

Transport of lithic raw material in the Mesolithic of southwest Germany

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Abstract

The different geographical subregions of southwest Germany yield characteristic raw materials which were used during the Mesolithic period. Unexpectedly, the different regional assemblages are all dominated by Upper Jurassic chert found in sources at distances of up to 50 km from the sites. These distances lie within the range of a macro-move of Mesolithic hunter-gatherers. Investigations at the Mesolithic open air sites of Siebenlinden demonstrate a quite complex system of procurement. Mainly, complete nodules of Jurassic chert were transported from campsite to campsite. If needed, local material from the different geographical subregions was also added to the inventory of raw materials used. At times the amount of local material increases to more than 50% of the processed nodules, whereas at other times only a few local nodules were knapped.

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History of research

Research on the Mesolithic sites of southwest Germany started at the beginning of the last century, when the famous skull burials of Ofnet Cave were assigned to a cultural stage which was called Azilian–Tardenoisian (Schmidt, 1913). During the 1920s and 1930s intensive research was conducted in Mesolithic cave and rockshelter sites (Peters, 1934, 1935) as well as at open air sites (Reinerth, 1930). Starting in the 1960s and continuing into the 1970s, Wolfgang Taute developed a very detailed typological and chronological division of the Mesolithic. He

divided the southwest German Mesolithic into an early stage called Beuronian and a later stage called “Late Mesolithic” (Taute, 1971, 1973/74, 1975).

In the 1980s new questions arose concerning both land use and the exploitation of resources during the Mesolithic, which guided subsequent research (Jochim, 1976, 1993, 1998). Finally, in the 1990s investigations into both the technological aspects of flint artifact production and the use of different lithic raw materials became central topics of Mesolithic research (Hahn, 1998; Kind, 2003; Pasda, 1994). Thus, it can be concluded that ongoing investigations of the Mesolithic in southwest Germany have always reflected the current direction of international scientific discussion.

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Archaeological background

As previously noted, credit for the typological differentiation of the southwest German Mesolithic goes to Wolfgang Taute, who, in the early 1970s, divided the Mesolithic into the Beuronian as the early phase and the Late Mesolithic as the final stage (Taute, 1971, 1973/74, 1975). This differentiation of the Mesolithic by Taute was based largely on typological considerations, as follows (Fig. 1):

Beuronian A is characterized by slender trapezes on irregular blades, obtuse-angled isosceles and triangular points with convex, dorso-ventrally retouched bases.

Beuronian B is characterized by acute-angled isosceles and triangular points with concave dorso-ventrally retouched bases.

Beuronian C is characterized by extremely scalene triangles, backed bladelets and triangular points with concave dorsally retouched bases.

Late Mesolithic is characterized by rectangular microliths such as trapezes and trapezoidal points as well as a new technique producing very regular blades. Also typical are broad harpoons made of red deer antler.

Recent investigations have demonstrated that the typological differentiation of the Beuronian is not as clear cut as Taute had envisaged (Kind, 1987; Hahn et al., 1993; Kieselbach et al., 2000). The general lines of chronotypological development can be defined as a dominance of larger isosceles together with triangular points with dorso-ventrally retouched bases during the first part of the Beuronian (Beuronian A and B) followed by a dominance of smaller scalene triangles together with triangular points with dorsally retouched bases at the end of the Beuronian (Beuronian C). But these are merely tendencies; the differences are manifested in proportional shifts, not in strict type-fossils.

One typical feature of the Beuronian is a high incidence of pinkish, fire-heated artifacts. Through the technique of thermal tempering the fracture qualities of the lithic raw material were optimized. This technique seems to be diagnostic for southwest German Early Mesolithic inventories. Assemblages dated to the Late Mesolithic do not contain such heat-treated artifacts. The technique of thermal tempering was apparently replaced by the new technology of highly regular blade production in these assemblages.

A revised differentiation of the Mesolithic of southwest Germany reflects the problems of a

strictly typological division (Table 1). The distinctions between the Early, Middle, Late, and Terminal parts of the Mesolithic are limited primarily by the chronological boundaries of environmental stages. Inventories dated to the Preboreal period belong to the Early Mesolithic, those dated to the Boreal period belong to the Middle Mesolithic inventories. An early and a later phase of the Middle Mesolithic can be identified, however, with the late phase being characterized by a distinct microlithization of the artifacts. Finally, the Late and Terminal Mesolithic are dated to the Atlantic period. The Terminal Mesolithic has additional archaeological implications because it should be contemporaneous with the earliest Neolithic in southwest Germany, the Linearbandkeramik Culture (LBK).

Open air, rockshelter, and cave sites

The southern part of Baden-Württemberg is bounded by the valley of the River Rhine in the west and to the south, by Lake Constance and the Alpine mountains on the south and by the River Iller to the east. This area can in turn be divided into several subregions, most of them due to geological conditions and resulting differences in their substrate, climate, relief, vegetation, and modern land use. Given these geographic considerations, the regions of current importance to Mesolithic activities are as follows (Fig. 2):

Upper Rhine Valley

A trench (rift) valley created by plate-tectonics. This valley is filled with up to several hundred meters of sands and gravels, and finally covered by flood plain deposits and loess soils.

Black Forest

Mountains with Mesozoic sandstones and Palaeozoic granites. The Black Forest is characterized by steep, incised valleys and medium elevations up to 1500 m above sea level.

Cuesta region

Steps of different geological ages, caused by tectonic uplifts and differential rates of erosion due to the differing resistance of the strata. The steps contain Triassic and Jurassic sediments, mainly

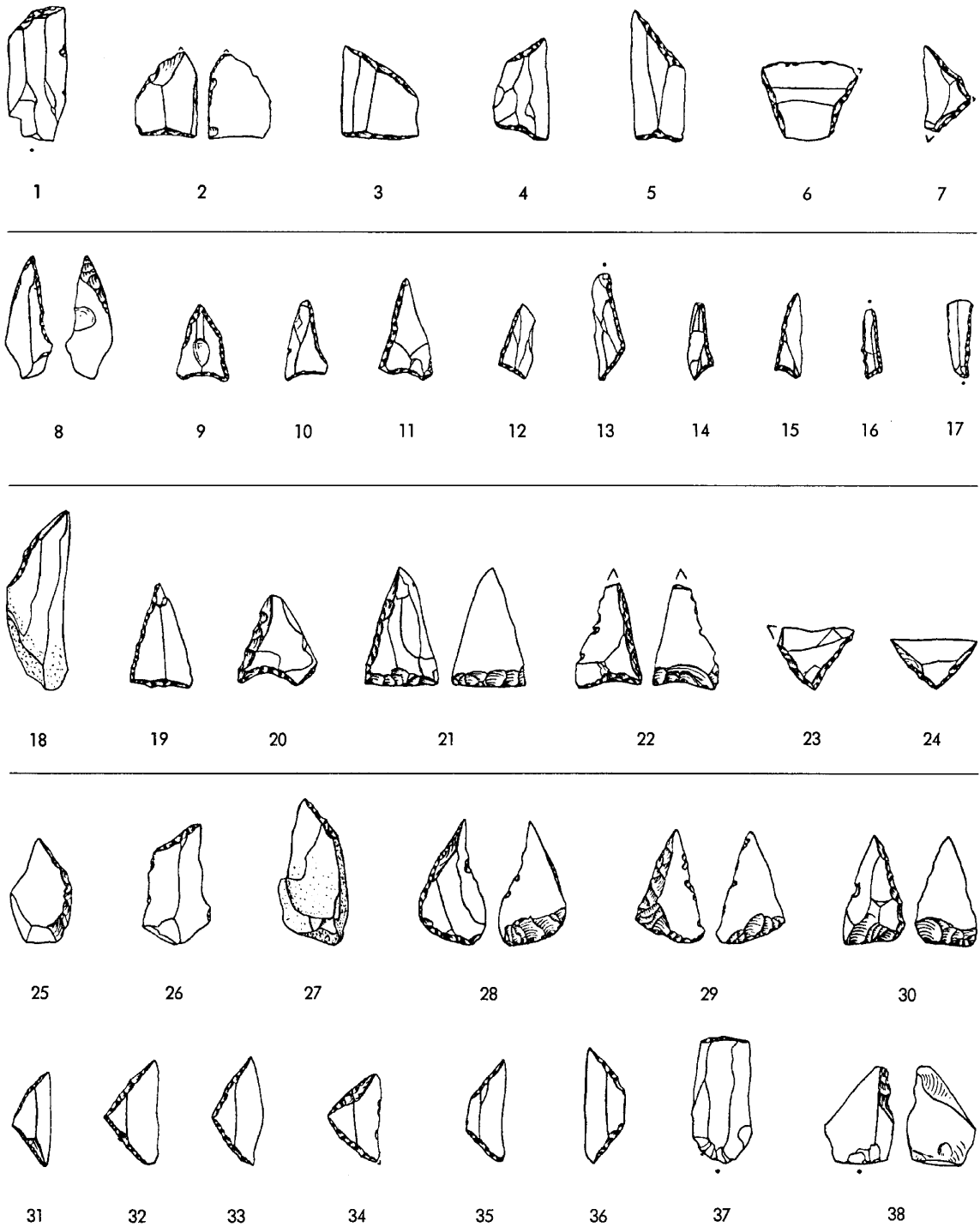


Fig. 1. Typological differentiation of the Mesolithic in southwest Germany (after Taute, 1973/74): 38–25, Beuronian A; 24–18, Beuronian B; 17–8, Beuronian C; 7–1, Late Mesolithic.

limestones, sandstones, mudstones, and marlstones and form a hilly landscape. The surface is mainly covered by periglacial sediments such as loess and

solifluction sheets which reworked the underlying sediments. The valley of the River Neckar is incised in the cuesta landscape.

Table 1
Differentiation of the Mesolithic in southwest Germany

Time scale cal BC	Period	Taute (1973/74)		Revised terminology
9600–9000	Preboreal	Earliest Mesolithic		Early Mesolithic
9000–8100		Beuronian A		
8100–7400	Boreal	Beuronian B	Early	Middle Mesolithic
7400–6900		Beuronian C	Late	
6900–5600	Atlantic	Late Mesolithic		Late Mesolithic
5600–5000				Terminal Mesolithic

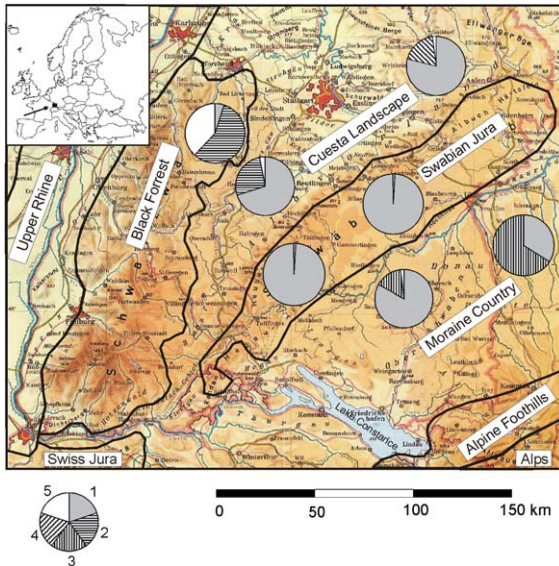


Fig. 2. Map of the southwestern part of Germany with the different geographical subregions. The circles display the average percentage of different lithic raw materials in Mesolithic sites of the different subregions: 1, Jurassic chert; 2, Middle Triassic chert; 3, Radiolarite and quartzite; 4, Upper Triassic chert; 5, Raw material not identifiable.

Swabian Jura

This is the last step of the cuesta landscape, made up of Upper Jurassic sediments, mainly limestones and marlstones. The sediments form a high plateau with altitudes between 600 and 1000 m above sea level. Although the plateau itself seems rather flat, it slopes imperceptibly to the south at an angle of about 2°. Consequently, the northern rim is much higher, forming an escarpment up to 300 m high. The surface is heavily influenced by karst phenomena and mostly covered by residual clay, slope debris, and rocky outcrops. The karst activity opened numerous cave systems. The southern border of the Swabian Jura is marked by the River Danube.

Morainial landscape

During the Tertiary this region was originally a basin created by the tectonic uplift of the Alpine mountains. It was subsequently filled by mollasse deposits. During the Pleistocene, the alpine glaciers formed moraines to the north. Glacial sediments such as tills, fluvio-glacial outwash, and glacio-lacustrine deposits form a hilly landscape with numerous lakes and bogs; the largest of these lakes is Lake Constance.

Alpine foothills

These are high elevations up to 2000 m above sea level caused by tectonic uplift during the Tertiary.

Mesolithic sites in Southwest Germany are numerous. More than 750 locations with Mesolithic artifacts are known in Baden-Württemberg, most of which are open air sites where finds can be collected from the surface. They are not randomly distributed but occur in distinct geographic clusters such as in the area east of Stuttgart, with more than 200 find spots, or the Federsee region with more than 50 sites.

All of the different geographical subregions of Southwest Germany yield Mesolithic open air sites (Fig. 2). They occur in the Rhine Valley distributed along river banks. In the Black Forest Mesolithic finds are present up to altitudes of more than 1300 m above sea level (Baum and Pasda, 2001). Mesolithic open air sites are numerous in the cuesta landscape and in the morainial region of Oberschwaben. In both regions site locations are clearly linked to sandy or fluvio-glacial soils. Mesolithic localities in areas with loess soils are rare, an observation which does not necessarily demonstrate special site location preferences. It is possible, for example, that heavy erosion of the loess regions caused by intensive agriculture during the last centuries is responsible for these observed site frequencies.

Mesolithic open air sites are also not very common in the highlands of the Swabian Jura. This again may be explained by erosion in a geologically very active landscape. Exceptions include some open air sites in the vicinity of Tertiary volcanoes. In these former calderas water was available, while it was lacking on the karstic highlands. Mesolithic occupation layers are also preserved in many caves and rockshelters of the Swabian Jura.

Archaeological excavations have been conducted in more than 45 Mesolithic sites of Baden-Württemberg, most of them located in caves or rockshelters. Excavations at open air locales are rare, but recent research has revealed some Mesolithic open air sites with preserved layers, discovered in special microgeographical situations. At bog sites at Lake Federsee, for example, the Mesolithic occupation layers were incorporated in peat (Jochim, 1993, 1998; Kind, 1997; Schlichtherle, 1989, 2000), while in pastures on the valley floors they were covered by alluvial sediments (Karle, 1998; Kieselbach et al., 2000; Kind, 2003; Pasda, 1994).

Despite the large sample of more than 700 open air sites their interpretation remains very difficult. This is because nearly all of them are known from surface collections rather than excavated samples, the collections are in private hands, and normally they are not analysed in sufficient detail. During the last several years, however, private collections from several areas have become the subject of more detailed scientific work. Therefore, at least minimal information has become available. The sites from Bayrisch Schwaben, an area in the morainal region south of the valley of the Danube River and north of the Alpine foothills, have been published (Wischnenbarth, 1999), as have some sites from the highlands of the Black Forest (Pasda, 1994). Inventories from Lake Federsee in the moraine region were the focus of intensive research (which has not yet been published), as were the artifacts from several surface collections from part of the cuesta region east of Stuttgart (Lauermann, 2006). Finally, research was also carried out in Pfrunger Ried, another region of the moraine landscape, during the last decade (Jochim, 2000).

Investigations of these sites are rendered more difficult because most of the surface collections are mixed; virtually no inventory belongs exclusively to the Mesolithic period. In most inventories there are artifacts that can be assigned to the late Paleolithic (the Federmesser period or Azilian), and some to the Neolithic. At some locales artifacts were found

which even seem to belong to the Upper Paleolithic Magdalenian period. On the one hand this demonstrates the continuity of settlement systems at the border between the Paleolithic and the Mesolithic periods. Yet, on the other hand, this makes it impossible to look at closed inventories from a precise chronological period. Usually it can only be stated that the sites were occupied during Mesolithic times, and that part of the artifact assemblage which was found falls within the Holocene.

Occurrence of lithic raw material

During the last few decades, research concerning the use of lithic raw materials in the Mesolithic of southwest Germany has intensified. The remainder of this paper will discuss the most significant results of this recent work, focusing on two main questions:

First, what frequencies of the different raw materials are represented at the different sites and is there any relationship to geographical conditions? Second, how was the supply of lithic raw material organized, in time, in space and, again, in what quantities?

The subregions discussed here each yield characteristic raw materials which were used during the Mesolithic period. White and grey Upper Jurassic chert comes from the highlands of the Swabian Jura. It occurs in nodules with a size up to 20 cm and is usually quite homogeneous and easy to knap. A special variety of this chert can be found at the southern edge of the Swabian Jura as well as in the neighboring northern part of the moraine region. It has a deep brown color and sometimes a polished cortex. It derives from secondary sources of Tertiary age, but can be identified as originally grey Jurassic chert with a secondary change of color. Red and green radiolarite, as well as a fine-grained quartzite, are found in the fluvio-glacial gravels of the morainal region. Both materials usually are of lesser quality and occur in small nodules. Grey and black Middle Triassic chert is found in the southern part of the cuesta subregion. The size of the nodules ranges from less than 5 to as much as 15 cm. The nodules are often quite heterogeneous and full of cracks, but at times nodules of a very high quality can be found. Finally, grey, white, and brown Upper Triassic chert occurs, mainly in the northern part of the cuesta landscape. This material also is of a lower quality.

To better understand lithic raw material distributions, the raw materials present in the assemblages

of about 50 Early and Late Mesolithic sites from the different geographical subregions of southwest Germany were analysed (Table 2). As a first result it must be mentioned that there is no indication of long distance transport of lithics. All raw materials were derived from sources between 100 m and 30–50 km from the different sites. Even the larger distances are within the supposed range of a residential move (Kelly, 1995, p. 128).

All sites in the highlands of the Swabian Jura yield high frequencies, up to 100%, of Jurassic chert (Fig. 2), the local raw material. High proportions of local chert fit the common distance decay model of spatial distribution and supply of raw material (cf. Renfrew, 1977). Additionally, sites in all of the other subregions show relatively high frequencies of local materials. Upper Triassic chert is quite common in the northern part of the cuesta region, Middle Triassic chert in the southern part of the cuesta region, and radiolarite and quartzite in the morainal region. However, in all these subregions the non-local Jurassic chert is well represented, with high proportions of up to 70%.

The results of this one-dimensional analysis are only partially as expected. In each subregion local raw material is represented, but the overall supply of raw material seems to be dominated by Jurassic chert. That means that there must be factors other than the pure distance from the source which might explain the quantities of raw material in the Mesolithic sites of southwest Germany. Although Mesolithic flint-knappers were surely able to produce an abundance of tools even from nodules of mediocre or poor quality, one important constraint might have been the quality of the chert (Kieselbach, 1996). Even if nodules from other, local, materials can at times be of very high quality, Jurassic chert certainly is the best quality material and therefore was preferred. One interesting and important detail relevant here is that the proportional supply of lithic raw material seems to remain stable over time. There is no indication for a shift from one material to another during a time span of more than 4000 years.

The Mesolithic open air sites of Siebenlinden

During the last decade several excavation campaigns have been conducted at Mesolithic open air sites at Siebenlinden on the outskirts of the town of Rottenburg on the banks of the Neckar River in southwestern Germany. To date, more than 550 m² have been excavated to reveal a stratigraphy with up

to five Mesolithic layers (Table 3). These sites can be used as test cases for some of the propositions presented above.

Hearths (38 in total) were documented in nearly every layer. Some were built level with the ground surface and lacked additional elements of construction. Evidence for this first type consists of a burnt loam floor and a concentration of burnt artifacts or bone fragments. A second type of hearth was demarcated by a circle of stones. A third type of hearth was paved with pebbles. Finally, a fourth type of hearth could be described as shallow pits sometimes surrounded or paved with stones.

Artifacts at the Siebenlinden sites are numerous, with typical triangular microliths characterizing the Early and Middle Mesolithic, as well as rectangular microliths representing the Late Mesolithic. Faunal remains are in quite a good state of preservation, and botanical material was also discovered.

Different kinds of campsites could be identified. For example, concentration 3 from layer IV of Siebenlinden 3/4/5, dated to the Middle Mesolithic at 8940 ± 75 years BP (ETH-26387), displays the typical distributions of artifacts, bones, and burnt pebble fragments (Fig. 3) forming a drop zone near a fireplace. This pattern conforms perfectly to the expectations of Binford's outside hearth model (Binford, 1983). Southeast of this fireplace a small roasting pit was discovered filled with a large quantity of burnt hazelnut shells. The occupation took place during late summer or early fall and was quite short, with the main activities being rehafting and retooling as well as preparing nuts for storage after collecting them in the meadows near the river. This site surely was a kind of short duration field camp.

Concentration 1 in layer II of Siebenlinden 3/4/5 (Fig. 4) is dated to the Late Mesolithic in the middle of the Atlantic period at about 7000 years BP (Table 3). Three fireplaces, all built level with the ground surface, were identified. The western and the central fireplaces were accompanied by one concentration of flint artifacts, and the eastern hearth by two concentrations of chipped flint artifacts. Additionally, nearly all microliths and endscrapers were found north of the middle hearth, indicating a distinct place for rehafting and retooling as well as possibly for working skins. Finally, a concentration of antler fragments from red and roe deer was found north of the western hearth, suggesting a location for the manufacture of projectile points or other tools. Thus, six separate activity areas could be located. Refittings of lithic artifacts demonstrate

Table 2
Amounts of lithic raw materials in selected Mesolithic sites of southwest Germany

	Typol.	Type	Excav.	Jurassic	Middle Triassic	Late Triassic	Local	Others
Morainal region								
Attenhofen "Stegmann"	A/B	Ridge/Hill	No	55	0	0	45	<1
Roth "Brand"	A/B	Ridge/Hill	No	50	0	0	50	0
Buch "Oberes Ried"	C	Ridge/Hill	No	10	0	0	90	0
Unterroth "Westerholz"	A/B	Ridge/Hill	No	22	0	0	78	0
Henauhof NW 5	A	Bog site	Yes	82	0	0	17	1
Henauhof NW 4	C	Bog site	Yes	82	0	0	17	1
Henauhof NW 3	LM	Bog site	Yes	80	0	0	19	1
Henauhof N II	LM	Bog site	Yes	85	<1	0	11	4
Taubried 2	A	Bog site	Yes					
Black Forest					Local			
Walddorf Mohnh. Berg	A/B	Ridge/Hill	No	1.1	82.7	0	0	16.3
Walddorf 1	A/B	Ridge/Hill	No	0.9	59.3	0	0	39.7
Wildberg Sulzer Eck	A/B	Ridge/Hill	No	1.2	51.9	0.1	0	46.8
Wildberg Kengelberg	A/B	Ridge/Hill	No	2.3	35.7	0	0	62
Altensteig	A	Valley Floor	Yes	14	56	3	<1	26
Cuesta Landscape NE						Local		
Gschwend	A/B	Ridge/Hill	No	68	1	31	0	0
Spraitbach 2	A/B	Ridge/Hill	No	80	<1	17	0	2
Welzheim 1	A/B	Ridge/Hill	No	84	0	16	0	0
Kapf 2	A/B	Ridge/Hill	No	83	<1	15	<1	1
Brend Linsenäcker 1	A/B	Ridge/Hill	No	81	0	17	0	2
Spraitbach 4	A/B	Ridge/Hill	No	73	0	25	0	2
Höldis 7	A/B	Ridge/Hill	No	89	0	9	0	2
Enderbach 4	A/B	Ridge/Hill	No	65	1	30	0	4
Enderbach 1	A/B	Ridge/Hill	No	82	0	15	0	3
Mutlangen 4	A/B	Ridge/Hill	No	83	0	15	0	2
Cuesta Landscape SW					Local			
Birkenkopf	A/B	Ridge/Hill	Yes	93	2	0	0	5
Siebenlinden 1 I	C	Valley Floor	Yes	87	11	0	0	2
Siebenlinden 1 II	B	Valley Floor	Yes	90	9	0	0	1
Siebenlinden 2	C	Valley Floor	Yes	41	55	0	0	4
Siebenlinden 3 II	LM	Valley Floor	Yes	56	44	0	0	<1
Siebenlinden 3 III	C	Valley Floor	Yes	43	57	0	0	<1
Siebenlinden 3 IV	B	Valley Floor	Yes	79	20	0	0	1
Bochingen I	A	Valley Floor	Yes	70	21	0	0	9
Swabian Jura				Local				
Malerfels	A	Rockshelter	Yes	100	0	0	0	0
Felsställe IIa3	C	Rockshelter	Yes	98	1	0	1	1
Dietfurt 9	LM	Cave	Yes	98	1	0	0	1
Dietfurt 10/11	C	Cave	Yes	98	<1	0	<1	1
Jägerhaus 6	LM	Rockshelter	Yes	100	0	0	0	0
Jägerhaus 7	LM	Rockshelter	Yes	94	<1	0	0	6
Jägerhaus 8	C	Rockshelter	Yes	97	<1	0	<1	2
Jägerhaus 9	C	Rockshelter	Yes	100	0	0	0	0
Jägerhaus 10	B	Rockshelter	Yes	99	0	0	<1	0
Jägerhaus 11	B	Rockshelter	Yes	98	0	0	2	0
Jägerhaus 12	B	Rockshelter	Yes	98	2	0	0	0
Jägerhaus 13	A	Rockshelter	Yes	100	0	0	0	0
Lautereck E	LM	Rockshelter	Yes	96	0	0	1	3

The typology is based on the differentiation of Beuronian A, B, C, and the Late Mesolithic (Taute, 1973/74, 1975). The low proportions of Jurassic chert in the assemblages from the Black Forest region is caused by a variety of Triassic chert which is very similar to Jurassic chert. Therefore numerous artifacts remain uncertain and were counted as "others," although at least part of them were made of Jurassic chert.

Table 3
Stratigraphy and radiocarbon dates in the Mesolithic sites of Siebenlinden

Technocomplex	Site	Layer	Lab. number	Date	SD
Late Mesolithic	Siebenlinden 3	II	ETH-12777	6845	80
			ETH-14243	5850	85
			ETH-14244	7170	70
	Siebenlinden 4	II	ETH-26380	6885	65
			ETH-26381	6640	65
	Beuronian C	Siebenlinden 1	I	ETH-8264	8035
Siebenlinden 2		I	ETH-7545	7795	80
			ETH-12773	7840	85
			ETH-12776	8070	75
Siebenlinden 3		III	ETH-14245	8010	75
			ETH-14247	7990	70
Siebenlinden 4		III	ETH-26384	8495	70
			ETH-26385	8250	70
Beuronian B		Siebenlinden 1	II	ETH-7544	8540
	ETH-8265			9110	80
	ETH-8266			8840	80
	Siebenlinden 3	IV	ETH-14246	8705	75
			ETH-14248	8680	75
	Siebenlinden 4	IV	ETH-26386	8875	75
			ETH-26387	8940	75

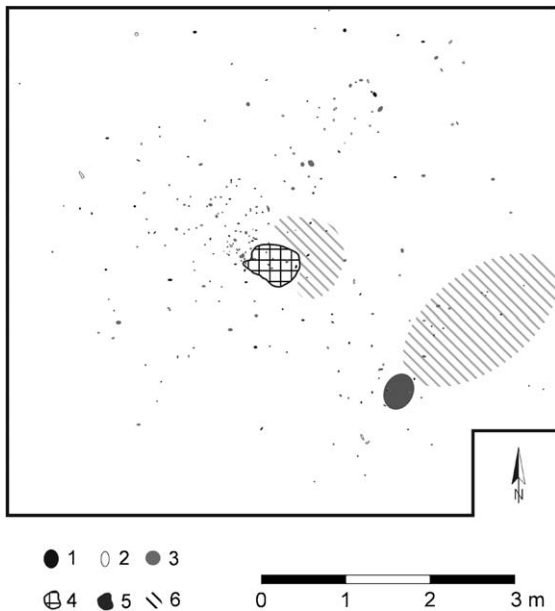


Fig. 3. Horizontal distribution of archaeological finds in concentration 3 of the Middle Mesolithic layer IV in Siebenlinden 3/4/5: 1, artifacts; 2, bones; 3, burnt pebbles; 4, hearths; 5, roasting pit; 6, hazelnut shells.

that the three fireplaces are contemporaneous. Bone refuse was dumped outside this area. This site clearly displays a series of different activities and can readily

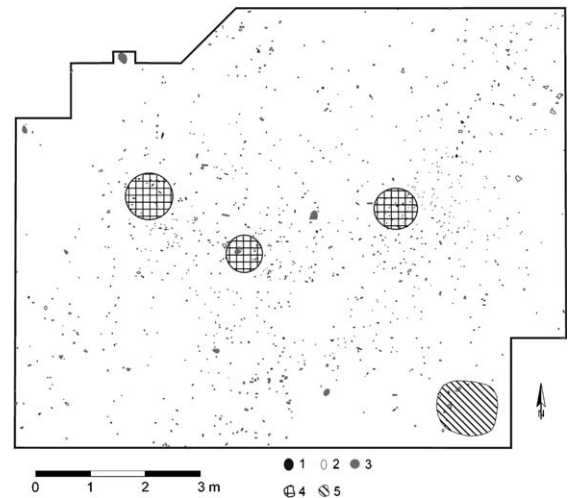


Fig. 4. Horizontal distribution of archaeological finds in concentration 1 of the Late Mesolithic layer II in Siebenlinden 3/4/5: 1, artifacts; 2, bones; 3, burnt pebbles; 4, hearths; 5, Iron Age pit.

be interpreted as a short-term residential camp or a field camp with residential attributes.

Layer III of Siebenlinden 3/4/5, dated to the late Boreal between 8500 and 8000 years BP (Table 3), displays at least 15 concentrations of chert artifacts, bones, and burnt pebble fragments (Fig. 5). Most of the 21 hearths were found inside these concentrations. The spatial concentrations of finds sometimes show a barrier effect, which makes it possible that they reflect former walls of tents or huts. Some of them are circular in plan, while others are rectangular. This layer clearly represents more intensive residential occupations. Although we cannot rule out the possibility that Layer III contains a series of occupations and is a palimpsest, we are considering the possibility of a larger, multi-unit aggregation site.

Raw material and reduction sequences in Siebenlinden

To date three of the Siebenlinden sites have been analysed, and the results are published. Layer II of Siebenlinden 1 is dated to the Middle Mesolithic at about 8800 years BP (Kind, 2003, p. 29), Layer I of Siebenlinden 2 to the late Middle Mesolithic at about 7900 years BP (Kieselbach et al., 2000, p. 16), and finally layer II of Siebenlinden 3 to the Late Mesolithic at about 7000 years BP (Kind, 2003, p. 29). Two different raw materials are represented in each layer (Table 4): the local Middle Triassic chert with frequencies ranging between 10 and 50%, and the non-local Jurassic chert with frequencies

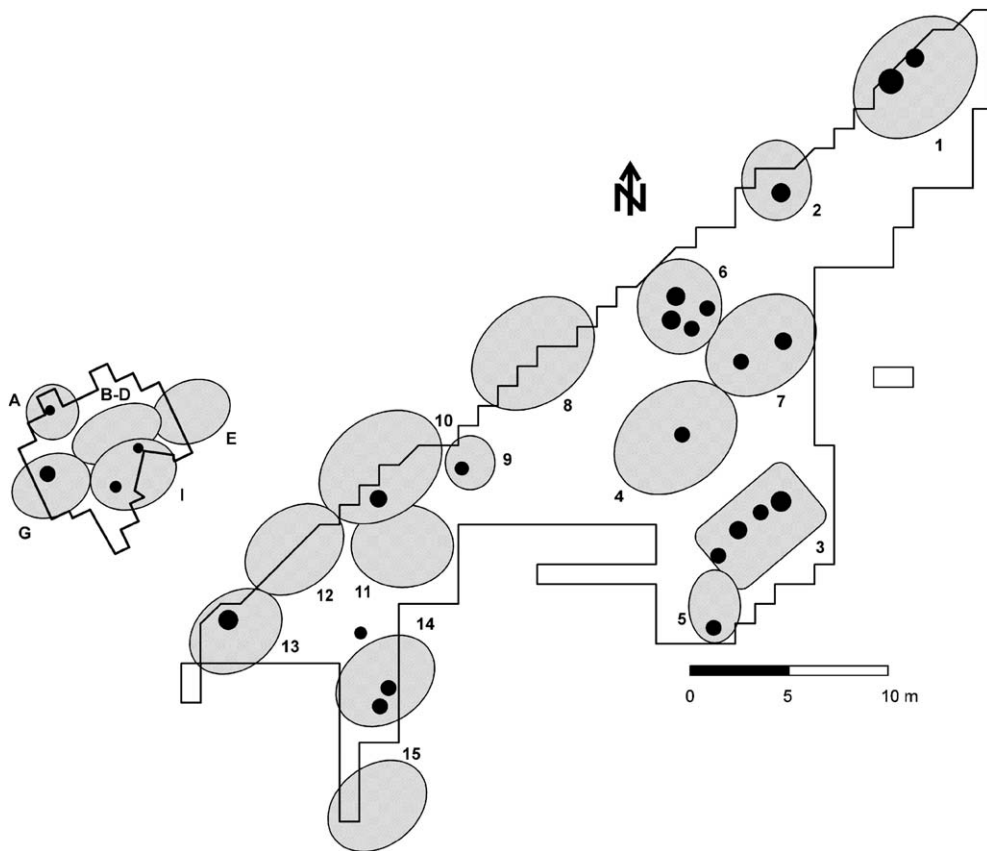


Fig. 5. Horizontal distribution of find concentrations in the late Middle Mesolithic layers I of Siebenlinden 2 (upper left) and III of Siebenlinden 3/4/5.

between 50 and 90%. This means that the conditions in Siebenlinden are consistent with the generalizations made above concerning the proportional representation of lithic raw material.

It should be expected that the nodules of the two different types of raw material would be treated in a different manner, given the differences in their transport distances and their quality for knapping. The non-local Jurassic nodules had to be transported over a distance of up to 50 km, while the local Triassic chert could be found only a few hundred meters away in the gravels of the river. It might be predicted, therefore, that the foreign nodules were prepared initially at their source in the highlands while complete local nodules were brought to the campsite.

To further investigate and test this proposition the various artifacts were assigned to different stages of the *chaîne opératoire* (Geneste, 1985). The results of the analysis were unexpected (Table 5). In all samples the initial phases of the operational sequence such as decortication and primary preparation are more frequent for the foreign raw material and quite rare for the local raw material.

It was also possible to assign the majority of the blanks to different nodules. Analysis of the stages of the *chaîne opératoire* for the different nodules further confirmed the previous result. In all three analysed layers (Table 6), dating from the beginning of the Boreal to the middle of the Atlantic period, the local nodules were mainly brought tested or as

Table 4

Distribution of lithic raw materials in the Mesolithic sites of Siebenlinden (Kind, 2003, p. 78)

Site and layer	Period	Average dates BP	Local Triassic chert	Foreign Jurassic chert	Foreign brown chert	Others
S 1 layer II	Beur. B	8800	178 = 9.4%	1674 = 88.1%	41 = 2.2%	8 = 0.5%
S 2 layer I	Beur. C	7900	1221 = 54.9%	801 = 36.0%	118 = 5.3%	86 = 3.9%
S 3 layer II	Late M	7000	220 = 44.0%	209 = 41.8%	70 = 14.0%	1 = 0.2%

Table 5
Reduction sequence of artifacts in Siebenlinden (Kind, 2003, p. 83)

	S 1 layer II		S2 layer I		S 3 layer II	
Production	1190 = 69.8%	129 = 72.5%	544 = 59.2%	515 = 42.2%	138 = 49.5%	94 = 42.7%
Blades	332 = 19.5%	30 = 16.9%	267 = 29.1%	241 = 19.7%	89 = 31.9%	105 = 47.7%
Modification	9 = 0.5%	6 = 3.4%	19 = 2.1%	3 = 0.3%	0	1 = 0.5%
Chunks	58 = 3.4%	8 = 4.5%	56 = 6.1%	331 = 27.1%	0	2 = 0.9%
Total	1705	178	919	1221	279	220

Table 6
Import of raw material units in Siebenlinden (Kind, 2003, p. 122)

	S 1 layer II		S 2 layer I		S 3 layer II	
	Foreign	Local	Foreign	Local	Foreign	Local
Complete nodules	15	0	1	2	2	2
Tested nodules	8	3	6	7	0	3
Cores and/or series of blanks	4	0	2	2	3	0
Unknown	1	1	0	1	0	0
Total	28	4	9	12	5	5

pre-cores to the site, whereas non-local Jurassic chert was imported more frequently as complete nodules. The raw material supply seems to be stable through time. Finally, there are some nodules, mainly of non-local chert, which are represented by cores or a series of blades and flakes only. This analysis demonstrates a system of procurement exactly the opposite of that which was expected.

Nodules of Jurassic chert are usually of relatively high quality. Therefore it was possible to transport them as complete items with no need to test them. Conversely, the local Triassic chert is sometimes full of cracks, and it therefore was necessary to perform the first steps of the operational sequence at the source. The nodules were tested or even completely decorticated at the procurement location, meaning that only pre-cores of very good quality local chert were usually brought to the campsite.

Siebenlinden 2: testing horizontal distributions

Several investigations of Stone Age living floors demonstrate that the deposition of artifacts is not a one-dimensional activity. It can be shown, for example, that during episodes of settlement activities larger artifacts tended to move to the borders of the habitation area, a process or mechanism called the centrifugal effect (Leroi-Gourhan and Brezillon, 1972; Stapert, 1989).

It can be assumed that artifacts of different nodules should show different patterns of horizon-

tal distribution and that these patterns should reflect the influence of settlement activities. If the artifacts of a single nodule are found close together and have not been spatially dispersed, they can be assumed to have been knapped or dumped without much secondary movement, which we may interpret as meaning that they were most likely deposited near the end of the occupation. Therefore, the concentration of the artifacts should decline in proportion to the length of the occupation. It would be most probable that nodules of foreign chert were mainly knapped at the beginning of the occupation sequence, while local material was used primarily at the end of the occupation.

This assumption can be tested by analyzing the horizontal distributions of the artifacts belonging to different individual nodules. Siebenlinden 2 offers a differentiated distribution of finds around four hearths (Kieselbach et al., 2000, p. 165–197). The artifacts made from some of the nodules were found close together (Fig. 6). They are remarkably concentrated and indicate little internal displacement and removal during the occupation. Artifacts made from other nodules show only a weak concentration. Obviously, internal displacement and removal had reached a distinct level but wasn't very intensive yet. Finally, artifacts from a third group of nodules show quite a random distribution, a good indication of intensive movement during settlement. If time is, indeed, a factor responsible for internal movement, then these nodules should belong to activities at the

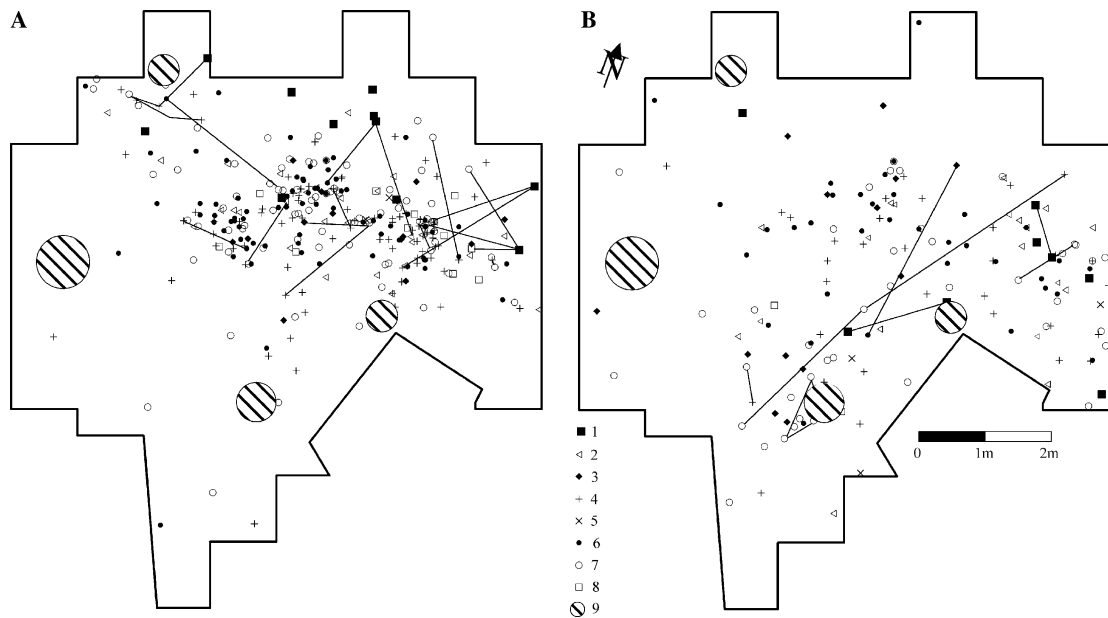


Fig. 6. Horizontal distribution of lithic artifacts in the late Middle Mesolithic layer I of Siebenlinden 2. (A) Nodule JA, Jurassic chert. Concentrated distribution as indication for a late moment of knapping. (B) Nodule JB, Jurassic chert. Random distribution as an indication for an early moment of knapping: 1, cores; 2, chunks; 3, modified artifacts; 4, blades; 5, cortical blades; 6, micro-débitage; 7, flakes; 8, cortical flakes; 9, hearths.

beginning of the occupation while the nodules with concentrated artifacts should have been worked towards the end.

Using these different types of horizontal distribution, some unexpected results can once again be demonstrated (Table 7). Nodules of foreign raw material were knapped at the beginning of the occupation. This is not very surprising because they would have been imported from a previous campsite in the region of the Jurassic chert sources. From the beginning, local chert was also integrated into the raw material supply. However, it can be demonstrated that foreign material was not only worked in the initial phases, but throughout the entire occupation sequence. This means that foreign nodules were either stored throughout the entire occupation, or, alternatively, were brought to the site through a system of embedded procure-

ment from hunting camps located in the region of the raw material sources.

Discussion

The supply of lithic raw material during the Mesolithic in southwest Germany is characterized by two phenomena: (1) useful lithic raw material could be found in each geographical region, and (2) Mesolithic flint knappers had all the technological skills necessary to produce artifacts out of each raw material. In spite of these two phenomena, all Mesolithic assemblages in southwest Germany are dominated by Jurassic chert. Jurassic chert was even transported over distances of up to 50 km as complete nodules. However, in contrast to late Upper Paleolithic assemblages, no lithic raw materials were transported over longer distances (Auffermann, 1998; Floss, 1994; Hahn, 1987).

In Mesolithic times, the supply of Jurassic chert was obviously based on a well organized, complex system. The simple assumption that the frequency of a raw material in an assemblage is related to the distance of the site from the source of the raw material does not apply to Jurassic chert in the Mesolithic of southwest Germany. There are, indeed, small numbers of retouched pieces, microliths, or blades in nearly all assemblages which are made of Jurassic

Table 7
Proposed moment of knapping of lithic nodules in the settlement sequence of Siebenlinden 2 (Kieselbach et al., 2000, p. 188)

	Foreign	Local
Very concentrated = very late	0	0
Concentrated = late	2	2
Medium	4	6
Random = early	3	4
Total	9	12

chert and cannot be assigned to identified nodules. These finished artifacts were manufactured outside the sites in which they are found, to which they were brought in primary tool kits. In addition, however, complete nodules of Jurassic chert were transported, and their frequency is independent of the distance from their source. Thus, in the procurement of lithic raw material in the Mesolithic of southwest Germany there was normally a constant number of nodules made of foreign Jurassic chert per time unit. Only if there was specific need, for example, when supplies of Jurassic chert were depleted, were artifacts made of local raw materials.

The variability of the lithic raw materials in the Mesolithic of southwest Germany seems to be surprising. It appears at first sight that the exploitation of resources in the Mesolithic of southwest Germany was diverse, with some features suggestive of a highly opportunistic pattern of subsistence. But on closer inspection, the supply of lithic raw materials was well organized. Problems of supply were avoided through the regular transport of the best raw material in the region, probably as part of an embedded procurement strategy in the more distant uplands.

The Swabian Jura with its sources of chert was the central region for the procurement of lithic raw material. It was surrounded by regions with only inferior quality chert. From the highlands of the Jura, high quality nodules were carried to areas at a distance of up to 50 km. That means, if we want to exclude an organized trade of lithic raw material, that all local bands in the area must have had access to the sources on the Swabian Jura.

The distribution of lithic raw materials in the different subregions of southwest Germany shows one further detail (see Table 2). As at other sites, the assemblages which were found on the Swabian Jura also yield small numbers of artifacts which were made of foreign raw material. These few artifacts, mainly modified tools, microliths, or blades, are made of radiolarite or Triassic chert. They again reflect transport as parts of primary tool kits. However, no lithic raw material was transported from one side of the Swabian Jura to the other. There is no Triassic chert in the morainal landscape and no radiolarite in the cuesta region.

This complementary distribution of lithic raw materials in the Mesolithic of southwest Germany indicates that there were different areas of supply. Obviously the inhabitants of the morainal region had no access to the sources in the cuesta region and vice versa. Thus, the distinctive spatial distributions of lithic raw materials may possibly reflect the borders

of Mesolithic territories. Two sites may be used to exemplify this (see Table 2). The late Boreal layer of Siebenlinden yielded both Triassic and Jurassic chert and, as has been shown, is a typical example of a site supplied with Jurassic chert. In layer 8 of Jägerhaus cave, also dated to the late Boreal, 97% of the artifacts were made of Jurassic chert, but a few artifacts were made of Upper Triassic chert as was also found in Siebenlinden. As a model, both sites could belong to a possible territory with a dimension of about 4000–6000 km². The size of this area corresponds very well with territories of recent hunters and gatherers in temperate forests (Kelly, 1995). This possible Mesolithic territory enclosed hills and mountains on the highlands of the Swabian Jura and was bordered by two rivers, the Danube and the Neckar. Thus, many different resources could be found inside this area.

Up until now, the supply of lithic raw materials has been analysed in detail for only a few Mesolithic assemblages in southwest Germany. Therefore, it is not currently possible to define a more complete system of territories. Better defining this territorial system will be an important aim of future research.

Conclusions

The supply of lithic raw material in the Mesolithic of southwest Germany was dominated by chert coming from Jurassic sediments. Mainly, complete nodules of this material were transported among campsites, while local material from the different geographical subregions was added only as needed to supplement the supply of raw material. Sometimes the amount of local material increases to more than 50% of the processed nodules, whereas at other times only few local nodules were knapped. The distributions of lithic raw materials in the Mesolithic of southwest Germany indicate that there were different areas of supply. These areas possibly reflect former territories of the Mesolithic hunters and gatherers.

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