splintered pieces classified as tools is also linked to limited or irregular raw material movements. The pieces were then used to obtain small, sharp flakes. Were splintered pieces purely practical tools, they would be far more evenly represented in settlements with ample raw materials as well.

Splintered pieces are somewhat more abundant in the earliest and the final phases of the LBK. This may relate to the more commonplace use of lower quality raw materials of smaller dimensions and originating from gravels (Małecka & Kukawka 1992b; Lech 1997, 255–256). The greatest number of splintered pieces, mainly splintered piece/cores, has been recovered from Asparn-Schletz, where they reach microlithic dimensions: their average size is 22 mm. All of the normal cores here also display a marked degree of exhaustion. Splintered piece/tools at Asparn-Schletz are mostly made on flakes; the remains of retouches on several pieces show that these were originally retouched tools, only later transformed into splintered pieces. The exact dividing line between splintered piece/tools and splintered piece/cores cannot be identified; the two functions are likely to have overlapped. As with other phenomena,



Graph 22. Proportion of splintered pieces in chipped stone assemblages at LBK sites in Moravia, Lower Austria and adjacent regions.

44 Mediterranean parallels are also indicated by the short trapeze with an acute angle and concavely retouched end, analogies to which have been found in the Mesolithic horizon of Franchthi cave (Perlès 1984, Pl. 2. 32, 33).

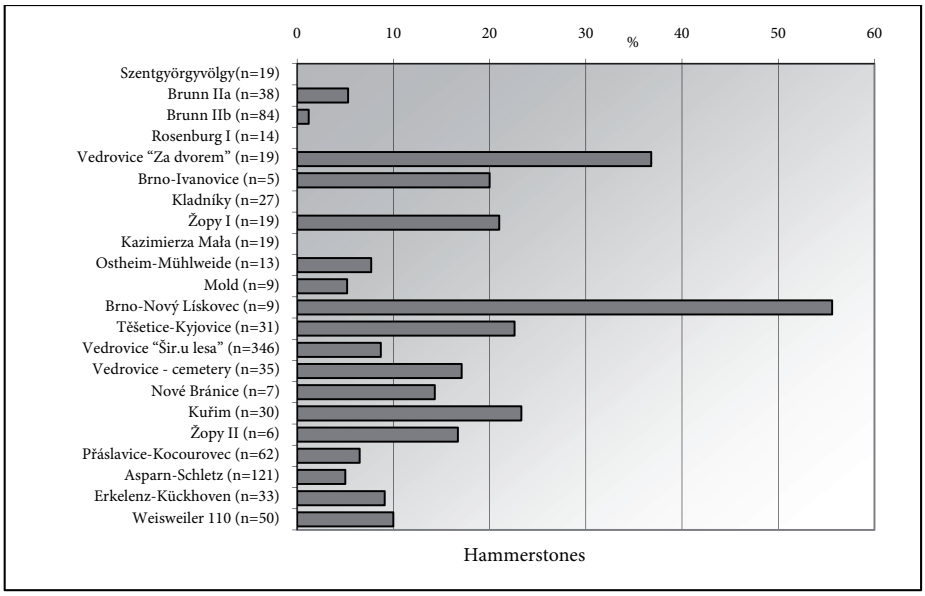
the high number of splintered pieces at Asparn-Schletz, where raw materials were used down to the last possible splintered piece, indicate that the settlement may have suffered from a serious shortage of raw materials, probably caused by long-term isolation.

6.3.9. Hammerstones

Hammerstones are most often represented in settlements that lie close to raw material sources, where they are related to the primary processing of chipped stone (**graph 23**) and most often appear in the form of unworked silicite nodules. Quartz pebbles are also common. In settlements taking advantage of distant raw material sources, they appear in the form of cores or mere fragments. Comparing hammerstone occurrences chronologically, it would seem that they were more common in settlements of the middle phase of the LBK. Within the general category of tools they dominate or are conspicuously present at the sites of Brno-Nový Lískovec, Vedrovice "Za dvorem", Těšetice, Vedrovice "Široká u lesa" cemetery, Kuřim and Žopy I. Of particular interest is their occurrence without relation to raw material processing at Brno-Nový Lískovec, where they predominate, and at the Vedrovice cemetery.

At Nový Lískovec, pebble hammerstones were found together with a large collection of unworked or only crudely shaped pebbles and natural raw material fragments. In general this was low-grade Jurassic chert classifiable as Krumlovský Les chert or more generally as Moravian Jurassic chert, but clearly collected in the immediate area. Given that this was a very poor quality raw material, it is hard to imagine that it could have been used to produce chipped artefacts. Several of the pieces have a grey-white surface with visible fractures resulting from fire cracking. One possibility is that these stones were used for heating water and cooking; other uses are of course also possible.

At the Vedrovice "Široká u lesa" cemetery, ten graves yielded eleven stone pebbles or pre-core forms. Six pieces bore traces of hammering; sometimes they appeared in graves together with stone slabs. The overall similarity of pebble/hammerstones and unhammered pebbles and the almost identical weight of four pieces and another pair (see chapter 11.14.3.4.2.) show that they fulfilled a similar function among the grave goods. The egg shape of the pebbles is striking. They were found mainly in female graves. Pebbles and hammerstones have also been found in other LBK cemeteries (Storch 1984/85).



Graph 23. Proportion of hammerstones in the category of tools at LBK sites in Moravia, Lower Austria and adjacent regions.

6.3.10. General tool characteristics

1) In the earliest phase of the LBK, endscrapers predominate over end-retouched blades in virtually its entire area of distribution. The only exceptions are the south-eastern part of the distribution and the Main valley, where truncated blades predominate.
2) In the later periods of the LBK, endscrapers predominate in all LBK areas. Truncated blades occupy an important position only in the south-east of central Europe.
3) Blades with ventral truncation appear at Late Mesolithic stations in southern Germany, Hungary and the Balkans. They also appear at sites of the Starčevo and Körös cultures, and at sites of the earliest phase of the LBK and AVK (Eastern Slovakian LBK).
4) Burins are almost entirely absent. They appear only in isolated instances in the earliest phase of the LBK. By contrast, they are relatively common in the Late Mesolithic of Hungary.
5) Transverse burins appear primarily at sites of the early phase of the LBK, in the Starčevo and Körös cultures and in the Late Mesolithic of southern Germany and Hungary.

6) Classic point borers/perforators are almost entirely absent from contexts of the earliest LBK in Moravia and Lower Austria. It will therefore be necessary to re-study the contents of the features at Vedrovice "Široká u lesa" and Mohelnice, and to revise their dating. Several uncertain fragments have been found at Rosenburg I and Brunn II. Point borers/perforators first appear in central Europe during the Early Neolithic, but their occurrence is not limited to this period – they appear throughout the Neolithic.
7) Slim perforators with a weakly distinguished point, which are termed '*Mèche de fôret*', appear in the Late Mesolithic in the southern half of central Europe. In the LBK, they are primarily early. In contrast to the Mesolithic, they also appear in the form of borers. In the Körös culture borers/perforators of this type have not yet been recognised.
8) The continuously laterally retouched blades abundant in the Starčevo-Körös cultural sphere appear only very rarely in the LBK of Lower Austria, Moravia and Transdanubia; they are also absent from the Late Mesolithic in Hungary.
9) Notch fragments are evidence of the division of blade blanks using the '*Kerb-Bruch-Technik*'. Notch fragments are mainly common in the early phase of LBK; they have also been recognised in the Körös culture. They do not appear in the Hungarian Mesolithic, which shows that in this period a different division method was used (*the microburin technique*).
10) The presence of splintered pieces is related to limitations on or the irregular supply of raw materials. They often appear in the earliest phase and then in the late phase of the LBK, when their occurrence corresponds to the more frequent use of lower quality raw materials of smaller dimensions coming from gravels.
11) Trapezes appear in Moravia and Lower Austria almost exclusively in the early phase I and at the turn of phase II of the LBK. Only exceptionally do they appear in phase II proper.
12) Trapezes from the investigated parts of Moravia and Lower Austria form two conspicuous, morphologically distinct groups:
    a) The first group comprises sites at which long trapezes (AA) and longer short trapezes (AZ) are heavily represented. The majority of the trapezes have rather acute angles. In particular, this group contains the settlements at Brunn IIa and Brunn IIb, which are the chronologically oldest settlements.
    b) The second group contains sites at which there is a predominance of broad trapezes (AC) and shorter short trapezes (AZ), the shapes of which are almost right-angled. These types appear in particular on the cemeteries at Vedrovice "Široká u lesa" and Kleinhadersdorf and in the settlement at Brunn I, all dated to the turn of LBK phase II.
13) Segments have been identified in eastern Lower Austria and Burgenland. They also appear in Late Mesolithic Hungary, Moravia, south-western Slovakia and the Balkans, as well as in the Early Neolithic of south-eastern Europe.

6.4. Artefacts with sickle gloss

Artefacts with sickle gloss are entirely absent from the earliest phase of the LBK in Moravia. In Lower Austria they were not found at Rosenburg I. They do occur at sites on the edge of the Vienna Woods (Brunn IIa, Brunn IIb, Brunn IV), and have also been found at the Szentgyörgyvölgy-Pityerdomb settlement. All those recovered, whether from the Brunn settlements or from Szentgyörgyvölgy-Pityerdomb, were made from Szentgál type radiolarite (**table 7**) and were made on blade blanks. Several blades were previously worked by retouching at one (Brunn IIa, Szentgyörgyvölgy-Pityerdomb) or both (Brunn IIb) ends. A single thumbnail endscraper, too, had sickle gloss on its surface (Brunn IIb). An isolated fragment of a blade with sickle gloss also occurred at the Bicske-Galagonyás settlement (Makkay, Starnini & Tulok 1996, Fig. 81. 2); no artefacts with sickle gloss have thus far been recovered from other sites in Transdanubia (Biró 1987, 140).

Two blades with sickle gloss were found in grave 17 at Kleinhadersdorf (Lenneis, Neugebauer-Maresch & Ruttkay 1995, Abb. 16. 1); one of these was made from Szentgál radiolarite. The gloss on both blades is relatively conspicuous, but essentially concentrates only along the edge and does not cover a larger area on the artefact; it therefore cannot be stated with certainty that it originated from the use of the blade as a sickle. This may be demonstrable through trasological analysis. It would be a mistake to interpret the collection of trapezes and trapezoidal fragments from graves 46 and 57 of the cemetery at Vedrovice "Široká u lesa" as sickle inserts (Lech 1983a, 51–52; Mateiciucová 1998, 87–89).

At Brno-Nový Lískovec two blades with sickle gloss were identified. One, laterally retouched, was relatively robust and regular, and was made from Olomučany chert. An almost identical blade with sickle gloss, again made from Olomučany chert, has been recovered from the settlement at Kuřim; in addition to a sickle blade of Olomučany chert, the same site also yielded a sickle blade made from Krumlovský

Les I chert. Very similar blades made of KL I chert have been recovered from Těšetice-Kyjovice and the settlement at Asparn-Schletz; indeed, at the latter site a whole series of sickle blades made from KL I chert were found. The blades give a very uniform impression, and the KL I variety is reminiscent of the raw material that occurs at Nové Bránice "V končinách". It could be conjectured that the "specialised" production of regular, relatively broad blades identified at sites at Kuřim and Nové Bránice-"V končinách" was oriented towards the production of blade blanks intended for sickle making.

In settlements dated to the middle and late phases, artefacts with sickle gloss occur relatively regularly: with the exception of Nové Bránice, where only a small area was excavated, they have been found at all investigated sites. If they have been retouched, then endscrapers also often appear alongside the terminal and lateral retouches. In southern Moravia and Weinviertel there is a predominance of sickle blades made from KL I; in central and eastern Moravia sickle blades were made from Krakow Jurassic silicites, which are the predominant raw material here. The most artefacts with sickle gloss have been identified from the late LBK settlement at Asparn-Schletz. Even a flake from a polished tool could have been used as a sickle. Splintered pieces with sickle gloss also indicate artefact re-use.

6.5. The interpretation of the studied sites based on analyses of the chipped stone industry

6.5.1. Producer and consumer settlements and raw material exploitation sites

J. Lech has divided sites into either producer or consumer settlements on the basis of whether raw material processing and blank production took place in the settlement or whether ready-made blanks and tools were obtained (Lech 1981, 130–133; 1989a). Exploitation sites (extraction zones) are also distinguished from producer settlements. The former comprise the workshops for the initial working of the raw materials and are located in the immediate vicinity of the raw material source. In the Czech literature, these are referred to as primary workshops or simply workshops (Svoboda 1984; 1987; Oliva 1990; 2001). The characteristics of the raw material exploitation sites and of both producer and consumer settlements have been defined by Lech on the basis of material related to the exploitation, working and distribution of Krakow Jurassic silicites from LBK and Lengyel culture sites (Lech, 1981; 1983a; 1989a).

Raw material exploitation sites (extraction zones); (Sąspów-workshop 1/1971, 1/1960, 3/1960, Jaskinia pod Kościołem hor. II; Lech 1981, 100–123)

1) Found in exploitation districts and in the immediate vicinity of raw material sources.
2) The proportion of tools present is < 1 %.
3) The category "flakes and waste" vastly predominates.
4) Within the "flakes and waste" category there is a high proportion of flakes with cortex.
5) Flakes lacking cortex occur at a smaller proportion than in producer settlements.
6) There is a high proportion of natural fragments of raw material.
7) The proportion of technical flakes (rejuvenation flake from a core's knapping surface, rejuvenation flake from a core's striking platform, rejuvenation flake from a core's base) in the category "flakes and waste" is < 4 %.
8) The category "pre-cores and cores" makes up a smaller proportion than in producer settlements.

Site	KL I	KL II	Krakow Jurassic	Bakony radiolarites	Olomučany	Erratic silicites	Erratic or KL II or Krakow Jurassic	Green schist ?	Undefined	Total
Szentgyörgyvölgy-Pityerdomb				3						3
Brunn IIa				3						3
Brunn IIb				3						3
Brunn IV				1						1
Kleinhadersdorf-cemetery				1						1
Asparn-Schletz	20	2	10	4		3	1	1		41
Těšetice	4									4
Vedrovice "Široká u lesa" – settlement	20	5	1							26
Brno-Nový Lískovec		1			1					2
Kuřim	2				6					8
Žopy I			1							1
Přáslavice-Kocourovec		1	14						1	16

Table 7. LBK in Moravia and Lower Austria. Proportion of artefacts with sickle gloss by raw material.

9) Within the raw material category "pre-cores and cores", unworked raw material fragments and pre-cores make up a far higher proportion (ca 20 %) than in the producer settlements using the same raw material.
10) Splintered pieces are absent.

Producer settlements (Vedrovice "Široká u lesa", Kraków-Olszanica, Kraków-Pleszów, Kraków-Mogiła 62, Mogiła 48; Iwanovice; Lech 1981, 126–141; 1983a, Fig. 2. I, II)

1) Generally found close to stone raw material sources.
2) Blanks were made within the settlement itself.
3) Raw material arrived in the settlement as unexploited cores or in the form of cores in the initial stages of exploitation.
4) Unlike at raw material exploitation sites, the proportion of unworked raw material and pre-cores is < 10 %.
5) Within the category of "pre-cores and cores", the proportion of exploited cores and core fragments is higher than at raw material exploitation sites.
6) Cores show a visible effort to maximise raw material exploitation. Even where production was oriented towards blade blank production, blade cores are accompanied by blade/flake cores and flake cores. Cores with altered orientations (multiple-platform core) and irregular cores also appear.
7) The proportion of "flakes and waste" is far higher than at consumer settlements, and fluctuates around 50–60 %.
8) Unlike the situation at primary workshops, most flakes lack cortex.
9) Technical flakes (rejuvenation flake from a core's knapping surface, rejuvenation flake from a core's striking platform, rejuvenation flake from a core's base) make up 5–6 % (and sometimes up to 11 %).
10) The proportion of natural raw material fragments is low.
11) The "blades and blade fragments" category contains a higher proportion of small blade fragments (basal, terminal and mesial blade fragments). Whole blades and longer blade fragments make up around 20 % in this category.
12) The proportion of tools fluctuates around 10 %.
13) The proportion of blades and tools is lower than at consumer settlements.

Secondary producer settlements (Niemcza, Přáslavice-Kocourovec; Lech 1989a, 116–118, Fig. 2; Mateiciucová 1997a, 99)

1) Found at greater distances from raw material sources.
2) Blanks were made within the settlement itself.
3) The raw material arrived at the site in the form of prepared, unexploited cores.
4) Cores show a visible effort to maximise raw material exploitation. Even where production was oriented towards blade blank production, blade cores are accompanied by blade/flake cores and flake cores.
5) Some cores have altered orientations (multiple-platform core), which indicates an advanced stage of blank exploitation.
6) The proportion of flakes and waste is greater than that of blade blanks.

Consumer settlements (Skoroszowice, Bylany; Lech 1981, Ryc. 36. I; 1989a, 116–118, Fig. 2)

1) Generally found at greater distances from raw material sources.
2) Chipped stone assemblages are usually small.
3) Blade blanks and tools predominate. The total proportion of blades and tools exceeds 50 %.
4) There is an absence of unworked raw material and of pre-cores.
5) Among the cores, there is a predominance of cores in an advanced stage of exploitation and of core/splintered pieces.
6) The proportion of flakes is low. Most are small and lack cortex.

If the studied sites from Moravia and Lower Austria are compared on the basis of the representation of the basic categories of chipped stone artefacts, three groups can be distinguished:

1) Sites with a high proportion of flakes and waste and a low proportion of blades and tools. This group includes sites that as a rule lie up to 20 km from the major raw material source they exploit. These sites may be termed producer settlements. The residents of these settlements obtained the raw material they required directly from the source and also worked it. The characteristics of this group are matched by the following settlements:
   a) in the Krumlovský Les upland area: Vedrovice "Za dvorem", Vedrovice "Široká u lesa", Nové Bránice-"V končinách", oriented towards the processing of Krumlovský Les chert **(graph 26)**
   b) Kuřim and Brno-Ivanovice, oriented towards working Olomučany chert **(graph 25)**
   c) Brunn I, working Mauer-type radiolarite **(graph 24)**

This group also includes the settlement at Mold **(graph 24)** because of the processing of the local sili-

ceous weathering products of serpentinites, but it is surprising that this site was mostly oriented towards the working of Krumlovský Les chert, the source of which lies some 80 km away. From this point of view, Mold could be described as a secondary producer settlement.

The proportions of the individual categories are very similar at Brno-Ivanovice and Brno-Nový Lískovec. At both, the proportion of 'pre-cores and cores' is extremely high, so as to be incomparable to the other locations. Even between these two sites, however, there are differences. At Brno-Ivanovice, the majority of finds in this category are pre-cores at various stages of working and cores at various stages of exploitation. Their high number probably relates to a way of working during which cores damaged at the beginning of or during knapping were not further rejuvenated, due to the ease of obtaining the raw material and perhaps due to their not particularly high quality. In other words, they were set aside and a different piece of raw material selected for working. Since the assemblage is relatively small, any attempt at interpretation might be misleading; nevertheless, two possibilities are suggested with regard to the character of the settlement: (1) this was merely a seasonal camp[45], perhaps related to the acquisition of raw materials and the creation of blanks[46], or (2) this was part of a settlement devoted to production (Mateiciucová 2002b). By contrast, the high proportion of unworked raw materials and other pre-cores at Brno-Nový Lískovec has nothing to do with the manufacture of chipped artefacts. Rather, this is very poor quality and partially charred raw material, the presence of which within an enclosed settlement on a slight rise probably indicates a different function. This is confirmed by the other chipped stone artefacts recovered, which were made from better quality raw material.

Within this group, tools form 6–9 % of all artefacts. The exceptions are the settlement at Brunn I, where tools make up 20 % of the finds, and Kuřim and Nové Bránice-"V končinách", where tools account for 1.2 % and 1.4 % respectively. The composition of chipped stone artefacts from the two latter settlements is in line with the definition of a workshop, as it is marked by a high proportion of flakes and waste. The raw material, raw material fragments, pre-cores and cores are of the same raw material as the other artefacts, which means that production took place on the site itself. The cores appear uniform and are generally for blades. Cores from more advanced stages of exploitation are less common. Blade negatives on cores are regular and relatively broad. Only unsuccessful, less regular blades and small blade fragments remained in place. These settlements were probably oriented towards the production of blade blanks. It would seem, however, that they were not primary workshops in the true sense, but functioned rather as parts of settlements[47]. Both sites are dated to the middle phase of the LBK when, as outlined below, communities that could be termed consumer settlements began to appear. It is in the middle and late phases that blades made either from Krumlovský Les chert or Olomučany chert appear at several sites or in isolation. Blades made from Krumlovský Les chert were produced at Nové Bránice-"V končinách", and blades made from Olomučany chert at Kuřim.

2) The second group includes sites with a high proportion of blades and tools, which together make up over 50 %, and often over 60 %, of the finds. Settlements of this kind are termed consumer settlements. In Moravia and Lower Austria such sites are to be found at Těšetice-Kyjoviceand Asparn-Schletz **(graphs 24 & 26)**. It may be that Žopy II is another, but the small size of the assemblage prevents wider conclusions.

At this type of settlement it is assumed that core preparation and blank manufacture took place off site, and that the raw material arrived in the form of blade blanks or complete tools. Within the settlement itself, tools were made from blanks. Tool re-utilisation is frequent. At the Asparn-Schletz settlement, the major component of the 'pre-cores and cores' category comprises splintered pieces and raw material in unworked form. The unworked raw material is in general different to the raw material used for the splintered pieces. Splintered pieces are made from the silicite which also commonly appears among the blades, flakes and tools, while the unworked raw material is of low quality and was generally obtained from gravels. A general analysis can offer an explanation. In this view, the settlement suffered from a lack of raw materials which led on the one hand to a search for new, suitable sources and on the other to the maximal exploitation of available raw materials. Splintering was the ideal technique for this. Asparn-Schletz mainly dates to the close of the LBK; in this later period similar settlements also appear in other regions, e.g. Strachów in Lower Silesia, dated to the Šárka phase of the LBK.

45 No house plans or storage pits were identified at Brno-Ivanovice.

46 The original surface rarely survives on artefacts made from Olomučany chert; this is probably due to its having undergone primary working outside this area.

47 At Kuřim, several longhouse plans were identified. The situation at Nové Bránice is not entirely clear, as it lies in the immediate vicinity of a primary source of raw material. The two small test trenches excavated to date have failed to demonstrate the existence of any features, including post holes (Mateiciucová 1992).

Here, cores primarily appear in the form of splintered pieces, while in settlements of the middle phase of the LBK (Skoroszowice) the usual blade and flake cores appear more often (Lech 1989a; 1997, 255–256). It would seem that developments at the end of the LBK were similar in many regions and indicate a collapse of the distribution system previously in use; the key consequence is a shortage of raw material. The formation of a new, altered distribution network is apparent in the Stroke-Ornamented Ware culture (Kazdová, Peška & Mateiciucová 1999, 153–154).

Mention must also be made of the settlement at Těšetice. Despite not being particularly far from a source of the Krumlovský Les chert preferentially used on the site, the proportions of the basic categories are typical of consumer settlements. In contrast, the settlement at Mold, dated to phase I/II, is a typical producer settlement with attributes characteristic of locations in close proximity to a raw material source, but lies some 80 km from the Krumlovský Les upland. The Těšetice-Kyjovicesettlement is roughly dated to LBK phase II. It was approximately in this period that settlements of the Kuřim and Nové Bránice type were making blade blanks, which were then transported away from their point of production and perhaps distributed to settlements of the Těšetice-Kyjovice and Asparn-Schletz type; similar examples were found on these sites. This fact demonstrates the existence of an exchange network that, in addition to common social functions, was oriented towards the supply of stone raw material and its products to communities at greater distances from the sources. The orientation of some settlements to the production of blade blanks, which in addition to supplying their own needs would have been an export, was probably linked to the emphasis on higher quality raw materials and the products manufactured from them. Such raw materials could best be obtained by extraction.

3) The third group comprises settlements at which cores and flakes with cortex appear alongside technical flakes and blades – artefact types documenting the production of blanks and tools directly on site. The proportion of flakes and waste is lower than in producer settlements and in general fluctuates around 50 %. The raw materials required could arrive at settlements of this kind in the form of prepared cores, obtained through intermediaries by exchange, or were brought to the production centre directly from the source by organised expeditions. It is possible that the necessary raw materials formed part of the essential supplies brought by settlers moving into new territories. Settlements of this type are marked by their relatively long distance from the source of the preferred raw material; J. Lech (1981; 1989a) has termed them secondary producer settlements.

Secondary producer settlements often occur in the early phase of the LBK (Brunn IIa, Brunn IIb, Brunn IV, Szentgyörgyvölgy-Pityerdomb, Rosenburg I, Žopy I and Kladníky; **graphs 24 & 25**). A concentration of secondary producer sites in Burgenland and Lower Austria, with a preponderance of Transdanubian radiolarite, shows that their occupants were in close and perhaps kin-based contact with communities in Transdanubia, from where they brought raw material supplies. The typical consumer settlements are absent from Lower Austria and Moravia at this time; this attests to self-sufficiency in terms of raw materials and to the production of artefacts primarily for their own use. The early LBK period can be characterised as a time when settlements specialised in manufacturing blade blanks for export did not yet exist and an organised exchange network – through which they could supply other settlements with the completed blades – was not yet fully developed. This was particularly the case for sites in the eastern part of central Europe. In the western part of central Europe, on the other hand, the clear predominance of blades and tools at some sites (Ostheim-Mühlweide, Bruchenbrücken) indicates that they may have been supplied with complete blade blanks (Gronenborn 1997, 52). The high quality of the raw material and its greater original size[48] may also have influenced the high proportion of blade blanks. Even a different manufacturing tradition producing more blades cannot be ruled out. The site at Přáslavice-Kocourovec may be classed among the secondary producer settlements of the later period. Of the analysed assemblages from neighbouring regions, the settlements at Frimmersdorf 122, Weisweiler 110 and Erkelenz-Kückhoven (Kegler-Graiewski 2004, Abb. 14) in Germany are similar in composition (**graphs 25 & 26**).

6.5.1.1. Comparisons with the Starčevo and Körös cultures

Compared to the Mesolithic and early phase of the LBK, when most settlements and camps secured raw material transport for themselves and produced chipped artefacts for their own particular needs, there was a completely different supply system in the Starčevo and Körös cultures. In these Early Neolithic cultures there is a huge prevalence of blades and tools and heavily exploited cores also sometimes appear. Flakes only make up an insignificant proportion of the finds (Kaczanowska, Kozłowski & Makkay 1981; Kaczanowska 1989). These

48 At the Bruchenbrücken and Ostheim settlements, high quality raw material was used preferentially and relatively large pieces of western European Rijckholt silicites appear.

villages can be designated as consumer settlements and their supply was probably based on limited access to primary raw material sources, often of a supra-regional character and therefore maybe controlled by local communities and clans. Some of these sources were situated outside the Starčevo and Körös culture areas, in territory occupied by the local Mesolithic population (obsidian, limnosilicite, radiolarites from the Bakony mountains). For other sources, acquisition (maybe through direct exploitation) could have been controlled by a small group, as can be assumed in the case of Banat silicite. These people also specialised in the production of large uniform blades of this raw material that were distributed into surrounding settlements. Some difference can be observed in settlements dating from the late phase of the Starčevo and Körös cultures, above all at the northern border of their distribution. Here, the composition of the chipped stone assemblage, which includes a higher ratio of flakes and exploited cores, without large regular blades, is more reminiscent of the LBK.

6.5.2. The localisation of raw material processing: in what form did raw materials reach settlements?

While working on the chipped stone industry from the Neolithic settlement at Hienheim (Ldkr. Kelheim) in Bavaria, M. de Grooth developed a special model making it easier to localise individual production stages (within or outside the settlement) on the basis of chipped stone industry composition. In creating this model she drew on both her own archaeological knowledge and that of others (Torrence 1986), as well as on many ethnological sources (de Grooth 1994). The model was further developed into eight basic models, which can be combined and which form further sub-models (de Grooth 1994, Abb. 2–5, Tab. 6).

The special model encompasses four main production activities:

1. the obtaining of raw materials
2. the production of blanks
3. the production of tools
4. use

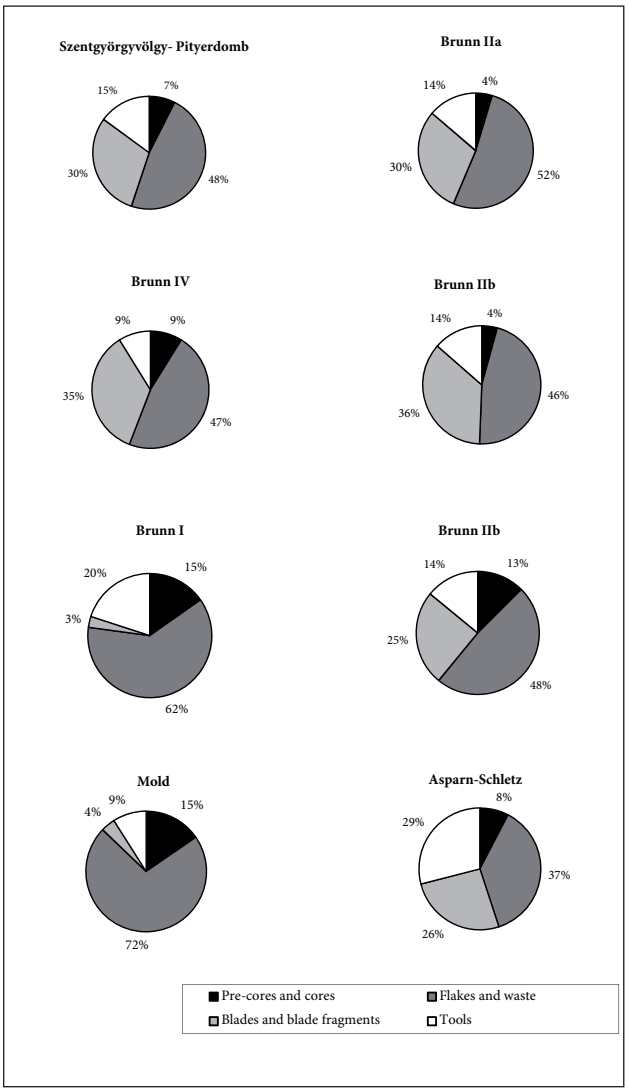
and two modes of transport:

1. within groups (*gruppenintern*), where the material was obtained by members of the community and was also processed and used within this community;

2. between groups (*gruppenextern*), where it was obtained by exchange.

The production waste and characteristic products were defined for each of these production activities.

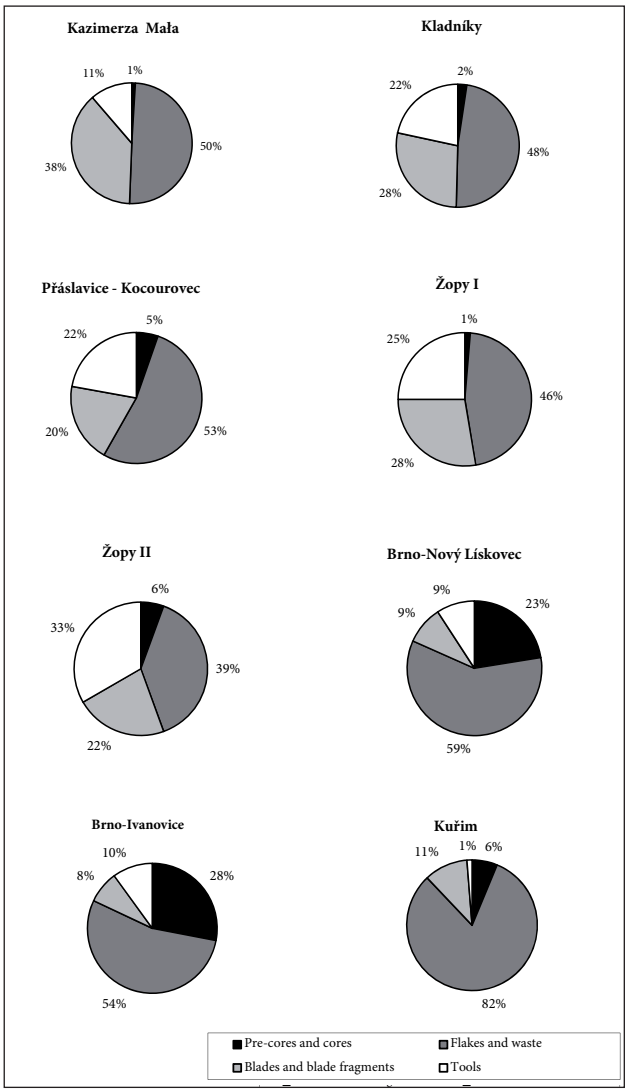
I have attempted to apply this basic model to the chipped stone artefacts made from particular types of raw material.



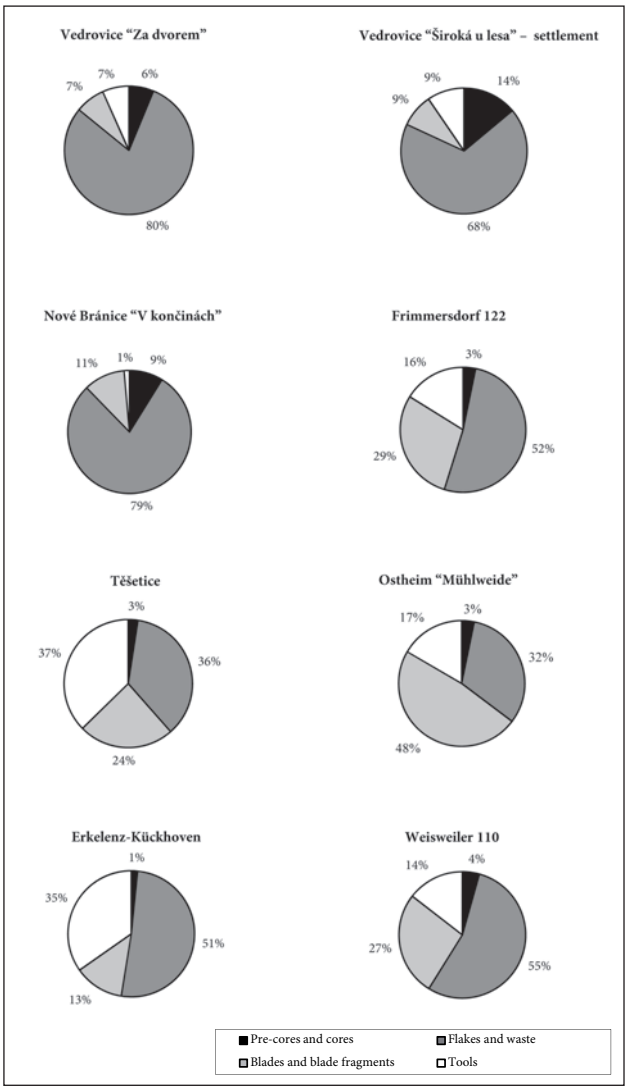
Graph 24. LBK. Basic morphological groups of chipped stone artefacts from Lower Austria and Hungary.

In the early phase of the LBK, raw material was most commonly brought to settlements in the form of cores prepared for exploitation and perhaps even partially exploited. Further production then took place within the settlement itself. This is attested by the presence within settlements of cores, as well as technical flakes and blades, which stem from the ongoing rejuvenation of the core during its exploitation.

Only in settlements dated to phase I do raw materials imported from great distances also appear in unprepared forms (**tables 8 & 9**). In later phases, unworked raw materials appear only in sites lying close to their sources (**tables 10 & 11**). Radiolarites from the Bakony mountains appear at great distances from their sources, which lie in the very region which a series of authors have regarded as the area of origin of the LBK (see chapter 3.2. above). Other imported raw materials do not appear in settlements in their natural form. This fact is extremely important, as along with presumed expeditions for raw materials it evokes the



Graph 25. LBK. Basic morphological groups of chipped stone artefacts from Moravia and Poland.



Graph 26. LBK. Basic morphological groups of chipped stone artefacts from Moravia and Germany.

idea of the spread of the LBK through the physical penetration of groups from the area of origin, along with the necessary supplies of stone raw material. Only after a certain amount of time, during which they adapted to their new environment and forged or strengthened relations with the local population, did these groups also begin to use local or other raw material sources. Bakony radiolarite appears in the form of natural raw material fragments at the earliest LBK settlement at Szentgyörgyvölgy-Pityerdomb, as well as at Brunn IIa and Brunn IIb; here, however, the chipped stone industry has yet to be analysed in detail. Natural raw material fragments even appear at Žopy in Moravia. On the other hand, Krakow Jurassic silicites were found in the form of natural fragments at Kladníky. In the later phases, imported raw material in unworked form appears only at Přáslavice-Kocourovec.

Raw materials considered local were transported as both prepared and unworked cores to early, middle and late LBK sites. Unworked Krumlovský Les chert has also been found at more distant settlements (Asparn-Schletz and perhaps also Mold). Raw materials were transported to middle and late LBK settlements as cores and also as blade blanks or completed tools; these were primarily raw materials from distant sources, which often appear on sites only in limited quantities.

The types of stone raw material will now be considered individually and in detail:

Bakony radiolarites

Radiolarites from the Bakony mountains were brought into LBK settlements in the form of unworked pieces of raw material, or as cores prepared for exploitation. Prepared cores evidently predominated. In the earliest phase of the LBK, Bakony radiolarites predominated even at very distant sites. It is in this period that the spread of unworked, raw shapes can be demon-

strated (Szentgyörgyvölgy-Pityerdomb, Brunn IIa, Brunn IIb and Žopy I). In the later LBK, there is no such spread of unworked raw material and only the distribution of prepared cores or individual artefacts can be demonstrated.

Krakow Jurassic silicites
Krakow Jurassic silicites spread most commonly in the form of prepared cores. The raw material was transported in this way over relatively long distances. At Kladníky and Přáslavice-Kocourovec, it cannot be ruled out that Krakow Jurassic silicites arrived at least in part as unworked raw material. At settlements where Krakow Jurassic silicites appear only in small quantities, cores may have been distributed with blade blanks or complete artefacts.

Erratic silicites
Erratic silicites were most commonly transported in the form of cores over both short and long distances. Only at Kladníky, close to a source, has this raw material also been found in an unworked form.

Krumlovský Les chert
Throughout the duration of the LBK, Krumlovský Les chert was transported to sites close to the source in the form of cores, but unworked pieces of raw material are not exceptional. In areas south of the primary sources, it was also taken to settlements further afield (Těšetice, Asparn-Schletz, Mold) in the form of cores prepared for exploitation and unworked pieces. In areas further north, a comparable role is played by Olomučany chert. At settlements where Krumlovský Les chert makes up only a minimal proportion of the finds, cores are accompanied by blade blanks or complete tools. The distribution of raw material in the form of blade blanks can be assumed only from the middle LBK and is probably linked to the existence of settlements oriented towards their production. A collection of blades and tools without the presence of cores is known for example from Kuřim. At Těšetice-Kyjoviceand Asparn-Schletz, too, the high proportion of blades and tools made from Krumlovský Les chert indicates the existence of such a method of distribution. At Žopy I only a single example of this raw material appears: a blade with pitch residues from hafting. It may have been transported to the site as a complete tool.

Olomučany chert
This chert was transported in the form of worked and unworked pieces of raw material to settlements in close proximity to the source and which were oriented towards its further processing. Distribution in the form of prepared cores predominates. Since the specialised production of blade blanks has been recognised at Kuřim, it may be presumed that it was also distributed in this form, as is the case with Krumlovský Les chert.

Mauer radiolarites
Thus far, this raw material has been identified with certainty only in settlements lying in the immediate vicinity of the primary source. It was taken there in the form of unworked raw material, after partial working and in the form of prepared cores.

Siliceous weathering products of serpentinites
The source of Japons type siliceous weathering products of serpentinites lies in Waldviertel, not far from Rosenburg I and Mold. At Rosenburg, datable to the early phase of the LBK, it passes almost unnoticed: only very few examples were brought to the site after a certain amount of working. At Mold, it is present in a higher proportion and was also brought in unworked; its importance, however, remains secondary to that of Bakony radiolarites and Krumlovský Les chert.

Quartz
Quartz pebbles served above all as hammerstones and grindstones. Flakes of this material appear only very rarely and probably originated as by-products.

Carpathian obsidian, chocolate silicites and Spotted Świeciechów silicites
These materials appear more or less rarely on sites. They are found most often as blades and tools. The presence of cores has not been securely demonstrated. It would therefore seem that most were distributed over long distances in the form of blades and tools, even though other forms cannot be ruled out in some cases (Kazimierza Mała, Asparn-Schletz, Mohelnice, Bylany I, Strachów; Přichystal 1985; Lech 1989a; 1997, 250).

6.5.3. The procurement of stone raw material: a summary of the problems

LBK sites in Moravia and Lower Austria can, on the basis of raw material supply, be divided into three groups, the characteristics of which essentially correspond to the typology proposed by J. Lech (1981; 1989a):
1) producer settlements;
2) secondary producer settlements;
3) consumer settlements.

For the early phase of the LBK, only producer sites (Vedrovice "Za dvorem", Brno-Ivanovice) and sec-

ondary producer sites (Brunn IIa, Brunn IIb, Brunn IV, Rosenburg I, Kladníky) have been identified; there are no typical consumer settlements. Both nearby and more distant settlements secured raw materials for themselves and made chipped stone artefacts more or less exclusively to meet their own needs. The raw material was brought to the settlement in the form of prepared cores. It remains a peculiarity of the earliest LBK that even over long distances, raw material could be transported not just as prepared cores but also in an unworked form (Szentgyörgyvölgy--Pityerdomb, Brunn IIa, Brunn IIb, Brunn IV and Kladníky). The Transdanubian radiolarites had also been transported over long distances in this way, and we can assume that these radiolarites came directly from primary sources and probably formed the essential reserves people brought into regions with unknown raw material sources. Raw materials had probably also been an object of exchange, but a large communication and barter network, as shown by finds of exotic raw materials (Spondylus, obsidian, chocolate and Świeciechów silicites), apparently served primarily social needs (exchange of information and partners, prestige) – at least in the study area.

The economically driven distribution of raw materials began to increase slightly later, in LBK phase II.

In LBK phases II and III, the following changes took place:
At sites of the middle phase, there began to be a predominance of just one type of raw material. The important requirement was quality. At the same time, however, preferences could depend on physical accessibility. Besides the production of chipped stone artefacts for own needs, a specialised production concentrating on exchange and the search for a market in the form of consumer settlements begins to develop. Raw materials from gravels disappeared, and where they occurred had specific purposes (e.g. were used for hammerstones or grindstones). They only appear again at the end of LBK.

a) In the Austrian Danube region, an area in which sites had operated as secondary producer centres employing mainly distant Transdanubian radiolarites in the early phase of the LBK, settlements in the later period (LBK phase I/II) concentrated on working closer raw material sources (Brunn I, Mold).
b) In Moravia, producer settlements (Vedrovice "Široká u lesa") and secondary producer settlements (Přáslavice-Kocourovec), manufacturing chipped stone artefacts more or less for their own use, existed. Alongside, settlements specialised in the production of blade blanks (Kuřim, Nové Bránice "V končinách") appear; these supply some consumer and also other producer settlements (Těšetice, Asparn-Schletz) with their products. In the case of Nové Bránice "V končinách", it is possible that the site was a primary workshop (for characteristics see above).
c) The existence of consumer settlements and 'supplier' producer settlements indicates the operation of a distribution network fulfilling not only social needs, but also an economic role. It is probably also linked to the control of access to sources.

Main production activities	Manufacturing artefacts	Szentgyör-gyvölgy		Brunn IIa			Brunn IIb			Brunn IV			Rosenburg I					
		I	L	I	L	L	I	L	L	I	L	I	I	R	L	L	I	I
1. the obtaining of raw materials	unworked raw materials raw material prepared by several detachments natural raw material fragments some pre-cores some cortical flakes	Bakony	quartz	?	Mauer		?	Mauer		?	Mauer							
2. the production of blanks	pre-cores,exploited cores, exhausted cores cortical flakes partly cortical flakes crested and secondary crested blades and flakes rejuvenation flake from a core's striking platform rejuvenation flake from a core's knapping surface rejuvenation flake from a core's base other technical flake unmodified flakes unmodified blades waste	Bakony		Bakony	Mauer	quartz	Bakony	Mauer		Bakony	Mauer	KL	Bakony	KL	quartz	SWPS		
3. the production of tools	failed tools retouching waste (chips) tool production waste unmodified blades	Bakony		Bakony	Mauer		Bakony	Mauer		Bakony	Mauer	?	Bakony	KL		?	Krakow Jurassic	erraic silicite
4. use	tools and their fragments artefacts with sickle gloss artefacts with use-wear retouch	Bakony	quartz	Bakony	Mauer		Bakony	Mauer	quartz	Bakony	Mauer		Bakony	KL			?	?

Table 8. Early LBK. Main activities in the production of chipped stone industry made from particular types of raw material. Proportion of raw material type < 5 % is marked by black. L - local raw material (< 30 km), R - regional raw material (30-80 km), I - imported raw material (> 80 km).

Main production activities	**Manufacturing artefacts**	**Vedrovice "Za dvorem"**					**Brno-Ivanovice**						**Žopy I**				**Kladníky**			**Kazimierza Mała**					
		L	R	I	I	L	L	L	L	I	I	I	I	I	I	R	I	L	I	R	R	I	I	I	I
1. the obtaining of raw materials	unworked raw materials raw material prepared by several detachments natural raw material fragments some pre-cores some cortical flakes	KL		Bakony		quartz	Olomučany										?	erratic silicite							
2. the production of blanks	pre-cores,exploited cores, exhausted cores cortical flakes partly cortical flakes crested and secondary crested blades and flakes rejuvenation flake from a core's striking platform rejuvenation flake from a core's knapping surface rejuvenation flake from a core's base other technical flake unmodified flakes unmodified blades waste	KL	Olomučany	Bakony			Olomučany	KL		erratic silicite	?	Bakony		Bakony	Krakow Jurassic silicite	?	Krakow Jurassic silicite	erratic silicite	?	Krakow Jurassic silicite	erratic silicite	?	?	?	?
3. the production of tools	failed tools retouching waste (chips) tool production waste unmodified blades	KL	Olomučany	?	Krakow Jur.		Olomučany	KL		?	Krakow Jur.	?	?	?	Krakow Jur.	erratic silicite	Krakow Jur.	erratic silicite	Bakony	Krakow Jur.	erratic silicite	obsidian	chocolate sil.	Świeciechów	Volhynian sil.
4. use	tools and their fragments artefacts with sickle gloss artefacts with use-wear retouch	KL	Olomučany		?		Olomučany	?	quartz				KL	?	Krakow Jur.	?	Krakow Jur.	erratic sil.	Krakow Jur.	Krakow Jur.	?	obsidian	chocolate sil.	Świeciechów	?

Table 9. Early LBK. Main activities in the production of chipped stone industry made from particular types of raw material. Proportion of raw material type < 5 % is marked by black. L - local raw material (< 30 km), R - regional raw material (30-80 km), I - imported raw material (> 80 km).

Main production activities	Manufacturing artefacts	Brunn I			Mold				Brno-Nový Lískovec					Žopy II		Vedrovice "Široká u lesa"						
		I	L	I	L	R	L	I	L	L	L	I	I	I	R	L	I	R	L	I	L	L
1. the obtaining of raw materials	unworked raw materials raw material prepared by several detachments natural raw material fragments some pre-cores some cortical flakes		Mauer		SWPS	?	quartz		KL + MJC	Olomučany						KL						
2. the production of blanks	pre-cores, exploited cores, exhausted cores cortical flakes partly cortical flakes crested and secondary crested blades and flakes rejuvenation flake from a core's striking platform rejuvenation flake from a core's knapping surface rejuvenation flake from a core's base other technical flake unmodified flakes unmodified blades waste	Bakony	Mauer		SWPS	KL	quartz	Bakony	?	Olomučany		?	?	Krakow Jurassic silicite		KL	Krakow Jurassic silicite	Olomučany	SWPS	?		
3. the production of tools	failed tools retouching waste (chips) tool production waste unmodified blades	Bakony	Mauer	?	SWPS	KL		Bakony		Olomučany		Krakow Jurassic	erraic silicite	Krakow Jurassic		KL	Krakow Jurassic	?	?	Bakony		quartz
4. use	tools and their fragments artefacts with sickle gloss artefacts with use-wear retouch	Bakony	Mauer	Krakow Jur.	SWPS	KL		Bakony	KL + MJC	Olomučany	quartz	Krakow Jur.	?	Krakow Jur.	erratic sil.	KL	Krakow Jur.				Stranská sk.	

Table 10. Phase I/II and middle phase of the LBK. Main activities in the production of chipped stone industry made from particular types of raw material. Proportion of raw material type < 5 % is marked by black. L - local raw material (< 30 km), R - regional raw material (30-80 km), I - imported raw material (> 80 km).

Main production activities	Manufacturing artefacts	Těšetice					Přáslavice-Kocourovec				Nové Bránice	Asparn-Schletz							Kuřim						
		L	L	I	L	I	I	L	I	I	L		I	I	I	L	I	I	L	L	L	L	I	I	I
1. the obtaining of raw materials	unworked raw materials raw material prepared by several detachments natural raw material fragments some pre-cores some cortical flakes	KL					?				KL	KL							?						
2. the production of blanks	pre-cores,exploited cores, exhausted cores cortical flakes partly cortical flakes crested and secondary crested blades and flakes rejuvenation flake from a core's striking platform rejuvenation flake from a core's knapping surface rejuvenation flake from a core's base other technical flake unmodified flakes unmodified blades waste	KL	SWPS	erratic silicite		?	Krakow Jurassic silicite	erratic silicite	Bakony		KL	KL	Krakow Jurassic silicite	Bakony	erratic silicite				Olomučany	Moravian Jurassic chert			?		spongolite
3. the production of tools	failed tools retouching waste (chips) tool production waste unmodified blades	KL	?	erraic silicite		Krakow Jurassic	Krakow Jurassic	erraic silicite	?	?	KL	KL	Krakow Jurassic	Bakony	erraic silicite		Świeciechów	obsidian	Olomučany	MJC	KL		Krakow Jurassic	erraic silicite	?
4. use	tools and their fragments artefacts with sickle gloss artefacts with use-wear retouch	KL		erratic sil.	quartz	?	Krakow Jur.	erratic sil.		KL	KL	KL	Krakow Jur.	Bakony	erratic sil.	quartz			Olomučany	?	KL	quartz	?		

Table 11. Middle and Late LBK. Main activities in the production of chipped stone industry made from particular types of raw material. Proportion of raw material type < 5 % is marked by black. L - local raw material (< 30 km), R - regional raw material (30-80 km), I - imported raw material (> 80 km).