Przegląd Archeologiczny
Vol. 30: 1982, pp. 47-80
PL ISSN 0079-7138

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FLINT MINING AMONG THE EARLY FARMING COMMUNITIES OF CENTRAL EUROPE. PART II — THE BASIS OF RESEARCH INTO FLINT WORKSHOPS

This article is the continuation of my study in „Przegląd Archeologiczny", vol. 28:1980 (Lech 1981a). Here, research into flint processing workshops is presented, and their origins characteristics, and occurrence in the LBK are discussed. Differentiated flint workshops are known from the Lengyel-Polgar complex in Little Poland. Using existing finds an attempt was made to define the main production trends of workshops on the sites of mines, and other raw material exploitation points, in Central Europe and adjoining regions.

Flint mines were usually centres for the mass processing of raw material on a scale rarely met in settlements and encampments. This aspect of prehistoric mining has not often received enough attention in concrete studies of materials from mines, although the significance of the problem has sometimes been recognized in the archaeological literature (Krukowski 1939-1948-I, 101 f.; Clark 1957-I, 204–217; Piggott 1954-I, 36 f.).*

I. ORIGINS OF RESEARCH INTO FLINT WORKSHOPS

Interest in flint mines in West Europe and in North America also drew attention to flint processing workshops. American research in particular has represented a great advance in this, making use of numerous observations on recently abandoned (and hence well-preserved) flint mines and also ethnographic data (e. g. Holmes 1894-I). W. H. Holmes drew together the results of many years of work on mines and workshops in his *Handbook of Aboriginal American Antiquities* published in 1919. Here he analyses the nature of workshops on the site of mines and the related problems of work specialisation:

> The hunter and warrior were able to supply themselves at slight cost of labour with weapon points as emergency required, and efficient hammers, axes, knives, picks, scrapers and the like were made with ease. The more highly specialised forms required time and in many cases no doubt, where there was no need of haste, the work was gradually brought to completion by intermittent labour. Where materials were plentiful and the demand great, implements, and especially implement blanks of certain classes, were often gotten out in numbers, and the sites became workshops or factories, and there was an opportunity for, and no doubt a tendency toward, specialization of labour. It was more convenient and profitable where separate operations, each requiring special skill, were involved, to have individuals or groups of craftsmen give exclusive attention to the separate steps: First, to quarrying; second, to breaking up the material and selecting choice available pieces in numbers; third, to roughing out blank forms in numbers; and fourth, to the work of trimming, specializing and finishing. This would apply more especially to the fracture-made implements. These four well-defined steps gave rise to separate industries carried on by the same individuals at different times or places, or by distinct groups of experts at convenient times and places. It would seem that the second and third steps, whether performed by one or by two groups of workmen, were generally accomplished on the spot yielding the raw material. It would be unprofitable to transport for long distances masses of material of which nine-tenths would finally, from the vicissitudes of fracture, be consigned to the refuse heap. The blank forms of articles to be shaped, worked out so far as to test thoroughly the material and its capacity for specialization in desired directions, were removed from the sources of supply, to be finished when convenient or when need demanded (1919-I, 280).

Although interest in flint mines developed early, for many years scholars could not surmount the organizational barrier which led them to concentrate on finished tools, or on tool forms at a very advanced stage of preparation. One reason for this was the greater effectiveness of shafts, and another, the apparent uniformity of the enormous mass of waste material rejected in processing, containing only a minimal quantity of tools

* The literature cited marked by I (e.g. Krukowski 1939-1948-I) were already listed in the bibliography of the previous study — Part I, „Przegląd Archeologiczny", vol. 28:1980, (Lech 1981a), p. 51–55.

and small numbers of nearly completed semi-products. In this situation it was natural to pay attention only to the more advanced forms of semi-products and tools, removed from the context of production waste (e. g. Armstrong 1926-I; 1934-I; Stone 1931-I; 1935; Żurowski 1962-I; Gurina 1976-I). It is typical that until the 1970s there were no publications at all which dealt with the structure of workshops, or the characteristics of the waste material, and used these data to reconstruct the process of flint working.

Workshops for processing flint on sites where the raw material was easily available are one of the earliest forms of specialization in human labour. Their origin was conditioned by diversity in the geographical environment, together with a rising demand for larger quantities of high quality raw material. As W. H. Holmes rightly observed, the final product always weighed considerably less than the natural flint nodule. Because the greatest reduction in weight was effected during the first stage of processing which was intended to form the general shape of the final product, raw material exploitation points became the sites for this work. In other words, the beginning of flint industry workshops on the site of mines was determined by the reduction in weight of successive series of waste flakes struck off during production processes; this was often supplemented by unsuccessful initial forms, sometimes very large, and exploited, useless cores. The observations made by M. Newcomer (1971) during experimental preparation of handaxes (Fig. 1) provide an example showing the weight of waste flakes at various stages of processing. There was an analogous situation in the preparation of other bifacial tools and also in the preparation of cores to produce blade blanks.

In the northern part of Sudanese Nubia, in the Wadi Hafa region, well-preserved workshop sites have been discovered, together with shallow pits for open-cast exploitation of ferrocrete sandstone — published as site 1033 and Arkin 5 (Chmielewski 1968, 135–146; Marks 1968, 284; Wendorf 1968, 1043 f.). These sites are linked with the Nubian Mousterian and Nubian Middle Palaeolithic with Sangoan elements. The materials from the sites are clearly different from the dwelling sites with processing and use of ferrocrete sandstone which are also found in this region — the difference lying mainly in the very large amount of industrial waste at the mine sites, and far fewer tools. These latter characteristics both remain typical of workshops on the site of mines in later periods also. Gradually, as work specialization increases, the proportion of tools in relation to waste material on the site of mines will greatly decrease. Thus, within the framework of the specialization of semi-product and tools production, the beginning of the process of the division of labour can be seen very early in archaeological materials. From this moment, it influences the structure of primitive society and the intellectual development of man, through changes in the economy (cf. Lech 1981a, 19).

In Central Europe, the archaeological sources confirm that there were separated workshop-type sites linked with the exploitation of stone raw materials in the

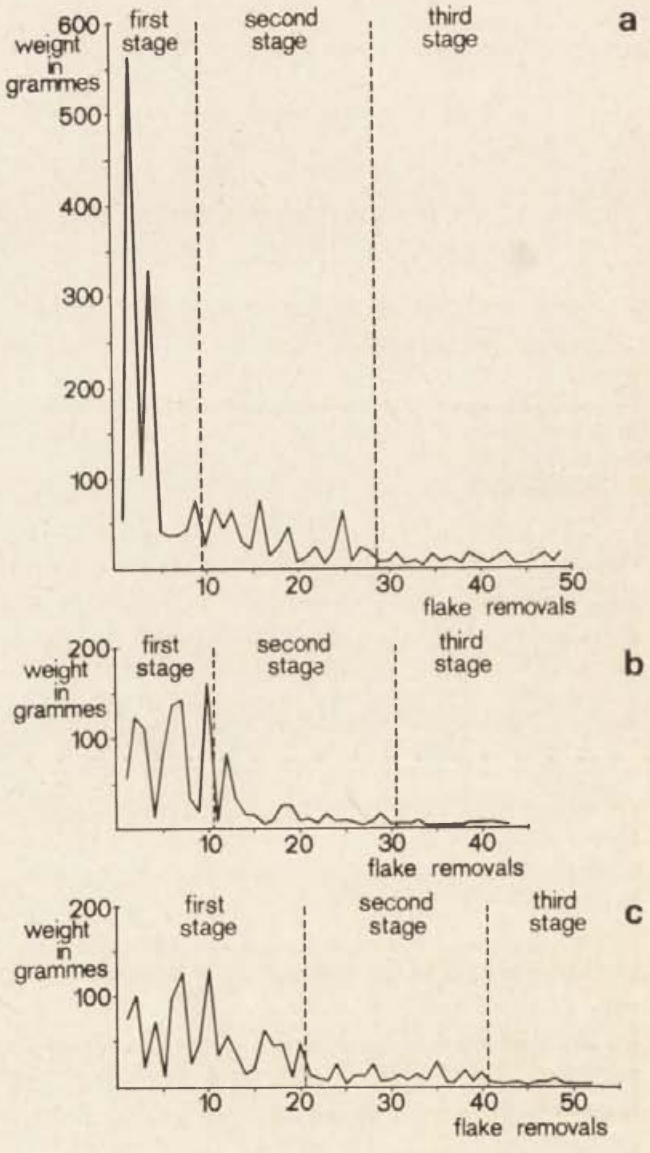

Fig. 1. Graphs showing the weight of handaxe waste flakes made experimentally plotted in their order of removal

a — flakes 1–5, 7, 11, 20, 27 are hammerstone struck, the rest soft hammer; *b* — flakes 1–8, 10 are hammerstone struck, the rest soft hammer; *c* — flakes 1–10, 13–19 are hammerstone struck, the rest soft hammer

After M. H. Newcomer

Upper Palaeolithic (Kozłowski 1967-I), and that there was a big growth in flint processing on the site of deposits in the Late Palaeolithic (Schild 1969; 1975; 1976a-I; 1980; Ginter 1974-I).

Flint working on the site of a mine or in related encampments and settlements near to the mine, and also working during transport to more distant settlements, comes under the general heading of mining. The

key to understanding the organization of work linked with mining and raw material processing in the early farming communities lies in comparative analysis of production remains in mines, settlements and encampments. This is more significant in the prehistoric context than analysis of shafts, for the location and size of these was determined by the quantitative and qualitative demand for raw material. The size and character determined the place and scale of exploitation and also, as well as natural conditions, influenced mining methods.

Analysis of mass production remains which bear the marks of assemblages, or their representative parts, based on comparison of the basic structure of the materials and observable changes in their fundamental characteristics, is the most certain way to reconstruct the organization of work on the site of the mine and the model, or models, of supplying the settlements with raw material. The dissemination of raw material of a given kind is a vital element in research, in order to reach conclusions about links between communities, models of distribution, and the role of exchange. The starting point for analysis, in order to arrive at the correct interpretation of materials remaining from flint processing, must always be the reconstruction of the end products of the workshop and the techniques by which they were produced. Unfortunately this is the only kind of information that we have at the moment about many of the mines in Central Europe. Moreover, even within this narrow scope, information is often incomplete for usually there is no information at all on the trends in flint processing in some prehistoric flint mining regions — for example, the Hungarian mines. Thus, here we must confine ourselves to presenting the processing of Jurassic-Cracow flint in the southern Polish Jura and vicinity, on which more research has been done, and on some other regions. But there is still a great deal to be done in the field of research into flint industry workshops on the site of mines.

II. THE EARLIEST WORKSHOPS OF THE EARLY FARMING COMMUNITIES (LBK)

Workshops, that is sites where intensive working of raw materials was carried out, and distinguished by the number of finds and also their planigraphy and structure, already occur in the LBK. The excavation of the LBK settlement and cemetery at Vedrovice—Zábrdovice, Znojmo dist., in South Moravia, carried out by V. Ondruš (1976-I giving further bibliography), and which has already been referred to above (cf. Lech 1981a, 47; 1982/1983), has provided the most interesting materials. This settlement, which dates from the middle phase of LBK development in Moravia, is situated in an area of loess covered with black earth or brown earth, a few hundred metres from deposits of hornstone of the Moravský Krumlov type which was worked here on a mass scale. Finds in the settlement included long dwellings, numerous specimens from the chipping industries and bones. Nearby, a cemetery which had been linked with the settlement was discovered, and here more than 50 graves were excavated[1]. More than 20 thousand chipping hornstones were found, and among these there were also concentrations of stone and bone finds which correspond to the concept of a workshop (Ondruš 1976-I, 134, 137). These are pit 037/1966 and the cavity numbered 098/1972.

Pit 037/1966 measured 4 × 2.8 m and was 95 cm deep. At a depth of 25–50 cm, a circular hearth was revealed, 1.1 m in diameter (Ondruš 1976-I, 134). V. Ondruš discovered in the southern part of the pit a cache of blades of Jurassic-Cracow flint, a variety which, for example, was characteristic of the settlement at Kraków-Olszanica where it was processed on a mass scale (Milisauskas 1976-I, 33–46). This cache contains 9 blades, obtained from at least two cores. The blades are regular and are without a cortex or other natural surface on the upper side. With the exception of one blade, all have the top fragment bent over. The platforms of the core were prepared. Additionally there were two blades with the top fragment broken off, although this may be accidental. There was one blade, measuring 38 × 18 × 4 mm, with intentionally broken off top and base fragments. A core from Jurassic-Cracow flint and a very interesting cortex flake were also among the finds. The flake measured 39 × 21 × 6 mm. On the cortex surface there are clear traces of iron or manganese compounds. These traces are characteristic of flint nodules obtained from eluvial clays in the southern Polish Jura. The conclusion is therefore that the Jurassic-Cracow flint used in this settlement was from a mine. Among the specimens of the chipping industry which have been analysed, hornstone of the Moravský Krumlov type, obtained in the neighbourhood of the settlement, predominates. But there are individual specimens made from other raw materials (Table 1).

The structure of materials from workshop 037/1966 is interesting (Fig. 2). This does not differ significantly from the analysed sample of materials from the settlement (Table 2). Comparison by the χ^2 test gave the following result: $\chi^2 = 2.903$ (3), i. e. $0.50 > p > 0.30$. However, it is possible to find certain specific characteristics distinguishing the assemblage from pit 037/1966

[1] Information given to me personally by Dr. Vladimir Ondruš of the Moravian Museum in Brno. Here, I should like to express my deep gratitude to Dr. Ondruš for making the results of unpublished research available to me, and for giving me so much useful information and help.

Table 1. Structure of chipping industry raw materials in the settlement at Vedrovice—Zábrdovice (selected)

Raw material	Sample of materials from settlement (400 specimens) %	Assemblages	
		workshop 037/1966 %	workshop 098/1972 %
Moravský Krumlov type hornstone	80.50	76.2	39.0
Jurassic-Cracow flint	1.75	8.3	37.5
Erratic „Baltic" flint	3.00	1.2	2.9
Radiolarites or jasper	—	0.4	10.3
Quartz	—	1.2	—
Other and unidentified	14.75	12.7	10.3
Total	100.00	100.0	100.0

in comparison with the inventory structure of materials from a large number of "Danubian" community settlements (Lech 1981-I, 124–147). The primary distinguishing characteristics is the high frequency of occurrence of the groups covering nodules, pre-core and core forms. These indicate a wider range of activities linked with raw materials processing. On the other hand, blades do not occur frequently. Moreover, if we leave aside blade fragments, among 19 blade specimens which were twice as long as wide, 9 came from the cache of blades deliberately placed apart and made from a different kind of raw material (referred to above). This indicates that a part of the blade blanks obtained in the workshop are missing. The proportion of tools is lower than is usually the case in settlements (around 10%).

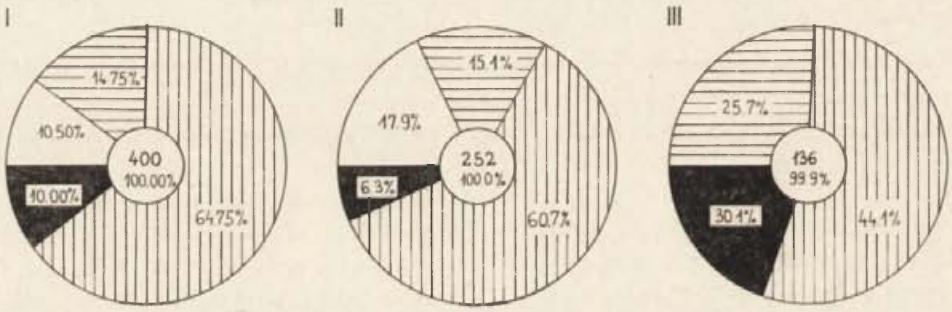

Fig. 2. Structure of chipping industry materials from the settlement at Vedrovice—Zábrdovice according to four inventory groups — Table 2

I — sample of 400 specimens from settlement; II — workshop 037/1966; III — workshop 098/1972. For explanation see Fig. 7

Table 2. Structure of chipping industry materials from the settlement at Vedrovice—Zábrdovice (Table 1), according to 4 inventory groups

Material	Inventory groups I natural nodules, pre-core and core forms %	II blades and blade fragments %	III flakes and other waste material %	IV tools %	Total %
Sample of 400 specimens from settlement	10.50	14.75	64.75	10.00	100.0
Workshop 037/1966	17.9	15.1	60.7	6.3	100.0
Workshop 098/1972	—	25.7	44.1	30.1	99.9

However, the most important aspect here is that the predominant category of tools were hammerstones (7 specimens); i. e. tools which were used in working of the raw material.

Pit 037 also contained tools and semi-products made from bone, as well as chipping industry specimens. The remaining flint tools were 6 end scrapers, a perforator and 2 macrolithic scrapers. These may have been used for working the organic materials, including bone. However, micro-wear study, which might have made it possible to confirm this, has not been carried out. Fragments of pottery with engraved ornamentation, pieces of graphite and lumps of burnt clay which had been deliberately shaped and fired were also found in the pit (Ondruš 1976-I, 134–137). V. Ondruš believes that the pit and materials found in it are the remains of a workshop where tools were made from chipped stone and bone, and where pottery was also made. The pieces of graphite and lumps of burnt clay discovered support this argument. Some of the bone tools of the awl type may have been used to decorate pottery. The discovery of two kilns in the vicinity of pit 037 would seem to argue in favour of this thesis. At the bottom of one of the kilns, the remains of unfired vessels were found, together with one badly fired vessel (Ondruš 1976-I, 137), V. Ondruš conclusions are confirmed by analysis of the chipping industry carried out independently according to principles worked out for the flint

industry of the Danubian communities in the Cracow region (Dzieduszycka-Machnikowa, Lech 1976-I).

In 1972, a shallow oval depression measuring 2.6 × 1.7 m was discovered in the settlement at Vedrovice—Zábrdovice and numbered 098/1972. The maximum depth in the loess ground was 30 cm. A concentration of bone and chipping industry materials was found in this depression with features that distinguished them from other specimens. The chipping industry materials moreover differed from materials from the settlement site or from workshop 037/1966, both typologically and in raw materials used. Strikingly, there is a considerably smaller proportion of materials from the local Moravský Krumlov type hornstone, and the large proportion, almost equal to this, of Jurassic-Cracow flint of the same variety found in workshop 037 (Table 1). There was a large quantity of radiolarities (jasper ?). The chipping industry, although represented by a small number of specimens, had a characteristic structure. There was a complete absence of nodules, pre-core and core forms or splinters. Blades and blade fragments clearly played a much greater role than in other materials analysed from Vedrovice-Zábrdovice (Table 2 and Fig. 2). The proportion of flakes and other waste material was much smaller, but there were three times more tools than in the sample of average materials from the settlement, and five times more than in workshop 037. In fact, workshop 098 differed in a statistically highly significant manner from the materials from the settlement and from workshop 037/1966, both in the structure of the inventories [in comparison with the settlement $\chi^2 = 27.453$ (3), and with the workshop 037, $\chi^2 = 38.86$ (3)] and in raw materials [in comparison with the settlement, $\chi^2 = 57.95$ (3), and with workshop 037, $\chi^2 = 39.92$ (3)]. In each case, the degree of statistical significance of the differences observed is $p < 0.001$.

The group of tools from workshop 098 is very interesting. From 41 artefacts, there were 26 perforators and borers, counting also specimens which formally were not entirely completed (i. e. with steep retouching on only one side). In addition to these, there was a fairly large group of end scrapers: 10 specimens. Finally, there were two truncated blades, two retouched blades and one trapeze. The absence of hammerstones should be noted, and it is also important that there is an absolute predominance of tools made from Jurassic-Cracow flint. There were 20 perforators and borers made from this material, and 6 end scrapers. Only 10 tools were made from Moravský Krumlov type hornstone. Such a big proportion of flint from the southern part of the Polish Jura may have been the result of its special properties. Its relative hardness, which is one of the highest for flint, gave it greater durability and ensured that it wore out more slowly when used to work tough materials (cf. Lech 1980-I, 218–221). V. Ondruš (1976-I, 137) observed clear traces of work on some borers.

The data collected to date suggest that depression 098 contained the remains and waste materials of a specialist workshop producing bone tools and composite tools made from organic materials with flint insets. The absence of cores and pre-core forms indicates that at least in part the workshop received ready-made blade blanks and perhaps also flake blanks. The large quantity of animal bones, bone tools and their semi-products suggest that they were made here.

Recent discoveries in the LBK cemetery at Vedrovice-Zábrdovice have offered interesting premises for the interpretation of workshop 098. V. Ondruš discovered there the remains of sickles[2] in the male graves No 46 and 57, excavated in 1977. The hafts must have been made from organic material which decayed readily; probably wood, as it has not survived. The existence of a haft is indicated only by the sickle-shaped arrangement of the insets. Two sickles were placed in grave No 46. The first was composed of 8 mid-blade fragments of radiolarites (jasper?). Five of these had retouching on one or both broken edges. In one case this was on the base fragment, and in the others on the top fragment. The insets for this sickle were made from three radiolarites blades, all in different colours. The second sickle was composed of 7 insets. Six of these were made from Jurassic-Cracow flint of a variety known, for example, from Kraków-Olszanica, and one from Moravský Krumlov type hornstone. Only two of the Jurassic-Cracow flint insets had retouching on one edge. The insets made from this raw material were produced from at least three blades. The third sickle, from grave No 57, was composed of 7 insets. Four of them were classical trapezes made from "imported" raw material, and the other three are blade fragments from Moravský Krumlov type hornstone, in two cases with retouching on one of the broken edges. The "imported" raw material was probably Jurassic-Cracow flint, but the light patina makes it impossible to identify the raw material with complete certainty. There is a possibility that this is erratic "Baltic" flint from the Racibórz region, or North West Moravia.

To sum up, of 22 insets in 3 sickles, as many as 18 were made from non-local raw materials. Analysis of the insets shows that the specimens made from non-local raw materials were of considerably better quality. They had stronger cutting edges (perhaps with the exception of the radiolarites?), and were more even and more penetrating than the insets made from Moravský Krumlov type hornstone. All the insets are similar in size, small. The largest specimen made from Moravský Kru-

[2] I am very grateful to Dr. Ondruš for making this revelationary find available to me before publication.

mlov type hornstone measures 17 × 18 × 2 mm; from radiolarites, 15 × 12 × 3 mm; from Jurassic-Cracow flint, 13 × 13 × 3 mm; and from "imported" raw material similar to Jurassic-Cracow flint or to erratic "Baltic" flint, 15 × 15 × 3 mm. The two smallest insets, from the second sickle, measure 9 × 9 × 2 mm (Jurassic-Cracow flint) and 11 × 9 × 2 (Moravský Krumlov type hornstone). Judging from the size of the insets, the quantity of insets in each sickle and their arrangement as given by V. Ondruš, all three sickles were made identically. They show that there was a defined technical concept of the sickle. In the light of the inventory of materials from feature 098/1972, it seems that the sickles were made in the settlement. The absence of traces of utilization suggests that they may have been made with the intention of placing them in graves. The fact that raw materials from far-distant deposits which had better properties in utilisation than the local hornstone, and also the cache of blades from pit 037 and the structure of the specimens in feature 098, all indicate that local LBK communities had an articulated ability to differentiate the raw materials occurring in the chipping industries.

More importantly, the characteristics of the materials from feature 098 enable us to identify it as the remains of a workshop producing composite tools. The differentiation in raw materials found here make it possible that all three sickles were linked with this workshop, or possibly another with similar characteristics. The trapeze found in feature 098 corresponds to specimens in the sickle from grave No 57. It seems in this case much less probable that all three sickles were obtained by exchange and only damage was made good locally (the hornstone insets). In any event, the unified type of composite sickle found in the graves at Vedrovice—Zábrdovice provides additional evidence that there were workshops in the settlement. These were both multifunction workshops (pit 037/1966) and specialist workshops with one line of production (098/1972). These belong to the category of dwelling-linked workshops, closely connected with the settlements which were the permanent residence of the communities and where they practiced agriculture.

V. Ondruš strongly emphasizes that features 037 and 098 are in other respects also exceptional in the Vedrovice—Zábrdovice settlement. A considerable number of the pits in the settlement are huge: they are often as much as 30 m in length. The features we have been discussing are among the smaller ones, which occur rarely in this settlement. But at the same time, their richness — both in the number of finds and in their diversity — is striking in comparison with the other features (Ondruš 1976-I, 137).

III. WORKSHOPS OF THE LENGYEL-POLGAR COMPLEX IN THE SOUTH OF THE POLISH JURA

At the moment, we do not know any LBK workshops with characteristics typical of those on the sites of mines. The specific characteristics of assemblages of this kind can be best shown by the example of materials from the Lengyel-Polgar complex in the South of the Polish Jura and the vicinity (Dzieduszycka-Machnikowa, Lech 1976-I; Lech 1981-I). Neither of the workshops in the Vedrovice—Zábrdovice settlement was a typical flint industry workshop. The working of stone raw materials was here not the only activity, but one of several. Usually, by the term flint workshop we understand a place where flint processing is the predominant activity. And a place of this type is usually easy to distinguish during excavations. The basic material mass is formed by flint production waste which accumulated in quantities many times greater than in the neighbouring areas of a given site. The proportion of finished tools is insignificant; usually it does not exceed 1 % on the site of mines and in the vicinity. Tools may however form a bigger group in workshops on settlement sites. The workshops at Vedrovice—Zábrdovice and the workshop at the Kraków-Pleszów settlement, pit 1/58/I/II/1961, give an idea of this. We will return to this problem later with some concrete examples.

A series of flint workshops have been discovered on the site of the flint mine at Sąspów Cracow dist. and in the vicinity, in the South of the Polish Jura (Dzieduszycka-Machnikowa 1962, Dzieduszycka-Machnikowa, Lech 1976-I; Lech 1972-I; 1981-I, 100-176). For example, in the area of the mining field, there was a workshop for pre-core and core forms (1/1971) and two workshops for core exploitation (1 and 3/1960) where blade blanks were produced. The original plan of workshop 1/1971 was preserved (Fig. 3). The larger diameter was 2.8 m and the smaller, 2.5 m. Within the outline of the workshop, on the northern side, there were empty places c. 0.8 and 1.3 m in diameter (Fig. 3a). The breakdown of the flint materials from the workshop indicates that this was the place occupied by the flint knapper during his work. The original arrangement of materials from workshops 1 and 3/1960 was not preserved. During the processing of the flint, the production waste, which accumulated in great quantities, was collected into pits which were probably the remains of shafts, partly filled in. This last view has however not been confirmed during excavations. Both the workshops were explored ten years before the first shafts were discovered on this site (Dzieduszycka-Machnikowa 1962; Lech

Fig. 3. Sąspów, Cracow dist., site 1. Flint mine. Workshop 1/1971

a – place where the flint-knapper probably sat; b – production waste from his work; *c* – other workshops and levelled waste heaps

Photo by J. Lech

1972-I). Materials from workshop 1/1960 were extracted from a round pit, 2.4 m in diameter and 130 cm deep. The remains of workshop 3/1960 were collected in a round pit 1.9 m in diameter and 135 cm deep. Observations made during the exploration of these pits, and analysis of the flint materials, indicate that production waste was intentionally placed in both these pits (Dzieduszycka-Machnikowa 1962; Dzieduszycka-Machnikowa, Lech 1976-I, 10–12).

In the Sąspów valley, about 500 m from the mine, there is a cave, called the ,,Pod kościołem" (Church cave), or sometimes the West Sąspów cave (Fig. 4). The excavation carried out here in 1970 by W. Chmielewski produced a rich inventory of flint materials linked with the mine, and also many fragments of pottery. These occurred in two layers (Marciniak 1974).

Interesting workshop materials linked with the Lengyel-Polgar complex are also known from other caves in the southern Polish Jura. These are different in character from materials from workshops on the site of mines or in settlements (Lech 1981-I, 152–168). However, as in the main they were found in excavations carried out many years ago and without proper documentation, great care is necessary in interpretation (Rook 1980, 5–8; Lech 1981-I, 147–152). We cannot exclude the possibility that the method of exploration and collection of finds influenced their structure. The best evidence that flint industry workshops with a different range of activities from those at mines or in settlements may have existed in caves is provided by the materials obtained in the "Church cave". Therefore we will mention only a few of the caves in the southern Polish Jura where flint materials of a workshop struc-

Fig. 4. Sąspów, Cracow dist. The "Church cave", or the West Sąspów cave

Photo by J. Lech

ture have been found: the Maszycka cave at Maszyce, Cracow dist., the Wierzchowska Górna cave at Wierzchowie Cracow dist.

The structure of materials from workshops on the site of mines and in their immediate vicinity (caves) are usually fundamentally different from chipping industry materials from settlements lying near raw material deposits (Table 3 and Fig. 7). The organization of work and flint working techniques were also differentiated in the area of the mine itself and in nearby workshops. Apart from selected blades, often corrected, cores, flakes and even nodules were taken to the settlements. Because of the nature of the flint industry of the Danubian communities, the whole production was directed towards the production of blades, and to a certain degree flakes. Workshops producing tools, usually composite, occur only in the settlements — see Vedrovice—Zábrdovice and Kraków-Pleszów, pit 1/58/I/II/ /1961. These are not known at all from mine sites.

Pottery sometimes occur in the workshops of the early farming communities. If this is found together with tools, it indicates that an encampment existed in the same place. In cases like this, the proportion of pottery may approach that of tools, as in workshops 1 and 3/1960, or camp activity is greater, as for example in layer II of the "Church cave", the proportion of pottery fragments may be as much as 10%. If there is considerably more pottery, the assemblage requires careful analysis. For we may be dealing not with a flint workshop, but with an encampment (layer IV from the "Church cave") or with some disturbance. In flint industry workshops in settlements, where the occurrence of materials which are not chronologically uniform is very likely, with the possibility that various types of activity overlapped within a short space of time, the proportion of pottery fragments may even exceed that of flint specimens. An example of this is provided by workshop 1/58/I/II/1961 at Kraków-Pleszów (Cabalska 1963; Godłowska 1963; Kulczycka-Leciejewiczowa 1969, 94).

In general, the flint workshops of the early farming communities can be identified on the basis of two criteria: planigraphic criteria, indicating a concentration of flint (Fig. 3) and structural criteria — a small proportion of pottery in relation to flint materials, a small proportion of tools, blanks and successful semi-products in relation to waste material. Flint materials remaining in the workshops, both unsuccessful specimens of blanks or semi-products and also the waste material from their production, indicate the particular phases of processing.

The range of structural differentiation in flint industry workshops is very great. This can be seen even within the framework of one cultural tradition — for example, the workshops of the Lengyel-Polgar complex from the southern Polish Jura which we will present below. On this basis, it is possible to differentiate the various categories of workshop. We have accepted the categories proposed by B. Ginter, worked out on the basis of analysis of workshops from the Late Palaeolithic epoch in the northern part of Central Europe (1974-I, 42 f., 82–84).

B. Ginter's concept is a development of the general lines laid down by S. Krukowski (1939-1948-I, 101 f.). Workshops are divided into: I — located off the area of settlements (extra-dwelling workshops); and II — close to settlements (dwelling workshops). The criterion applied here is the relationship of the location of the workshop to the dwelling of the flint worker. Usually there are specific characteristics connected with this in the materials. Workshops located off the area of settlements are sub-divided into: 1 — workshops located at exploitation points (on the site of mines); 2 — workshops located off the exploitation points in the immediate vicinity of mines. The criterion for categorisation is the relationship of the workshop to the raw materials exploitation point, either a shaft or other type. Workshops located off the exploitation points are usually from a few hundred metres to a few kilometres from the mines, depending on the geographical, and settlement organisation. In workshops a few hundred metres from mines there is usually a discernible difference in the composition of the materials. In the flint industry workshops of the early farming communities which we know, a distance of a few dozen metres from the raw materials exploitation point as the lower limit for the occurrence of characteristics typical of mine-vicinity workshops is not sufficient. This relates to the hunting and gathering communities of the late Pleistocene, studied by B. Ginter. But apart from this, contrary in fact to the opinion of this scientist himself, the categories of workshops which he laid down are confirmed also in research into raw materials exploitation and flint processing among the early farming communities (cf. Ginter 1974-I, 42, 83).

A clear distinguishing characteristic between workshops located at the exploitation points (mine-site workshops) and workshops located off the exploitation points (mine-vicinity workshops) is the low frequency of occurrence of natural flint nodules in the first inventory group (Cf. tables 2 and 3, giving the division into groups). The first inventory group for workshops dealing with the production cycle of blade blanks covers pre-core forms, cores and core fragments, splinters (*pièces esquillées*), and also the natural nodules suitable for core preparation which have been referred to already. When core tools are produced, their initial forms and semi-products are included in the group. For example, on the site of the Sąspów mine, natural nodules from 3.9% of materials in workshop 1/1960, 9.8% in work-

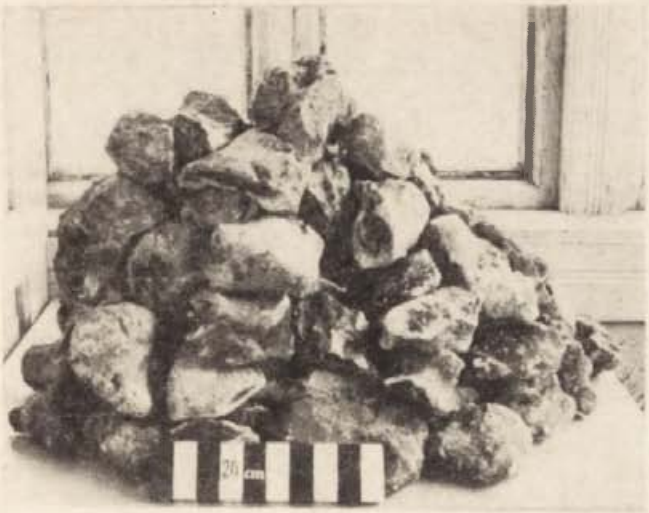

Fig. 5. Sąspów, Cracow dist., site 1. Natural flint nodules from workshop 1/1971 — see Fig. 3

Photo by J. Lech

shop 3/1960 and as much as 56.7% in workshop 1/1971 (Fig. 5). In mine-vicinity workshops and in dwelling workshops, we know only isolated specimens. However, in the mine-vicinity workshop in layer II in the "Church cave" there were no natural nodules at all. They are also very rare in settlements far distant from mines, but occur in greater numbers in settlements near deposits. In workshop 037 at Vedrovice—Zábrdovice, from 45 specimens in the first inventory group, there were 7 nodules, the source of which was several hundred metres from the site.

In the workshops excavated at the Sąspów mine, numerous fragments of nodules occurred and were placed in one group with flakes and flake fragments. They form about 10 to 60% of this third inventory group — flakes and other waste material. The presence of fragments of natural nodules, which wre unsuitable for further working because of their size, is even more characteristic of mine-site workshops than the presence of the nodules themselves (Fig. 6). The nodules were sometimes transported long distances for processing, but this was not true of small waste fragments of nodules. They are practically missing in the materials from the "Church cave" and have rarely been found in settlements excavated. In the Lengyel-Polgar community settlements at Iwanowice, Cracow dist., the proportion of natural nodule fragments in the flake and waste material group is 0.4% (in the Malice group settlement) and 1% (in the Modlnica group settlement). Even at Vedrovice—Zábrdovice, despite the proximity of deposits, there was only a small proportion of these fragments. In workshop 037, they formed 4% of materials, in workshop 098, 5%, and in the sample of materials from the settlement, only 2.4%. In view of the proportion of nodules and nodule fragments in workshop 037, we should conclude that there are two cross-currents operating here: the predominant characteristics of a dwelling workshop, and much more faintly, but still clearly, the characteristics typical of a mine-vicinity workshop. This reflects the proximity of raw material deposits which we have mentioned.

Fig. 6. Sąspów, Cracow dist., site 1. Fragments of natural flint nodules from workshop 1/1971 — see Fig. 3

Photo by J. Lech

Assemblages which are directly linked with encampments occur among mine-site workshops. These are identified by the presence of pottery fragments and tools with domestic characteristics — e. g. workshops 1 and 3/1960 from the mine at Sąspów (Dzieduszycka-Machnikowa, Lech 1976-I, 102–114, 121 f.). Workshops without remains of materials of this type are however much more common (workshop 1/1971). The mine-vicinity workshops a recharacterised by analogous differentiation. Of these, site Sąspów III and the rock shelter no 360 in the Sąspów valley are examples of workshops not linked with flint knappers camps. The materials from layer II at the "Church cave" provide a characteristic example of a workshop on the site of a camp.

Analysis of the materials from workshop 1/1971 showed that this was a workshop in which pre-core and rudimentary core forms were prepared (Lech 1981-I, 103–109). Nodules were brought to the workshops, together with considerable quantities of small natural flint fragments. The nodules were selected and initial preparatory work was carried out to prepare pre-core and initial core forms. Many nodules were discarded without any work being undertaken on them. This is indicated by the preponderance of natural nodules in the materials in the first inventory group 56.7% (Fig. 5). Various kinds of pre-core forms formed 37.1% and cores only 6.2%. Workshop 1/1971 undoubtedly belonged to the group of workshops in the flint processing cycle which dealt with blade production. The exceptionally low percentage of cores resulted from the fact that the aim of the working was to prepare forms from which blades could be obtained, and not to prepare

blade blank. The cache of 15 pre-core forms and pre-cores with wedge-like bifacial pre-flaking surfaces made from Jurassic-Cracow flint, which was discovered on the site of the settlement at Výčapy-Opatovce, Nitra dist.,[3] provides emphatic evidence of the demand for specimens of this type. This lies in the northern part of the West Slovakian Plain, about 220 km to the South of the Polish Jura. The nodules examined were of almost uniform size. Of the 11 specimens measured, the largest diameters varied between 122 mm and 144 mm.[4] The nodules came from deposits in eluvial clay — this is indicated by the well-preserved cortex with black superficial traces of iron or manganese compounds. The uniform preparatory working on the specimens examined indicates that they were produced in a mine-site workshop, or in the neighbourhood of a mine. The workshop 1/1971 produced similar forms. The cache at Výčapy-Opatovce indicates that these formed one of the categories taken away from the mine.

The characteristic pattern of the structure of materials from workshops dealing with pre-core and core forms is that there is a higher proportion of specimens than usual in the first inventory group, an exceptionally low proportion of blades and blade fragments and a high proportion of flakes and other waste material (Table 3 and Fig. 7). In the flakes and waste material

Table 3. Structure of flint materials from selected assemblages and sites of the Danubian communities linked with the processing of Jurassic-Cracow flint, according to 4 inventory groups[5]

Materials	Inventory groups I nodules, pre-core forms, cores, splinters %	II blades, blade fragments %	III flakes, other waste material %	IV tools %	Total %
Sąspów					
Workshop 1/1971	7.06	1.02	91.59	0.33	100.00
„ 1/1960	4.20	26.58	69.15	0.07	100.00
„ 3/1960	4.35	28.33	66.94	0.38	100.00
Cave, layer II	1.41	66.24	31.46	0.88	99.99
„ „ IV	2.50	41.40	53.70	2.50	100.00
Other caves					
Wierzchowska Górna	3.85	51.18	28.91	16.06	100.00
Maszycka	8.03	16.38	64.99	10.60	100.00
Settlements					
Iwanowice, Malice group	2.50	30.00	62.76	4.74	100.00
Iwanowice, Modlnica group	14.50	26.80	48.60	10.10	100.00
Kraków-Pleszów workshop 1/58/I/II/1961	3.58	29.80	58.85	7.77	100.00
Modlnica, Cracow dist.	8.74	18.59	60.19	12.47	99.99
Niemcza, Wałbrzych dist.	9	42	21	27	99

group, there is a noticeably low proportion of technical flakes struck off from the core during exploitation. In workshop 1/1971 they formed 0.5%, while in core exploitation workshops 1 and 3/1960, they formed respectively 3.4% and 3.3% — i. e. roughly six times more. There were still more of these materials in settlements lying close to deposits. In the Malice group settlement in the Iwanowice Lengyel-Polgar complex, they formed 5.2% and in the Modlnica group settlement, as much as 6%. Moreover, the high percentage of complete cortex flakes among flakes is noticeable (33.8%). From 9 tool specimens, as many as 7 are hammerstones —

[3] This hoard was found in pit no 3, in sounding trench no XXXV, at a depth of 45 cm, near to pits no 2 and 4. It was wrongly linked with the LBK settlement of the Želiezovce phase on this site (e.g. recently by Pavúk 1970, 47). This mistake probably arose because pit no 3 in the nearby sounding trench no XXXIX really did belong to the LBK. In the neolithic material from the site at Výčapy-Opatovce there is an absolute preponderance of Lengyel culture material, and little from the LBK. The manner of preparation of the striking platforms and the dimensions of blades which could be obtained link this hoard with the Lengyel culture. Here I should like to thank Professor Anton Točik Dr Sc. and Dr Juraj Pavúk C. Sc. for making available to me the documentation of the excavations, and for discussing the chronological problems of the hoard with me.

[4] Specimens in the Museum at Bojnice, Prievidza dist., inventory no 2948, made available to me by Dr Marta Remiašova.

[5] The structure of the materials from the "Church cave" is given on the basis of B. Marciniak's study (1974); that of the materials from the Wierzchowska Górna and Maszycka caves on the basis of E. Rook's study (1975); that of the workshop in the Kraków-Pleszów settlement on the basis of M. Cabalska's publication (1963); and that of materials from the Modlnica settlement on the basis of S. Kowalski's study (1955). The materials from the Modlnica group at Iwanowice were made available to me for study by Mrs. A. Dzieduszycka-Machnikowa, M. A., and Professor J. Machnik, and I should like to extend my warm thanks to them here. Differences in the figures given for the IIIrd and IVth inventory groups at Niemcza, compared with other publications of mine, are because additional specimens from excavations in 1972 have now been taken into consideration (Lech 1981-I, 128; 1981b); and differences in the structure of materials from the Pleszów workshop, compared with earlier publications, are because of faulty calculations made at that time (Lech 1975 b-I).

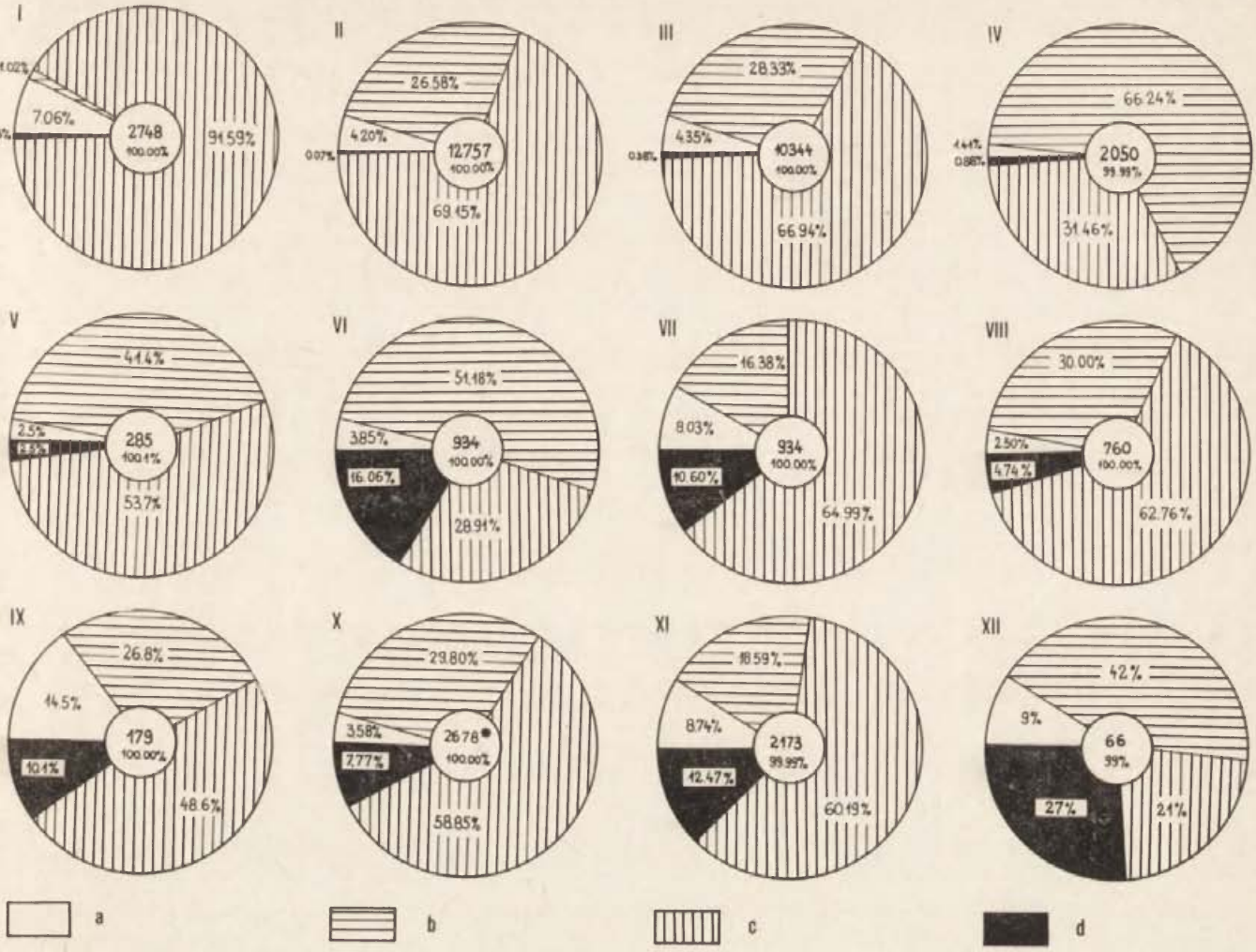

Fig. 7. Structure of flint materials from selected assemblages and sites connected with treatment of the Jurassic-Cracow flint according to four inventory groups — Table 3

a — Ist group — natural flint nodules, pre-cores and cores; *b* — IInd group — blades and fragments of blades; *c* — IIIrd group — flakes and waste; *d* — IVth group — tools; I–III Sąspów, workshop 1/1971 (I), workshop 1/1960 (II), workshop 3/1960 (III); IV, V — Sąspów, the "Church cave" — West, leyers II and IV; VI — Wierzchowie, Cracow dist., Wierzchowska Górna cave; VII — Maszyce, Cracow dist., Maszycka cave; VIII — Iwanowice, Cracow dist., materials from the Malice group settlement of the Lengyel-Polgar complex, where flint was treated; IX — Iwanowice, Cracow dist., materials from the Modlnica group settlement of the Lengyel-Polgar complex where flint was treated; X — Cracow-Pleszów, workshop 1/58/I/II/1961 at the settlement of the Lengyel-Polgar complex; XI — Modlnica, Cracow dist., materials from the Modlnica group settlement of the Lengyel-Polgar complex; XII — Niemcza, Wałbrzych dist., materials from the LBK settlement of flint-users

*Without obsidian artifacts

i. e. tools connected with flint working. The complete absence of pottery, and the discovery of only two tools apart from hammerstones (end scraper and burin), indicate that the flint knappers encampment must have been elsewhere. The materials from layer IV at the "Church cave" provide an example of the remains of an encampment of this type.

Workshops 1 and 3/1960 at the Sąspów mine were completely different in materials structure. Analysis of the materials suggests that these were workshops producing blade blanks (Dzieduszycka-Machnikowa, Lech 1976-I, 56–62). In comparison with flint materials from workshops processing initial and pre-core forms, these have a smaller proportion of specimens from the first inventory group, usually varying between c. 3.5 and 4.5%, a high proportion of blades and blade fragments (25 to 30%) and a smaller proportion of flakes and waste material — c. 60 to 70% (Table 3 and Fig. 7). The percentages given should be treated as approximate; and excavation of a greater number of workshops may make it possible to correct these figures. The structure of the first inventory group is completely different from that of workshop 1/1971. The proportion of natural nodules does not exceed 10%, while cores and core fragments form 60% of the materials in the group (for more details cf. Dzieduszycka-Machnikowa, Lech 1976-I, 39–43 and 62–71). Single platform blade cores form the basic group among cores in both workshops. They represent 97.6% of the 407 cores in workshop 1/1960, and 95.9% of the 268 cores in workshop 3/1960 (Fig. 8).

Blades and blade fragments form a very important group in core exploitation workshops. These are rejects in the selection of blade blanks which were taken from the workshop. The remaining blades are usually irregular in shape and have faults in the raw material.

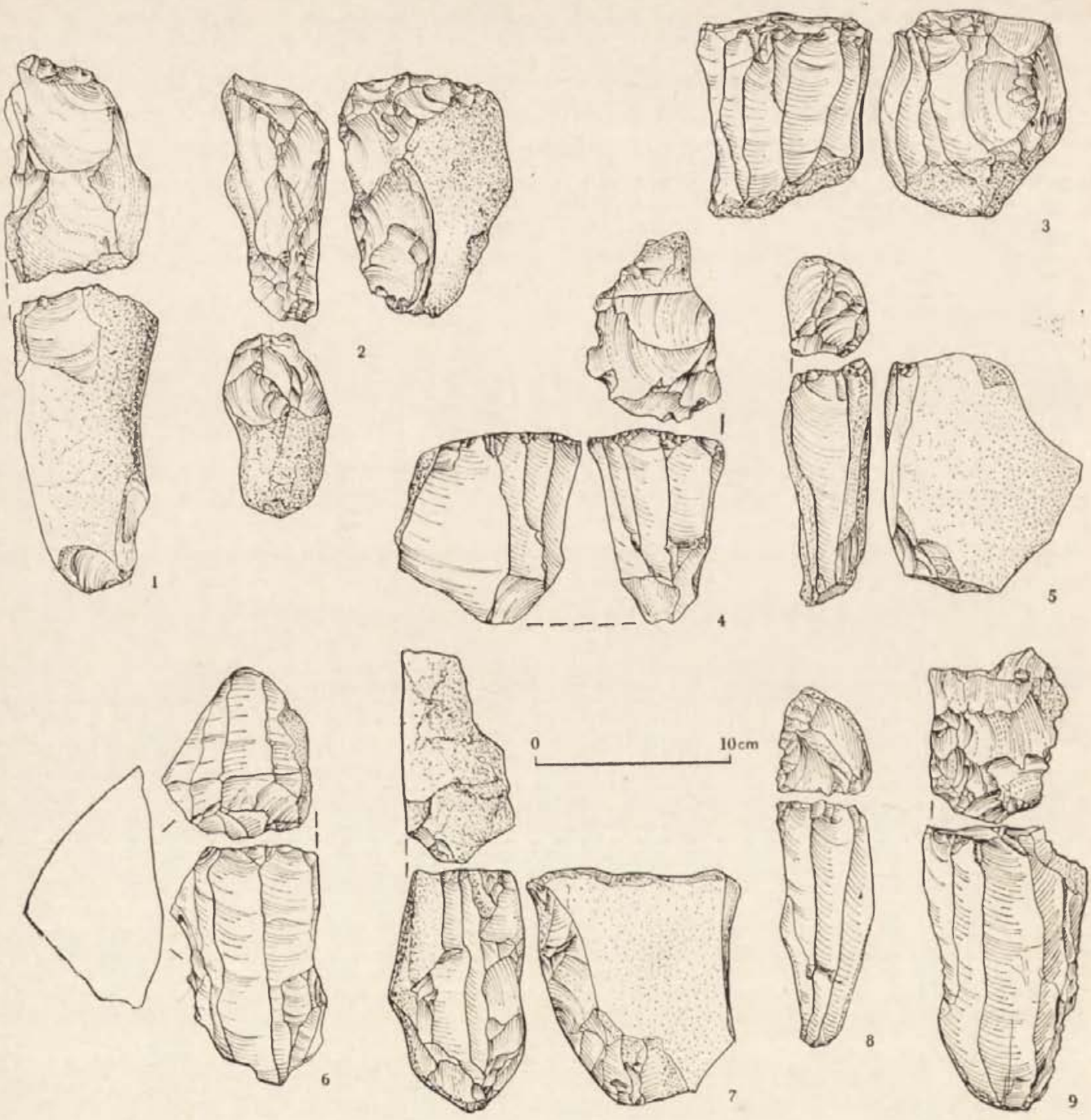

Fig. 8. Sąspów, Cracow dist., site 1. Pre-cores (*1*, *2*) and cores (3–9) from workshops 1 and 3/1960
After A. Dzieduszycka-Machnikowa, J. Lech

Regular blades are found only very rarely. Figures 9-11 show the best specimens among almost 1500 blades from workshop 3/1960. In both workshops, some of the blades were corrected (Fig. 10 and 11). In this way, the quality of the blades as potential semi-products was raised by the removal of their most irregular parts. As a result of this corrective working, 24.1% of the second inventory group specimens from workshop 1/1960 are base, middle or top fragments of blades, broken off by the flint knappers. In workshop 3/1960, these form 36.2% of the materials.

The differences in structure between pre-core form workshops and core exploitation workshops are directly and closely linked with the different activities carried out in both these types of mine-site workshop (Fig. 12).

The materials from layer II of the "Church cave" are different again in structure. The inventory structure indicates that mainly blades, and to a certain lesser degree pre-core forms and cores, were carried to the cave (Table 3 and Fig. 7). In the workshop, correction processes and selection of the blades were carried out. Moreover, to a certain degree there was some additional working done on the pre-core forms and cores. Core exploitation was also carried out here, and also undoubtedly additional selection of cores and pre-core forms before they were taken to their destination.

Fig. 9. Sąspów, Cracow dist., site 1. Selection of the finest, unbroken blades from workshop 3/1960

Scale 5 cm

Photo by S. Biniewski

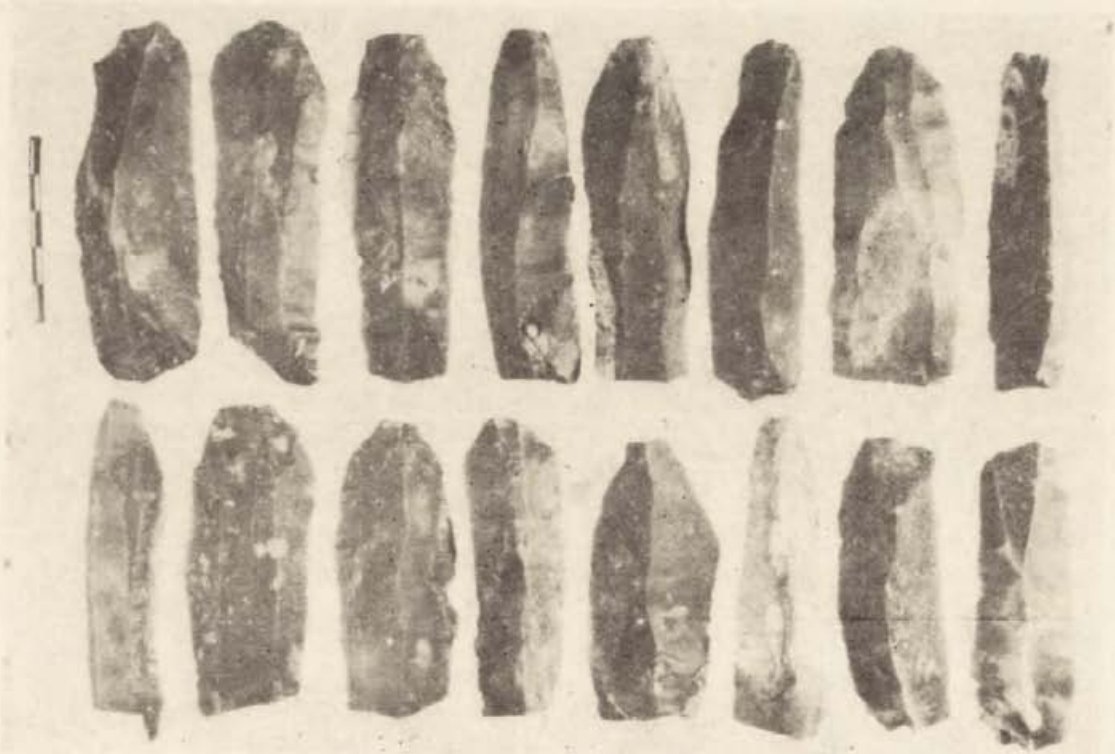

Fig. 10. Sąspów, Cracow dist., site 1. Selection of the best blades (without their top fragments) from workshop 3/1960

Scale 5 cm

Photo by S. Biniewski

Fig. 11. Sąspów, Cracow dist., site 1. Selection of the best blades (without their base fragments) from workshop 3/1960

Scale 5 cm

Photo by S. Biniewski

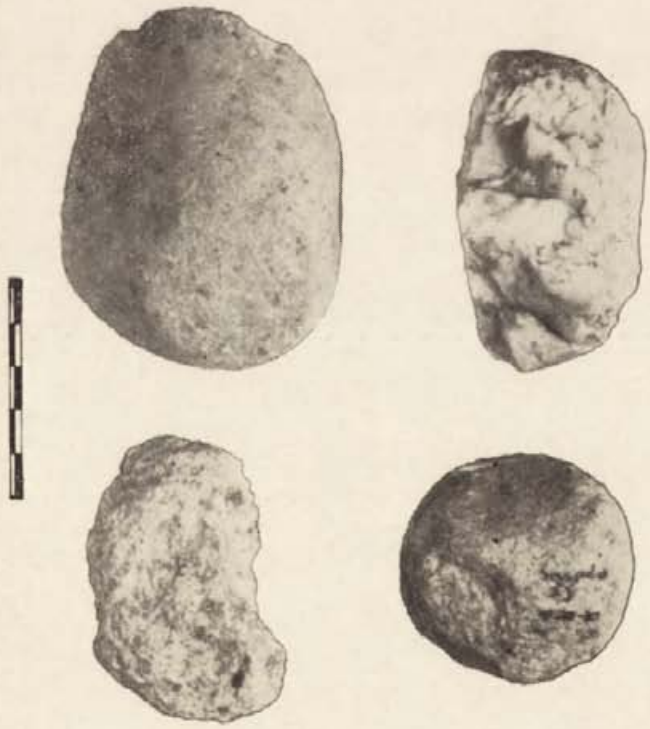

Fig. 12. Sąspów, Cracow dist., site 1. Hammerstones from workshop 3/1960

Scale 5 cm

Photo by S. Biniewski

As the cave floor deposits in the Atlantic period grew slowly, it is probable that the materials obtained in layer II are the remains of more than one habitation of the cave. This being the case, the materials would indicate the character of this habitation. However, in this particular instance it does not affect our conclusions. Processes linked with the correcting and selection of blades were predominant, and therefore blades and blade fragments are most numerous. The proportion of these is almost twice as great as in other materials studied (Table 3, Fig. 7). Nearly half of this group is made up of blade fragments (49.5%). Among 29 specimens from the first inventory group there were as many as 10 pre-core forms. These were probably left behind after additional selection before transport to the settlement. The 296 pottery fragments from the Lengyel-Polgar complex, and a somewhat greater proportion of tools, are the remains of the encampment linked with the workshop. This is further confirmed by the large quantity of charcoal ash on the bottom of layer II and also the fact that many specimens are burnt (Marciniak 1974, 7).

Activities connected with core exploitation and the correction and selection of blades were carried out in the "Church cave" and in workshops 1 and 3/1960. But the fundamental difference between the two types of workshop lies in the fact that the activities decisive in the formation of layer II were correction and selection of blades, while in workshops 1 and 3/1960 core exploitation was decisive. This is plainly apparent in the general structure of the assemblages (cf. also Lech 1981-I, 110–122). In core exploitation workshops, the processes of corection and selection of blades, although important elements of the work cycle, were only of secondary importance compared with the shaping of cores and the production of blades. In the layer II workshop, however, blade production was of secondary importance.

The small number of finds from layer IV in the "Church cave" were concentrated around the hearth (Marciniak 1974, 8 f.). The relatively small quantity of flint (285 specimens) and the considerable number of pottery fragments (163) indicate that this is the remains of an encampment. This is supported moreover

by the proportion of tools, which at 2.46% is greater than in layer II or in the mine-site workshops. Although the inventory structure approximates to that of the core exploitation workshop, flint processing was not carried out here on a major scale (Table 3, Fig. 7). The number of flints given could have been produced by a small workshop in the settlement.

The character of the assemblage is also determined by the composition of the first inventory group. This included 2 natural nodules, 3 pre-core forms and only 2 cores. The second inventory group shows that there were at least 66 blades in the assemblage. We may therefore conclude that natural cores and pre-core forms were brought to the cave from the mine. Here they were, to a minor extent, additionally prepared and selected. Partly corrected and selected blades were also brought here. The relatively high proportion of blades with traces of core preparation (7.6%) may also confirm that there was trial core exploitation and blade selection. The high proportion of negative flakes (68.7%) indicates that most of the pre-core forms brought to the cave had had the cortex removed elsewhere. On the whole, flint processing was of less importance here than activities connected with the encampment.

The Wierzchowska Górna cave is about 1.5 km from the flint mine at Bębło, Cracow dist. The most important characteristics of the flint inventory is the very high proportion of blades and blade fragments (51.18%). This is accompanied by a high frequency of occurrence of tools, primarily specimens made from blade blanks (Table 3, Fig. 7). The proportion of specimens from the first inventory group corresponds to that in core exploitation workshops, and there are exceptionally few flakes and waste materials. These characteristics suggest that the Wierzchowska Górna cave had a special function in the Atlantic period. The large quantity of pottery fragments and tools (Fig. 7) indicates that the cave was intensively inhabited. In the waterless surroundings of the Bębło mine, this cave on the upper course of the Kluczwoda stream was an attractive habitation for groups of people. On the other hand, the structure of the flint inventory indicates that large numbers of blades were brought to the cave, probably for reasons analogous to those operating in the "Church cave" at Sąspów. Thus the blades and blade fragments found in the Wierzchowska Górna cave were the remains left after correction and selection processes before transport to further destinations. The exceptionally low proportion of flakes, among which nearly 93% are negative specimens, suggests that activities connected with the processing of pre-core forms did not play a major role.

The Maszycka cave is c. 5 km from the nearest flint mines currently known — at Bębło and Jerzmanowice-Dąbrówka, Cracow dist. The inventory here is completely different from that from the Wierzchowska Górna cave (Table 3, Fig. 7). The proportion of pre-core and core forms, and also of flakes and waste material, is twice as high here, while the proportion of blades and blade fragments is three times lower. This indicates that this collection was of different origin. Although there is similarity in the general structure to materials from some settlements, especially Modlnica (Table 3, Fig. 7), it seems that it is a typical example of a workshop where preparatory work on pre-core and initial core forms was completed. There is a fundamental difference between the Maszycka cave and the Modlnica settlement, Cracow dist. in the structure of the first inventory group. Pre-core forms are predominant in the cave, forming more than 50% of the specimens in this group. But they are rare in the settlement.

Another argument in favour of flint processing being included among the activities carried out in the cave is the three times greater proportion of hammerstone in the tools group (leaving a side the secondary use of cores to perform this role). In the Maszycka cave 15.1% of tools were hammerstones, and at Modlnica 5.17%. Among 75 pre-core forms and cores found in the cave, 38 specimens were nodules with negatives of the flake scar and 6 were initial cores — jointly 59% of the first inventory group. The proportion of pre-core forms is greater than in the core exploitation workshops at the mine at Sąspów, not to mention the settlements. The proportion of blades and blade fragments is low, much lower than in mine-site core exploitation workshops. As the proportion of blades with traces of core preparation is analogous — 6.3% in workshop 1/1960, 5.4% in workshop 3/1960 compared with 5.9% in the cave, some part of the blades may be linked with trial exploitation of pre-cores. Generally the proportion of blades with traces of core preparation in settlements near mines is low, usually about 1%. On rare occasions it may be more, for example in the Pleszów group settlement at Kraków-Pleszów — c. 2.2% (Lech 1981-I, 137). It is only in the Modlnica group settlement at Iwanowice that there were more finds of this type. The above facts would seem to fit in with observations which indicate that initial cores were also brought to settlements, after a trial series of blades had been struck off. The predominance of flakes with a negative on the upper side of the specimen at the Maszycka cave, shows that nodules which were already to a large degree prepared were brought to the cave.

Some of the materials from the cave (pottery, tools, cores), may be linked with its frequent use as a habitation by groups of people who came from settlements elsewhere.

The flint materials from settlements show a considerable differentiation of characteristics in finds and the organization of the processing of Jurassic-Cracow

flint, depending on the distance of the settlement from the deposits and also on local patterns of behaviour. This can be best shown by comparison of finds from the LBK settlement at Kraków-Olszanica and that at Niemcza, Wałbrzych dist. At Olszanica, flint was clearly predominant (more than 42000 flints), with several times more specimens of this type than of pottery. At Niemcza, which is 200 km from deposits, flint formed 3.5% of finds, while pottery formed 96.5% (Kozłowski, Kulczycka 1961-1; Lodowski 1973; Milisauskas 1976, 33; 1976-1). At Bylany near Kutná Hora the chipping industry also provided only a minimal proportion of finds. There were about 1500 finds here from an excavation covering about 6 ha. The materials from Iwanowice provide an example of the variability in the scale and character of flint processing in the settlements of the Lengyel-Polgar complex dating from different periods but situated in one place (Table 3 and Fig. 7).

On the grounds of the differences noted above, it is possible to divide settlements into flint working settlements with rich remains from raw materials processing, and settlements of flint users, with only limited remains of local processing. We give the inventory structure of three flint working settlements (2 at Iwanowice and Modlnica) and a flint users settlement (at Niemcza) in table 3. The settlements at Iwanowice were about 15 km (Fig. 13) from the mines at Sąspów and Bębło, and the Modlnica settlement about 5.5 km

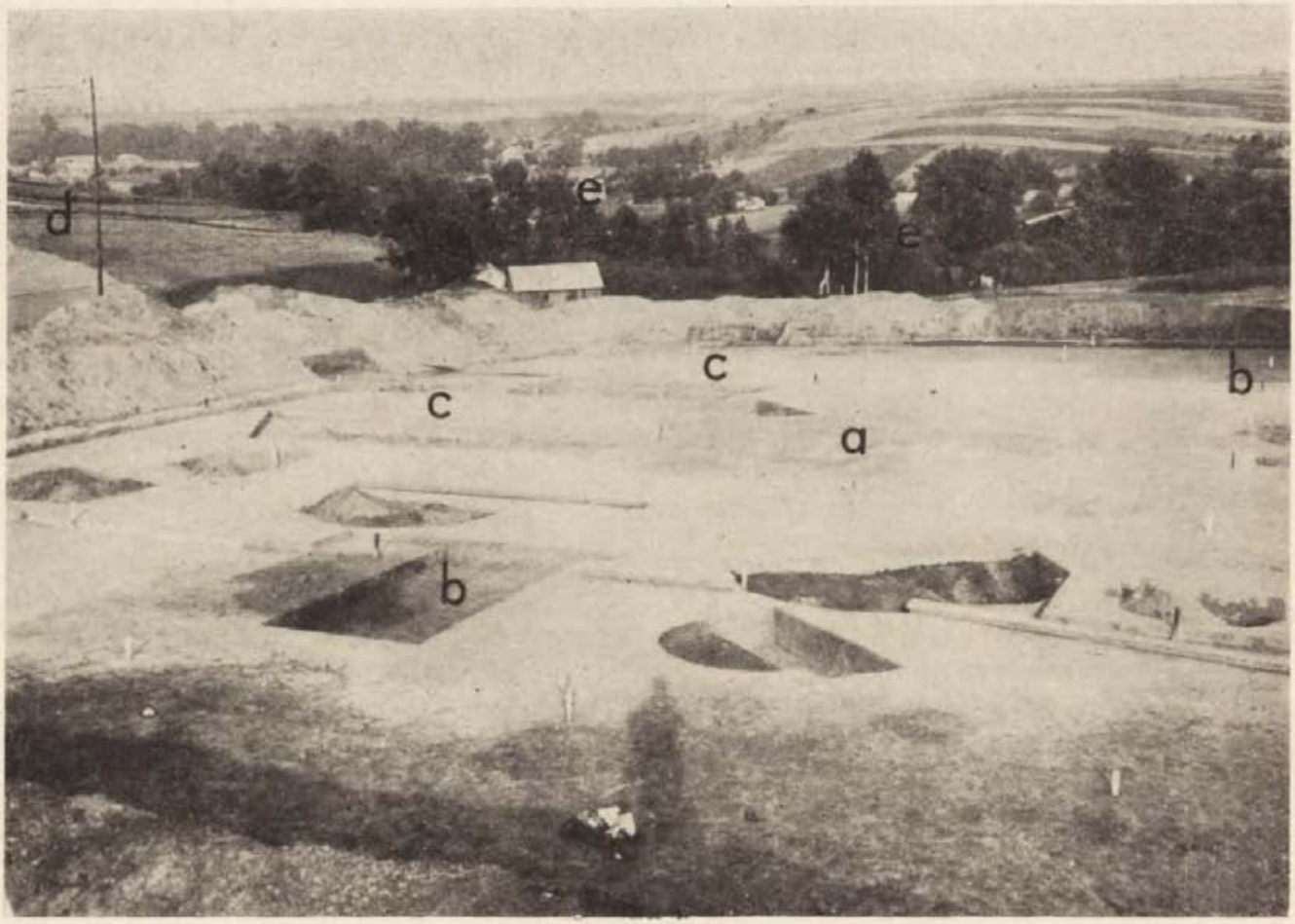

Fig. 13. Iwanowice, Cracow dist., site Babia Góra II during the excavations of 1972

a — Pits containg Modlnica cultural material of the Lengyel-Polgar complex; *b* — Pits containg Malice cultural material of the Lengyel-Polgar complex; *c* — Pits containg cultural material of the Mierzanowice culture; *d* — site Babia Góra III; *e* — Dłubnia river valley
Photo from the PA ZAM IHKM PAN archives at Igołomia

from the mine at Bębło and about 11 km from the mine at Sąspów. Usually the proportion of production waste is considerably higher in the flint working settlements (I and III inventory groups). The proportion of tools is lower. Blade and flake blanks and also pre-core and initial core forms were brought to the users settlements; but nodules were brought only exceptionally. There is a clear tendency towards the maximum utilisation of raw material obtained. This can be seen in the much greater proportion of tools and splinters (in French: *pièces esquillées*) than in assemblages from the vicinity of deposits.

The structure of flint finds from settlements differs from that of materials from mine-site workshops in

that there is a higher proportion of tools (Table 3 and Fig. 7). Even in the materials from the Malice group settlement at Iwanowice, the proportion of tools is considerably higher. Generally also the proportion of cores is much higher, although there are sometimes exceptions here (for example, the Malice group settlement at Iwanowice). The proportion of blades varies. We should remember here that the majority of tools were made from blade blanks. If we add these two groups of finds together, we see that there are far more of them in the settlements than in the workshops at the mine at Sąspów. The frequency of occurrence of flakes is on the whole lower in flint working settlements. If we examine the structure of flakes more closely, we find that the number of preparatory flakes struck off in settlements was lower than on mine sites. However, the proportion of reshaping flakes (technical) was growing in relation to these, primarily flakes struck off from the platform or flaking surface.

The structure of the materials from the workshop at Kraków-Pleszów does not differ fundamentally from that of other materials from settlements. Basically, the workshop was identified because of a great concentration of flint finds in one place. Blade cores from mined flint predominate in the first inventory group. Among these there are specimens from a raw material analogous to that mined at Sąspów, about 30 km away. There are many specimens of blades and blade fragments, and also some tools, with traces of harvest wear and tear (cf. Cabalska 1963). This would seem to indicate that the workshop not only produced blade blanks, but also repaired composite tools. The workshop at Pleszów is a typical dwelling workshop. We can find similar characteristics in the materials from the Malice group settlement at Iwanowice. However, at Iwanowice this was considerably influenced by the inclusion of materials which had the characteristics of workshop materials, discovered in one of the pits (Lech 1981-I, 142–144).

In the structure of the inventory at the users settlement at Niemcza, the fundamental role of blades and blade fragments is clear (Table 3 and Fig. 7). The preponderance of these over other classification groups suggests that mainly blade blanks were brought to the settlement. We should add that all specimens from the first inventory group were splinters, and that the majority of tools were made from blade blanks. If the whole materials inventory is divided according to the original form of the specimen, then blades and blade fragments form 64% and flakes and waste material, 36% (Lech 1981b, 40). Serious shortages in raw materials supply are reflected in a strong tendency to make maximum use of raw materials obtained. Prepared tools form one quarter of all materials here; no other inventory studied equalled this. Moreover, almost all other blades and blade fragments, and also flakes, bear visible traces of use.

In the later period, the division into flint working settlements and flint users settlements can be seen very clearly in TRB materials from Little Poland, where B. Balcer (1971, 55 f.; 1975-I, 178–191) was the first to draw this distinction. Some other scholars term flint working settlements industrial, or productive ones.

When studying flint materials from the point of view of processing organization and technique, valuable information is supplied by comparative analysis of some selected characteristics. These include the type of surface on the upper side of flakes and the type of striking platform. The type of surface on the upper side of flakes very clearly differentiates mine-site workshops from other kinds of materials inventories examined (Fig. 14). The considerably greater proportion of flakes with a complete natural surface on the upper side and a somewhat greater proportion of flakes partly covered by the natural surface, in all three workshops, corresponds to the place occupied by the mine-site workshops in flint processing. To go back to the remarks

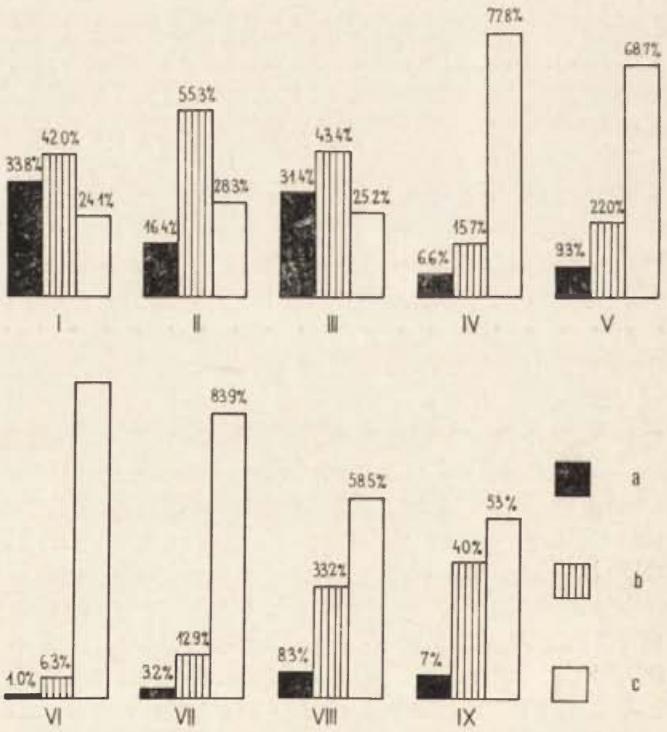

Fig. 14. Structure of flakes according to the characteristics of the ir upper surface

a — cortex flakes; *b* — partially cortex flakes; *c* — negative flakes; I–III Sąspów, workshop 1/1971 (I); workshop 1/1960 (II); workshop 3/1960 (III); IV, V — Sąspów, the "Church cave" — West, layers II and IV; VI — Wierzchowie, Wierzchowska cave; VII — Maszyce, Maszycka cave; VIII — Iwanowice, materials of the Malice group; IX — Iwanowice, materials of the Modlnica group. Data sources see footnote to Table 3

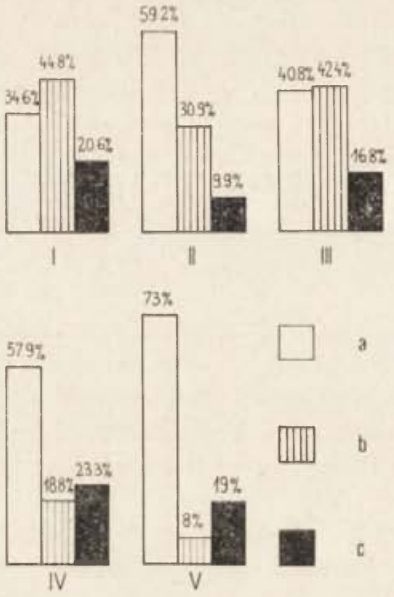

Fig. 15. Structure of flakes according to their type of striking platform

a — prepared; *b* — unprepared; *c* — pointed butt; I–III — Sąspów, workshop 1/1971 (I), workshop 1/1960 (II), workshop 3/1960 (II); IV — Iwanowice, materials of the Malice group; V — Iwanowice, materials of the Modlnica group

made above about the characteristics of materials from the two layers at the "Church cave", it is not surprising that in this respect they are more closely related to materials inventories from flint working settlements than to mine-site workshops.

The flakes from the materials inventories under discussion are clearly distinguished by the type of striking platform (Fig. 15). If we accept that unprepared and dotted striking platforms are characteristic of the first stages of flint processing, then with one exception, these materials distinguish between assemblages from mines and materials from settlements. There is a certain similarity between materials from workshop 1/1960 and the inventory from the Malice group settlement at Iwanowice. This confirms the suggestion that these latter materials had a workshop character. It is also clear that the range of preparatory processing was smaller in the Modlnica group settlement at Iwanowice than in the Malice group settlement, and smaller in the 1/1960 workshop at Sąspów than in workshops 1/1970 and 3/1960.

IV. WORKSHOPS IN OTHER FLINT MINING REGIONS

Research into the organization of Jurassic-Cracow flint processing among the Lengyel-Polgar communities has been aided by the discovery of flint workshop assemblages of various types on the site of the Sąspów mine and in the vicinity. The confirmation of the thesis that there had been one line of production there, aimed at obtaining blades as the end product, was of vital importance. But the situation is much more difficult when we study many other mines. Often, modern ploughing over a long period has destroyed all concentrations of materials which were the remains of workshops. In this situation, it is only possible to find workshop materials in the secondary position in the filling in of shafts (Fig. 16). Another serious diffficulty is that research into the chipping industries of many of the units of the traditional cultural divisions has not been very extensive. This is an additional obstacle to the correct reconstruction of the lines of production of mine-site workshops. But even in these cases, analysis of production remains from the mine site yields interesting results. The recently excavated "chocolate" flint mines at Polany II, Polany Kolonie II and Wierzbica "Zele", Radom dist. provide an example. Bifacial core tools of various types were produced on a mass scale on the sites of all three mines. On the site of the Wierzbica "Zele" mine there was also large scale processing to obtain blade blanks. The completed and published excavations of the Polany Kolonie II mine (Schild, Królik, Mościbrodzka 1977-1) are in particular worth attention.

Fig. 16. Polany, Radom dist., site 2. Flints from workshops found in the secondary deposit of shaft fillings

a — concentration 1; *b* — concentration 2

Photo by J. Lech

Research designed to identify the basic characteristics in the processing of the flint obtained from the shafts of the Polany Kolonie II mine at the turn of the 3rd and 2nd millennia b. c. began with comparative studies of materials from the mine and from the contemporaneous settlement, in order to define the main

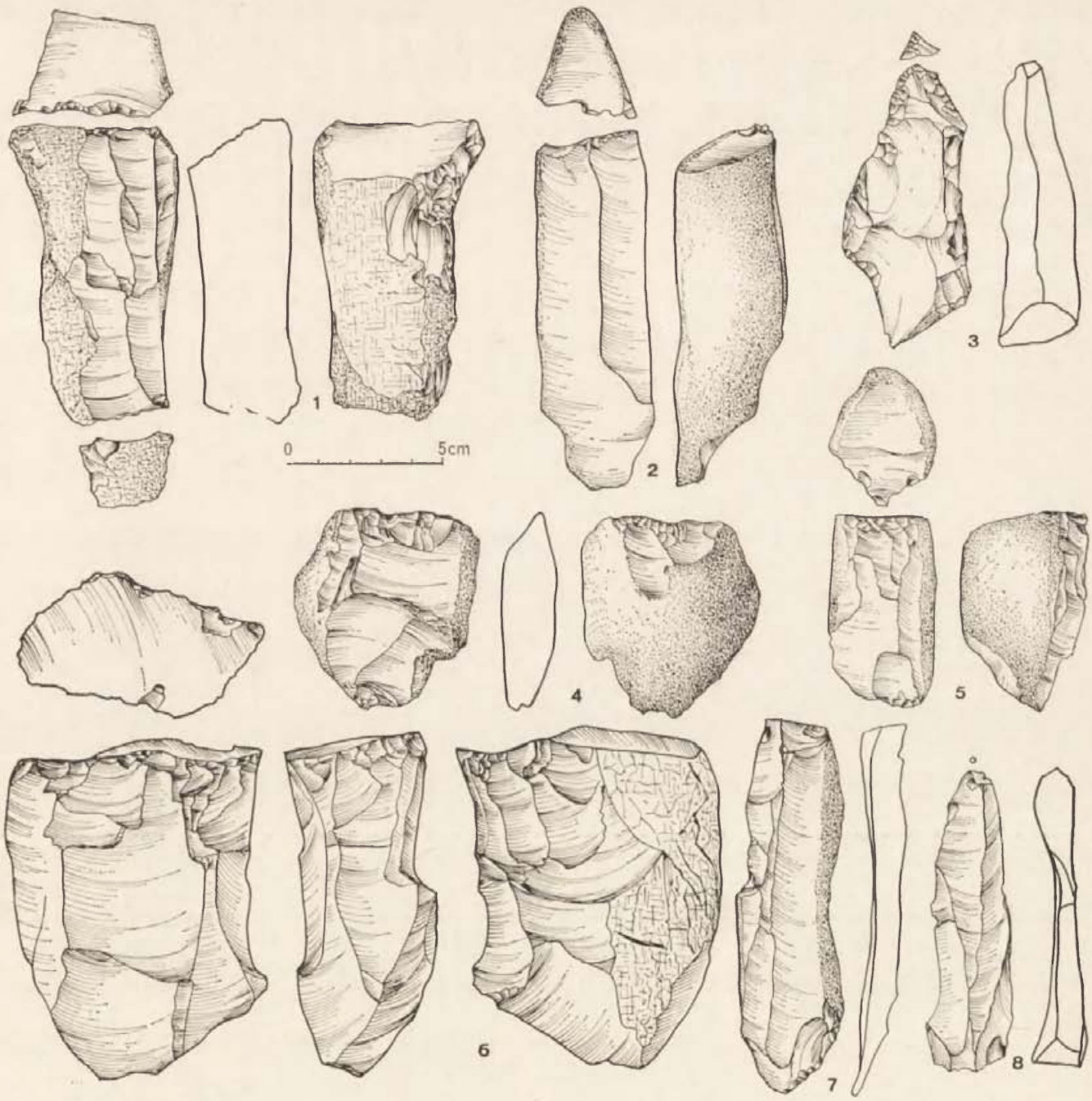

Fig. 17. Wierzbica, Radom dist., site "Zele". Flint mine. Trends of raw material treatment

trends in production. Next, typological sequences were drawn up, showing the intermediate forms between natural nodules occurring on the mine site, through early and more advanced initial forms to the semi-products for particular core tools. Throughout this work, the technological and morphological characteristics of initial forms found were compared with finished tools from settlements (Schild, Królik, Mościbrodzka 1977-I, 56–66).

This analysis confirmed that the following categories of products occurred on the site of the Polany Kolonie II mine: indefinite initial forms; bifacial initially worked pieces; more advanced initially worked bifacial pieces; unfinished bifacial oval axes; unfinished bifacial subtriangular axes; unfinished undefined bifacial axes; unfinished sickles; unfinished bifacial foliates; and naturally backed bifacial knives. In the waste material there was a preponderance of various types of flakes produced in the working of these forms. The authors found functional differentiation in flint materials from various parts of the surface of the mine. This resulted in the formulation of the hypothesis that there were initial workshops on the mine site where initial processing of nodules was mainly carried out, and others which dealt with more advanced stages of processing (Schild, Królik, Mościbrodzka 1977-I, 77–80). Because

of the frequency of occurrence of some particular categories, it was thought that production dealing with the preparation of semi-products for bifacial axes was of primary importance here. The production of semi-products for the other categories of core tools mentioned did not play a major role. The tools were not fin-

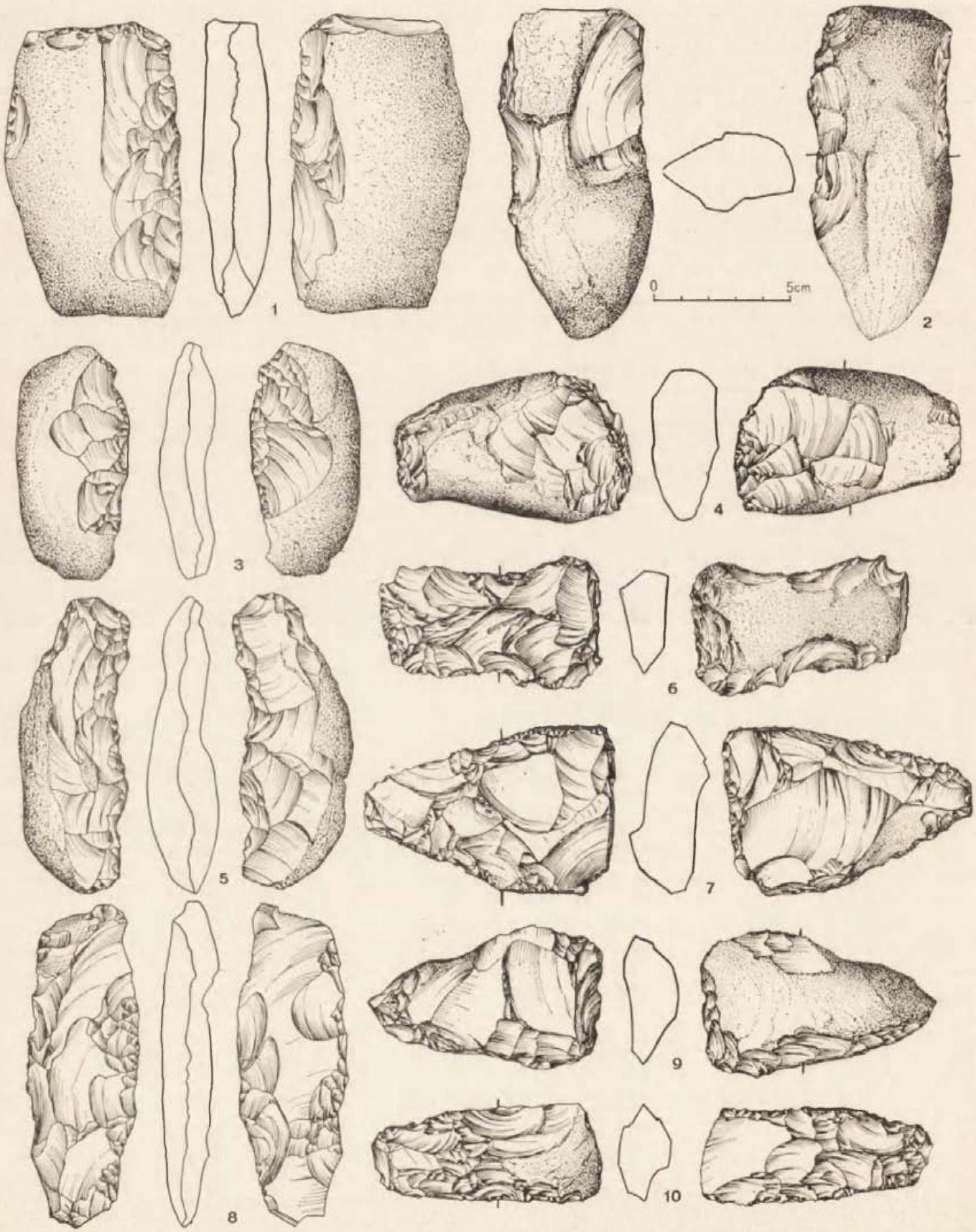

Fig. 18. Wierzbica, site "Zele". Flint mine. Trends of raw material treatment

ished on the site of the mine: the last stage in preparation of tools was carried out elsewhere, most probably in the settlements (Schild, Królik, Mościbrodzka 1977-I, 83 f.). The mine at Polany II (Chmielewska 1973-I) in part provided similar semi-products.

Similar lines of production are suggested by the materials obtained by systematic surface collection on the site of the Wierzbica "Zele" mine.[6] In contrast to the mines at Polany II and Polany Kolonie II, there is here a strong emphasis on blade production. Single platform blade cores have been found here which were adapted to the shape of the nodules obtained, and also blades and blade fragments (Fig. 17: 1,2,5–8). The blade blanks made from "chocolate" flint which occur on the site of the Wierzbica "Zele" mine are known from materials from the settlements of early farming communities from the LBK onwards. The presence of large splinters on the mine site, which are analogous to specimens found in the TRB settlement at Poganice, Słupsk dist. (Fig. 17:4) is characteristic, and suggests that they came for flake blanks (see: Lech 1982/1983, 29-31). They are probably linked with the Trzciniec culture, or another culture close to it in time. In earlier assemblages, the splinter technique was only used when there was a considerable shortage of raw materials, but this did not apply to the site of the mine.

The production of bifacial tools can be traced very clearly in the surface materials from the Wierzbica "Zele" mine. There are very many initially worked bifacial pieces (Fig. 18:1–3). In the materials from the mine it is easy to find evidence that nodules were selected on the criterion of the planned end product. Bifacial tools were formed wherever possible from elongated flat nodules — flint "pancakes", completely covered with cortex. These occur in the deposits here and also in the area of the neighbouring Polany II and Polany Kolonie II mines. The cores formed from bigger nodules are of varying thicknesses. This made it possible to obtain blades of the required sizes. Much smaller nodules were chosen to produce splinters — oval and flat.

The preparation of bifacial tools was usually begun on one of the longer side edges (Fig. 18:1,3), and much more rarely on the transverse edges (Fig. 18:4). The preparatory working might initially be concentrated on only one side of the nodule (Fig. 18:6, 9) or might at once cover both sides (Fig. 18:1,3–5). The sequence of processes was undoubtedly to a great extent determined by the individual characteristics of a particular nodule. The extent to which the first stages of processing influenced the differences between finished bifacial tools is a subject for further research. Usually the remaining edges were dealt during further processing. The semi-products for various core tools were made in this way. But specimens which can be identified as finished semi-products for particular bifacial tools are very rare in the mass materials from the mine site. However, forms which illustrate particular stages of initial processing are more common. The tools most frequently prepared were bifacial lenticular axes (Fig. 18:4,6,7,9,10). Among these it is possible to differentiate bifacial elongated oval axes (Fig. 18:10), and bifacial sub-triangular axes (Fig. 18: 7,9). But there are very many specimens which it is impossible to attribute to any group (Fig. 18:4,6). The production of other bifacial tools was much lower, because of the quantity of axes produced. But there are also unfinished bifacial sickles (Fig. 18:5,8) and naturally backed bifacial knives.

The great similarity of the first stages of processing for all the types of tools mentioned means that in many cases it is not possible to be sure of the end form intended. For example, we cannot exclude the possibility that one of the initially worked sickles mentioned may have been intended as a bifacial axe (Fig. 18:8). The classification categories can only be made more precise by study of workshop assemblages from mine sites, or of their representative samples. The tools used on the mine site form a separate category group of finds, much less numerous. Flint hammerstones and macrolithic specimens of other tools, including perforators (Fig. 17:3), are classified here. On the basis of production trends in the chipping industries which have been discussed above, the bifacial core tools from the Wierzbica "Zele" mine may in the main be linked with the Mierzanowice culture which occurred in this region in the first centuries of the 2nd millennium b. c. (Lech 1982/1983, 46-50).

Surface examination and some small-scale excavations at the site of the flint mine at Świeciechów, Tarnobrzeg dist., have indicated that it was exploited over a long period, but further data on this subject are provided only by analysis of the distribution of this very characteristic raw material (Krzak 1965-I; Balcer 1971-I; 1975-I). The blade cores, blades and blade fragments found indicate that this type of semi-product was made (Fig. 19:1, 2, 4, 5, 14). Flake blanks were also produced (Fig. 19:8). The production of axes was important here (Fig. 19:3, 10, 14; 20) and initial forms and unsucessful semi-products found on the mine site indicate that tetrahedral and bifacial axes were made. Research carried out by B. Balcer (1975-I, 74) has shown that all bigger cores of this raw material were made into tetrahedral axes. Tetrahedral axes made from grey-white spotted flint from the Świeciechów mine were popular tools among the Little Poland TRB groups and communities of the Corded Ware complex. The Mierzanowice culture group used bifacial axes. Initially worked sickles

[6] Unpublished materials from research by Miss Hanna Młynarczyk, M. A., whom I should like to thank for allowing me to make use of them.

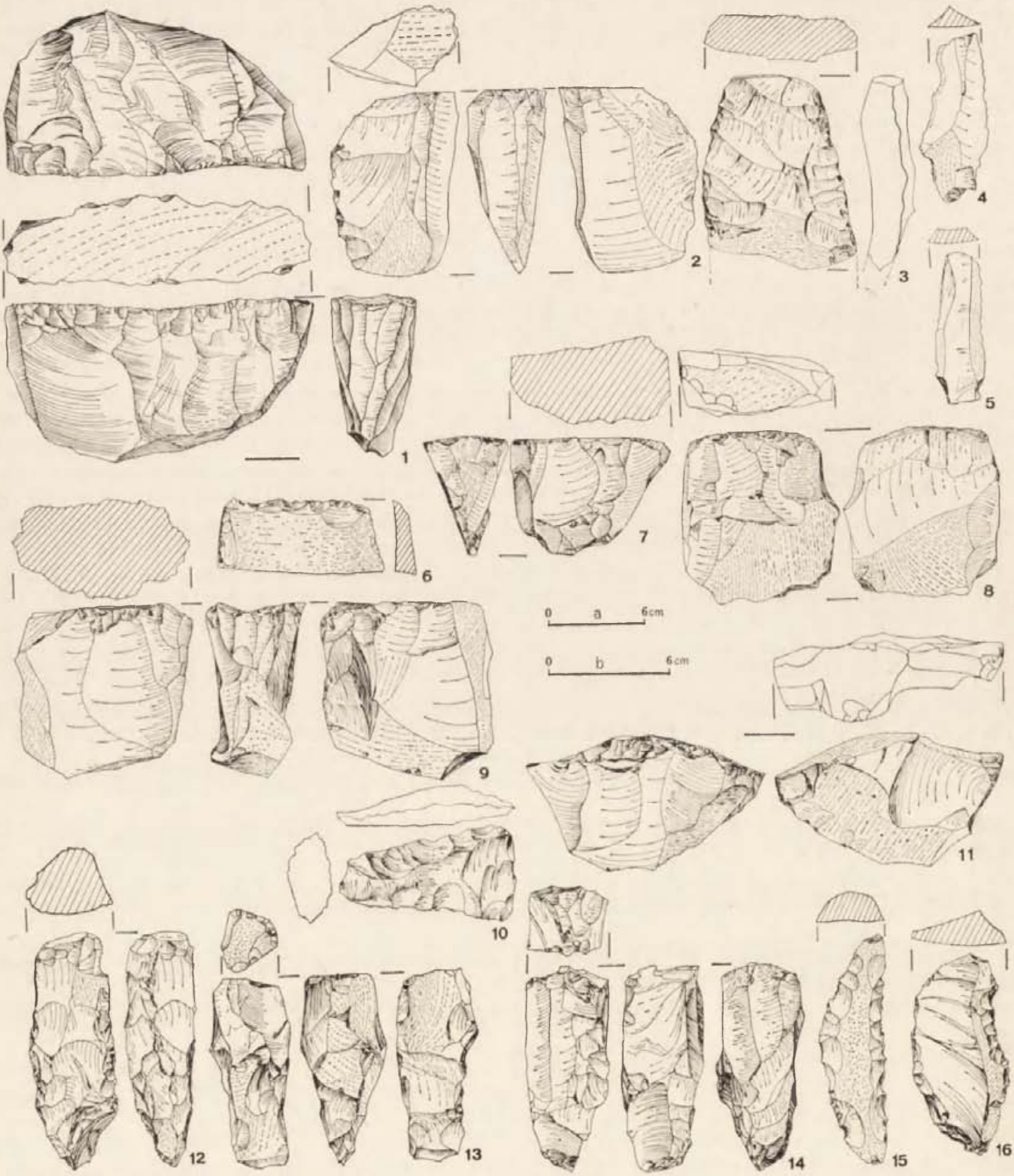

Fig. 19. Świeciechów, Tarnobrzeg dist. Flint mine. Trends of raw material treatment

Scales: *a* – 6, 9, 10, 13; *b* – 1–5, 7, 8, 11, 12, 14–16

After B. Balcer

or other types of tools are rarely found (Fig. 19:12,13).

Flint of the Świeciechów type was most popular in the Little Poland TRB group. B. Balcer (1975-I, 177 f.) believes that in this period the mine at Świeciechów and other exploited mines (e.g. Krzemionki) were only temporary centres for initial working, from which initial forms were taken to settlements outside the mine area, and also to a lesser extent blade blanks and axe semi-products. It thus seems that in this respect there were major differences in the organization of flint pro-

cessing production from that found in the mines of the Lengyel-Polgar complex in the southern part of the Polish Jura in the 4th millennium b.c. This is important, because serious qualitative differences have been sought between the two cultural complexes in flint mining, including the organization of flint working production (Tabaczyński 1970-I, 263–282; 1972, 61–72; Balcer 1975-I, 280).

As we have already mentioned, there is a clear division among TRB settlements in Little Poland into

Fig. 20. Świeciechów. Flint mine. An early stage of axe preparation

Scale in cm

Photo by S. Biniewski

flint-working and flint-using ones. The flint working settlements were closely linked with particular mines. The settlement at Zawichost, and to a lesser extent the settlement at Ćmielów, Tarnobrzeg dist., were linked with the Świeciechów flint mine. The community in the settlement at Ćmielów also processed major quantities of flint from the mine at Krzemionki Opatowskie, Kielce dist., 9 km distant from the settlement as the crow flies, on the opposite bank of the Kamienna river. The Świeciechów mine is 22 km distant to the East (Balcer 1975-I, 180). Traces of a flint processing workshop are concentrated on the northern edge of the settlement (Podkowińska 1950; 1962; Wiślański 1979, 209–211).

In pit No 102, 22, 157 flints occurred, of which 49.13% were specimens from Świeciechów flint and 50.87% specimens from striped flint from the Krzemionki mine (Balcer 1975-I, 180–186, table 19). In the materials from both types of flint there was an absolute preponderance of flakes, which formed 93.91% and 96.33% in the two groups respectively. These proportions, and the total number of specimens, indicate that these materials had the characteristics of workshop assemblages. The remaining indicators are also characteristic. Of the specimens from Świeciechów flint, 0.3% were pre-core forms and cores or initially worked axes, 0.36% were tools and 5.43% were blades. From the analysis carried out by B. Balcer, we know that blade blanks and axes were also produced here from Świeciechów flint. Because used cores were also made into axes, the number of cores of this type is disproportionately low. Probably all larger specimens of nodules were either made into axes or were taken elsewhere for further exploitation. The fact that there are only 4 cores compared with 591 blades is irrefutable proof of this.

The composition of the rest of the striped flint materials from pit 102 was somewhat different. There were no cores at all. But there were 122 initially worked forms or axe semi-products and 5 splinters — together forming 1.13% of the total. As striped flint was not a good raw material for the production of blades, these formed only 2.46% of the materials, and tools 0.07%. The quantity of flint, combined with the structure of the materials, leaves no doubt that there was a large flint processing workshop, or several workshops, functioning in the vicinity of pit 102 — which contained their waste materials. In the light of the arguments presented above, these were dwelling workshops. The lack of natural nodules or nodule fragments is an additional indication here.

In comparison with the dwelling workshops from Vedrovice—Zábrdovice and Kraków-Pleszów, the minimal proportion of tools, which corresponds to that in the mine-site workshops at Sąspów, is striking. This cannot be convincingly explained by the fact that the workshops at Vedrovice—Zábrdovice and Kraków-Pleszów were multi-function workshops, and that composite tools were prepared in two of them. It is possible to find evidence in the large mass of waste material and the minimal quantity of tools of some progress in work specialization, and also a more isolation of the flint workshop in the spatial structure of the Ćmielów settlement than in the Danubian communities at the end of the 5th and during the 4th millennium b.c. We should remember that the Ćmielów settlement is several hundred years later than the settlement at Pleszów or flint mining at Sąspów (Lech 1981a, 48–50). However, we may expect to find similar features in flint processing among the late Polgar communities in the West Ukraine and Volhynia which were connected with the exploitation of local flint deposits. This indicates that Volhynian type flint was distributed among the Tiszapolgár and Bodrogkeresztúr communities in Eastern Hungary and Slovakia.

The large accumulation of flint finds in pit 102 is of an order which makes it outstanding in the territory of settlements in Central Europe. The quantity of flint in other pits at the Ćmielów settlement was much lower. In pit No 45, there were 4689 striped flint specimens and 12 from grey-white spotted flint. In three more pits, there were between 1000 and 2000 specimens, but in the majority of pits at Ćmielów there were fewer than 100 specimens. The average for 74 pits was 519 specimens, of which 62.10% are specimens of flint

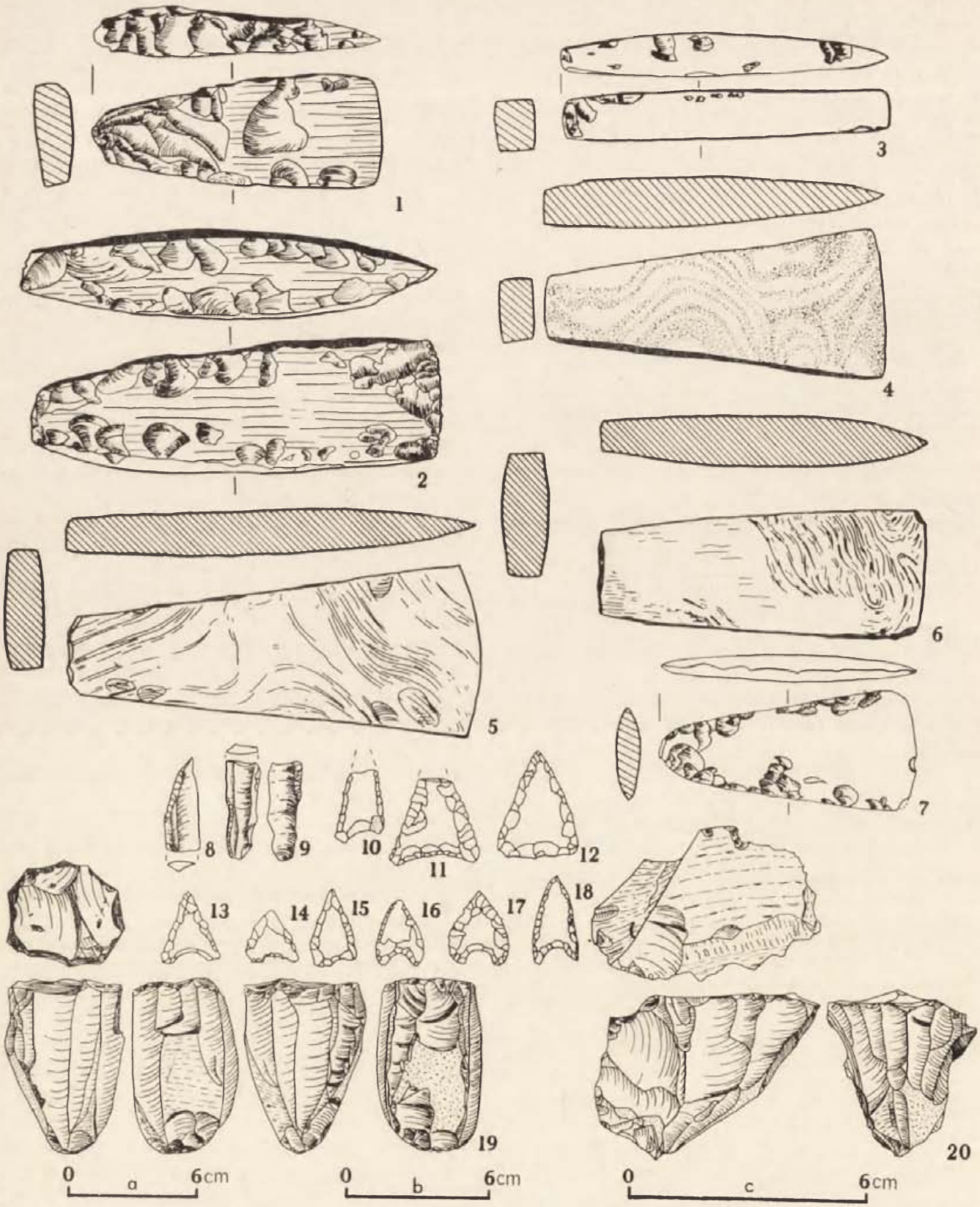

Fig. 21. Production trends of striped flint of the Krzemionki type

1, 2 — Ćmielów, Tarnobrzeg dist.; *3, 19, 20* — Krzemionki, Kielce dist.; *4* — Pruskolęka, Ostrołęka dist.; *5* — Stok, Lublin dist.; *6* — Malice, Tarnobrzeg dist.; *7* — Mierzanowice, Tarnobrzeg dist.; *8, 9, 18* — Brzozówka, Kielce dist.; *10* — Połaniec, Kielce dist.; *11–16* — Borzymów, Kielce dist.; *17* — Sieczków, Kielce dist. Scales: *a* — 19, 20; *b* — 1–7; *c* — 8–18

After B. Balcer, K. Kowalski and S. Nosek

from the Krzemionki mine 37.87% from the Świeciechów mine and 0.04% from other raw materials (calculations based on Balcer 1975-I, Table 19).

The Ćmielów settlement at the moment is the first evidence of the beginning of the exploitation of striped flint at the mine at Krzemionki Opatowskie. This raw material was obtained for the production of tetrahedral axes used by the TRB communities in Little Poland (Fig. 21:1,2). Apart from axes, chisels were also made from striped flint. In accordance with B. Balcer's suggestion, we understand that chisels are specimens similar to axes with cutting ends less than 2 cm across, and where the relationship of length to maximum width is greater than 4 : 1 (1975-I, 114). To date no research has been carried out which would make it possible to define the large flint working workshops on the site of the Krzemionki mine. In the case of tools from striped flint prepared in the workshops, we know more about them from materials from the settlements and burials of various cultures than we do from excavations and chance finds on the site of the mine. On this evidence we know that the Globular Amphora culture communities continued the production of tetrahedral axes and chisels (Fig. 21:3–6).

Bifacial axes were prepared from striped flint in the Mierzanowice culture (Fig. 21:7) and they also used this material for projectile points — arrow heads (Fig. 21:10–18). The other mines exploiting this raw material, at Ruda Kościelna (Fig. 22), Borownia and Korycizna, Tarnobrzeg dist., were also probably functioning in this period. The exploitation of cores to obtain blade or flake blanks was of purely marginal significance (Balcer, Kowalski 1978, 132). Blade cores from striped flint are very rare as also are blades and blade tools (Fig. 21:8,9,19,20). In the Trzciniec culture, this raw material was used to produce flake tools. The flake blanks were often obtained by the splinter technique (Więckowska 1971, 140–145). The initial forms and semi-products of the bifacial tools mentioned and also pre-core forms, have been found on the site of the Krzemionki mine.

Surface examination of the flint mine at Ożarów, Tarnobrzeg dist., has indicated that the flint workshops on this site produced mainly semi-products for bifacial axes and sickles. Sporadically, semi-products for naturally backed bifacial knives occur, and also for tetrahedral axes with a broadened cutting end which are characteristic of the Corded Ware culture (Krzak 1970-I, 296–301). It has been confirmed that flake blanks were obtained from rather small single platform flake cores, as also were splinters. A small number of blade fragments confirm that blade blanks were produced here.

About 50,000 industrial flints from various shafts on the site of the Krasnoye Selo mine on the River Roś near Volkovysk in White Russia have been published (Gurina 1976-I, 165–173). Because the archaeological excavations carried out at Krasnoye Selo were of an emergency nature in the area of chalk deposits exploited by the local cement factory, archaeologists used bulldozers to discover the outlines of shafts. In this way the workshop, which was on the surface of the mine near the shafts, was damaged (Gurina 1976-I, 10–13, 19–21). In the shafts, the flint materials were usually found in the secondary position. It was rare for a flint workshop to be situated at the bottom of a shaft — for example, in shaft no 3 in cutting I. More often, flint processing was carried out in a shaft already filled with chalk rubble. In cases like this, there was a "floor" at a depth of not more than 1.5 to 2 m, composed of very tightly packed chalk rubble (Gurina 1976-I, 94–97). This calls to mind the "crawling floor" in the galleries of the Grime's Graves mines. In the shafts at Krasnoye Selo stones and masses of flakes and other waste material occurred on this "floor".[7]

Fig. 22. Ruda Kościelna, Tarnobrzeg dist. Mine of striped flint. A hammerstone and a bifacial with initial working
Photo by S. Biniewski

In general, processing of raw material was not car-

[7] Unpublished materials from research by Z. Szmit in the collection of the State Archaeological Museum in Warsaw, kindly made available to me by Mr Krzysztof Kowalski M. A., and information kindly given to me by Professor N.N. Gurina Dr Sc. (cf. also the book referred to).

ried out in the shafts of the Krasnoye Selo mine during the time when it was being extracted, which accords with observations made on the sites of other European mines. Only initial selection of nodules with a view to their suitability for processing was carried cut at the bottom of the shafts. The nodules extracted were processed in workshops on the surface of the mining field, or sometimes in earlier-abandoned and partly filled in shafts. There were sometimes the remains of hearths together with the workshops. If we assume that the number and size of hearths gives a fair indication of the size of the workshop, then on the whole the workshops were small or medium-sized. More than 1000 flints were found in the filling of shaft 3, cutting I, of

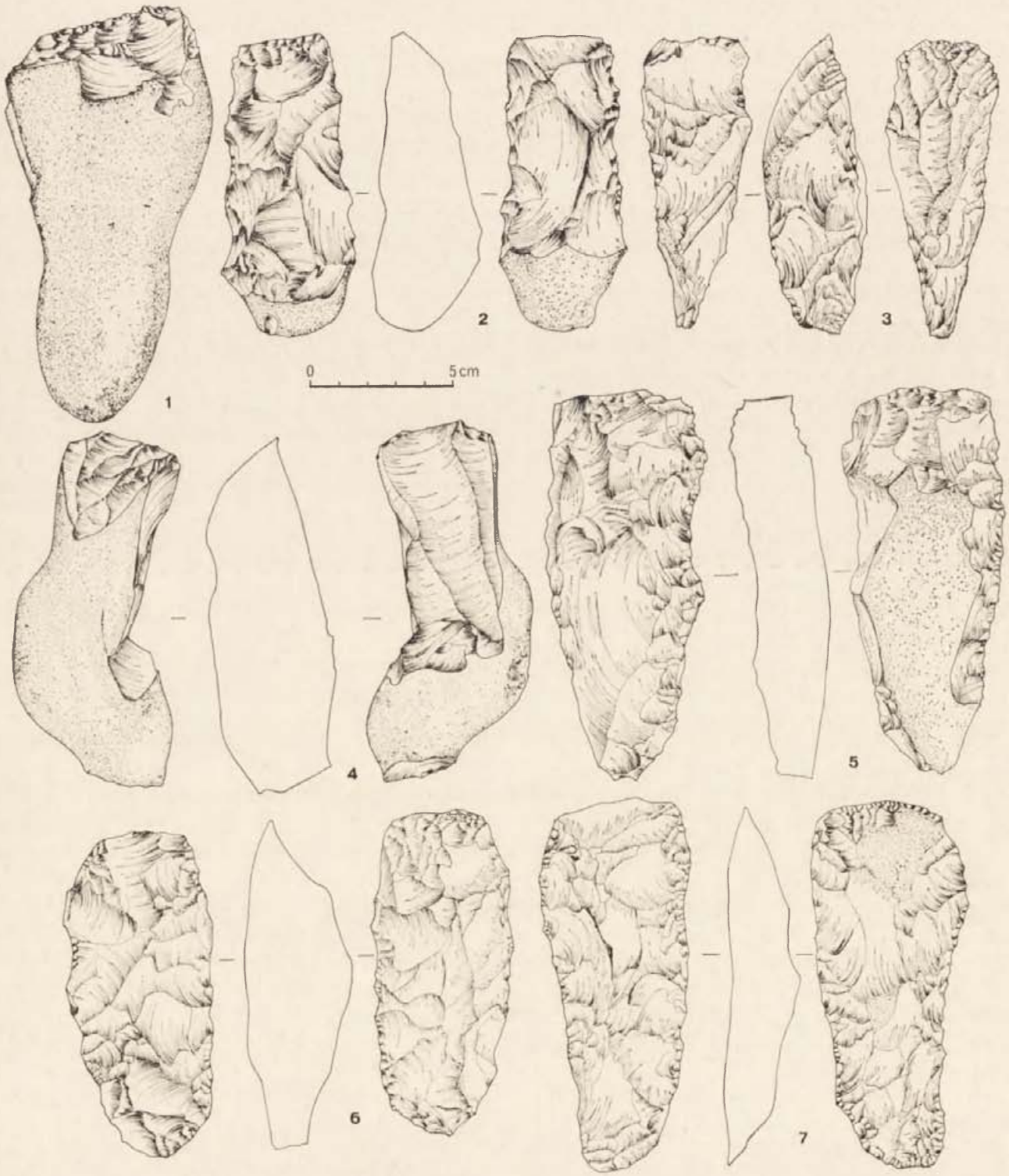

Fig. 23. Krasnoye Selo, Volkovysk dist. Flint mine. Trends of raw material treatment

After N. N. Gurina

which 565 can be linked with the workshop at the bottom of this shaft, already mentioned above. Usually also, if the filling of a shaft contained several hundred flints (or in rare cases much greater numbers, between 1 and 2 thousand), then there are reasons for thinking that there was a workshop in that shaft. Shaft No 24 from cutting II and shaft No 7 from cutting III, containing 1739 and 1681 specimens respectively, are exceptions to this pattern. The largest number of flints were found in shaft No 56 from cutting I, in which 2082 specimens were obtained at a level between 0 and 22 cm (Gurina 1976-I, 165–174). As we can see from the information above, flint processing in the workshops at the Krasnoye Selo mine was probably on a much smaller scale than in some cases on the site of the Sąspów mine, and also, judging by the materials from Ćmielów, than at Krzemionki Opatowskie and Świeciechów.

Analysis of the materials from the Krasnoye Selo and Karpovcy mines Volkovysk dist. has shown that the development of exploitation of these deposits was linked with demand for raw material for the production of axes (Fig. 23). The flint from these two neighbouring mines was of rather poor quality. The nature of this raw material made it impossible to produce long and slender blades from it (Gurina 1976-I, 75). Thereore we may conclude that apart from the production of axes, or possibly other bifacial tools, the flint knappers used flake blanks to a certain extent. Nodules were chosen in the light of the shape and size fo axes. Elongated medium-sized nodules, i. e. about 10–15 cm long, were most frequently processed (Fig. 23:1,2,4). Processing began with the removal of flint excrescences occurring at odd points on the surface of the nodule. Next, one platform was prepared, from which further working was carried out, depending on the shape of the nodule. These steps were similar to those in core preparation (Fig. 23:1,4). Next, the flint knapper formed the edges along the longer sides of the axe and the cutting end (Fig. 23:2,5). On the site of the mine, processing was aimed at producing semi-products for bifacial oval axes (Fig. 23:6,7), or more rarely sub-triangular ones (Fig. 23:3; Gurina 1976-I, 63–79). This dates the exploitation of these deposits at the end of the 3rd and in the 2nd millennium b.c. (cf. Lech 1981a, 48–51).

Further to the South, many workshops occur on the area of deposits of Volhynian type flint, or related varieties. Three regions where flint workshops were concentrated can be identified over this extensive area: the upper Bug river basin; the region between the Styr and Horyn rivers, especially the southern part between the Ikwa and Horyn rivers; and the district around the central reaches of the Dnestr. Workshops linked with

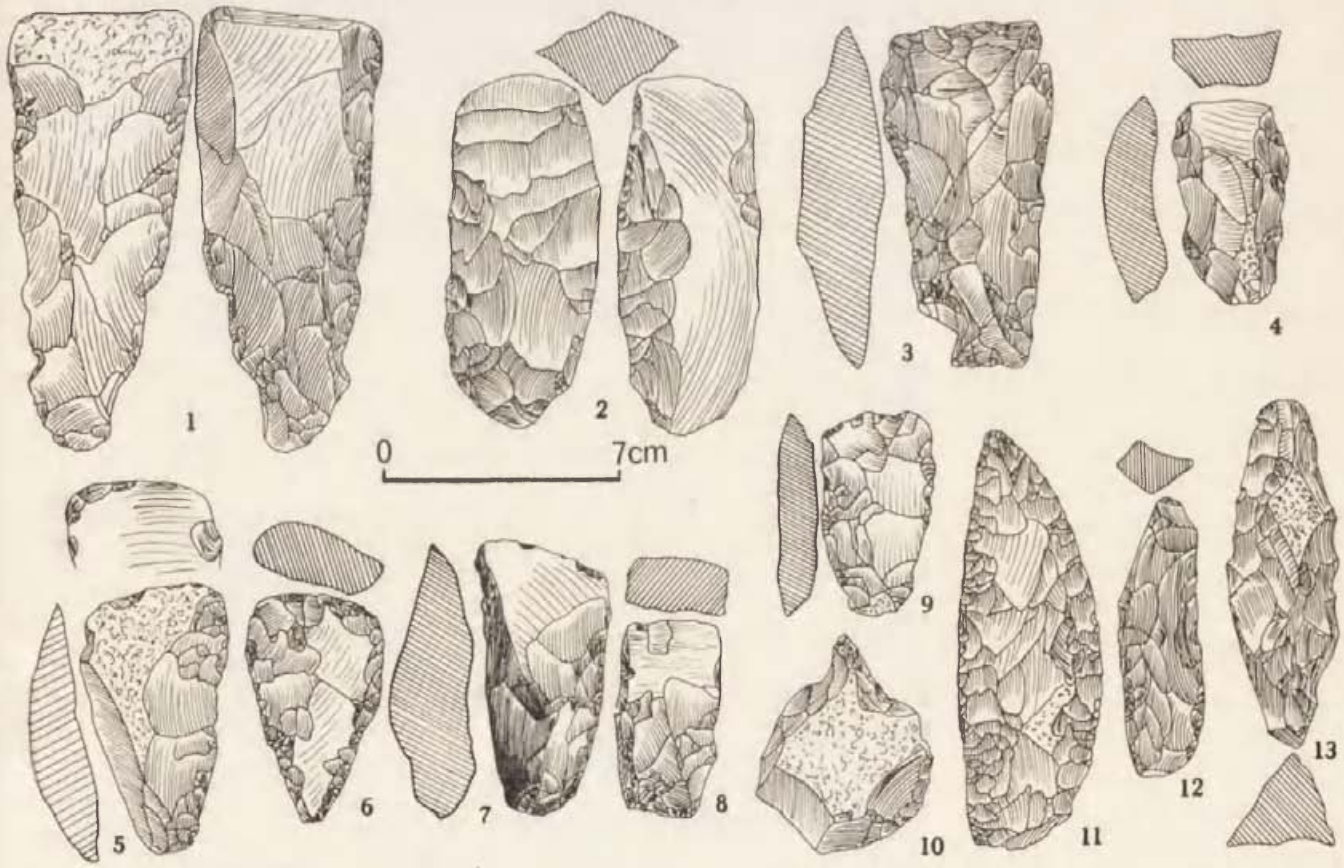

Fig. 24. Trends of the Volhynian flint treatment

1–6, 10–12 — Sapaniv. *7, 9, 13* — Gaye Leviatynskie, Tarnopol dist.

After J. Bryk

local communities of the Polgar, TRB, Corded Ware and Strzyżów cultural complexes occur on the upper Bug. Blades, tetrahedral axes, bifacial axes, bifacial sickles, knives, daggers and spear heads were made in their workshops, in line with the general trends in production in the chipping industries in these cultures (Sulimirski 1957-1959; Svešnikov 1967).

The flint industry workshops linked with the Polgar complex in the territory between the Styr and Horyn rivers has been examined in recent years in Listwin and Ostriv, Rovne dist. (Peleščišin 1976, 375; Svešnikov, Konopla 1975, 351). At Listvin there are also notable flint workshops from the Tripolye complex. Other workshops dating from the end of the BII Tripolye phase are found at Bodaki on the Horyn, near Krzemieniec, Tarnopol dist. However, the majority of workshops from this region are linked with the Corded Ware complex or the Strzyżów culture (Fig. 24). The remains of large workshops which prepared core tools, found by J. Bryk in 1924 in the dunes at Sapaniv and Gaye Leviatynskie near Krzemieniec, belonged to these cultures (1928). Here axes were prepared, usually bifacial, oval (Fig. 24:2–4,9) or sometimes sub-triangular (Fig. 24:1,5,6), as well as picks (Fig. 24:12,13) and bifacial sickles (Fig. 24: 11). Other tools were also found, for example macrolithic perforators (Fig. 24:10). To date we have no data on the structure of the workshops based on Volhynian flint, although in the future they should provide interesting materials to add to the debate on workshops.

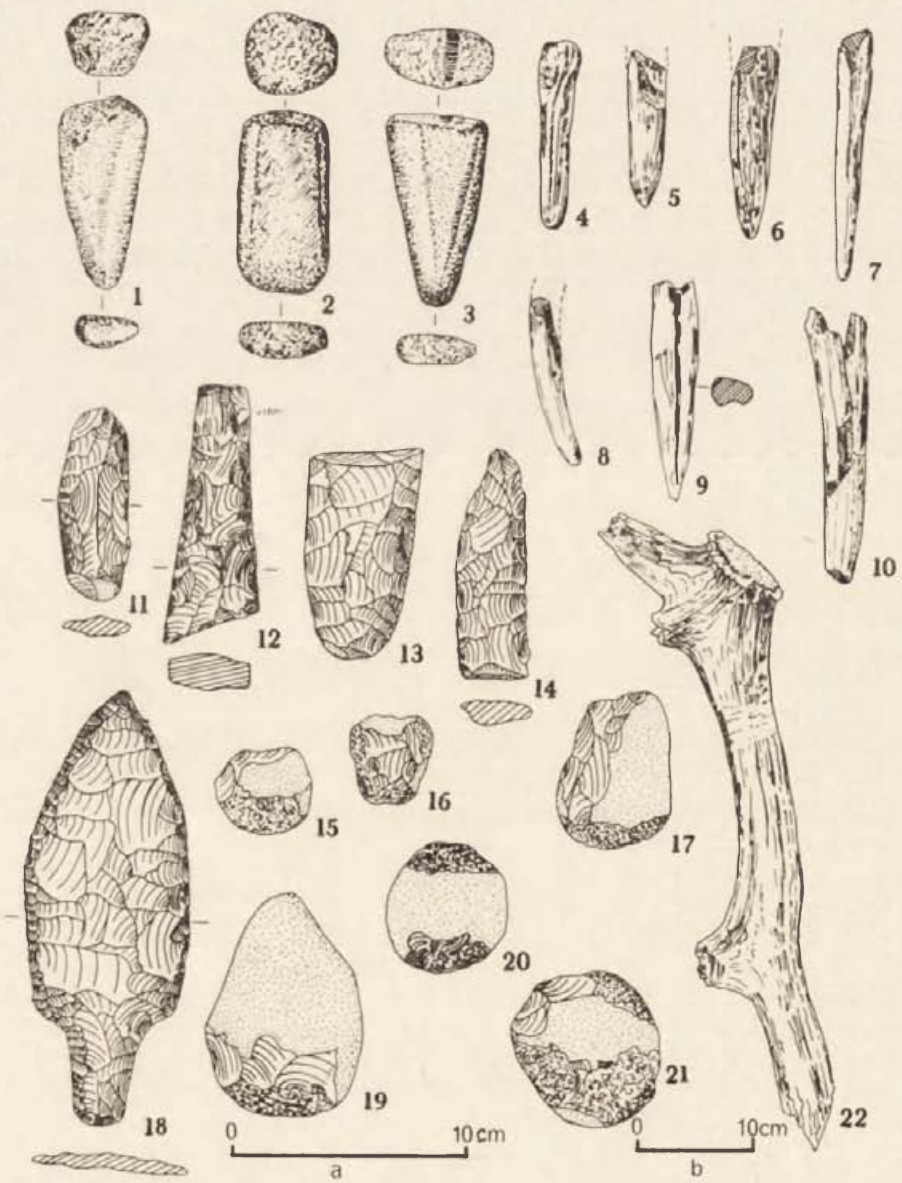

Fig. 25. Finds from settlements of the Gorodok–Zdovbicya culture (Corded Ware complex) near the flint mine of Višnevaya Gora at the village of Gorodok

1, 3, 4, 9, 12 – Zoziv, *2, 5–8, 10, 11, 13, 14, 16–22* – Gorodok, *15* – Velikiy Oleksin, Rovne distr. Scales: *a* – 1–21; *b* – 22
After I. K. Svešnikov

Over the whole territory between the Styr and Horyn rivers, a close geographical link has been found between the mines, flint workshops and settlements. The flint mine at Višnevaya Gora in the village of Gorodok, Rovne dist., was situated on the outskirts of an eponymic settlement from the Gorodok phase of the Gorodok—Zdovbicya culture of the Corded Ware complex (cf. Lech 1981a, 20 f.). On the edge of an excavated working, cortex flakes from initial working of nodules were found, and in the same settlement, an antler pick, wedges, levers for extracting nodules, flint hammerstones, bone punchers, stone retouchers were found together with initially worked forms, and semi-products for bifacial flint tools and the waste materials from their production (Fig. 25). Between 500 m and 5 km from the mine, the remains of more than 20 settlements from the Corded Ware complex were found, with analogous tools and workshop remains.

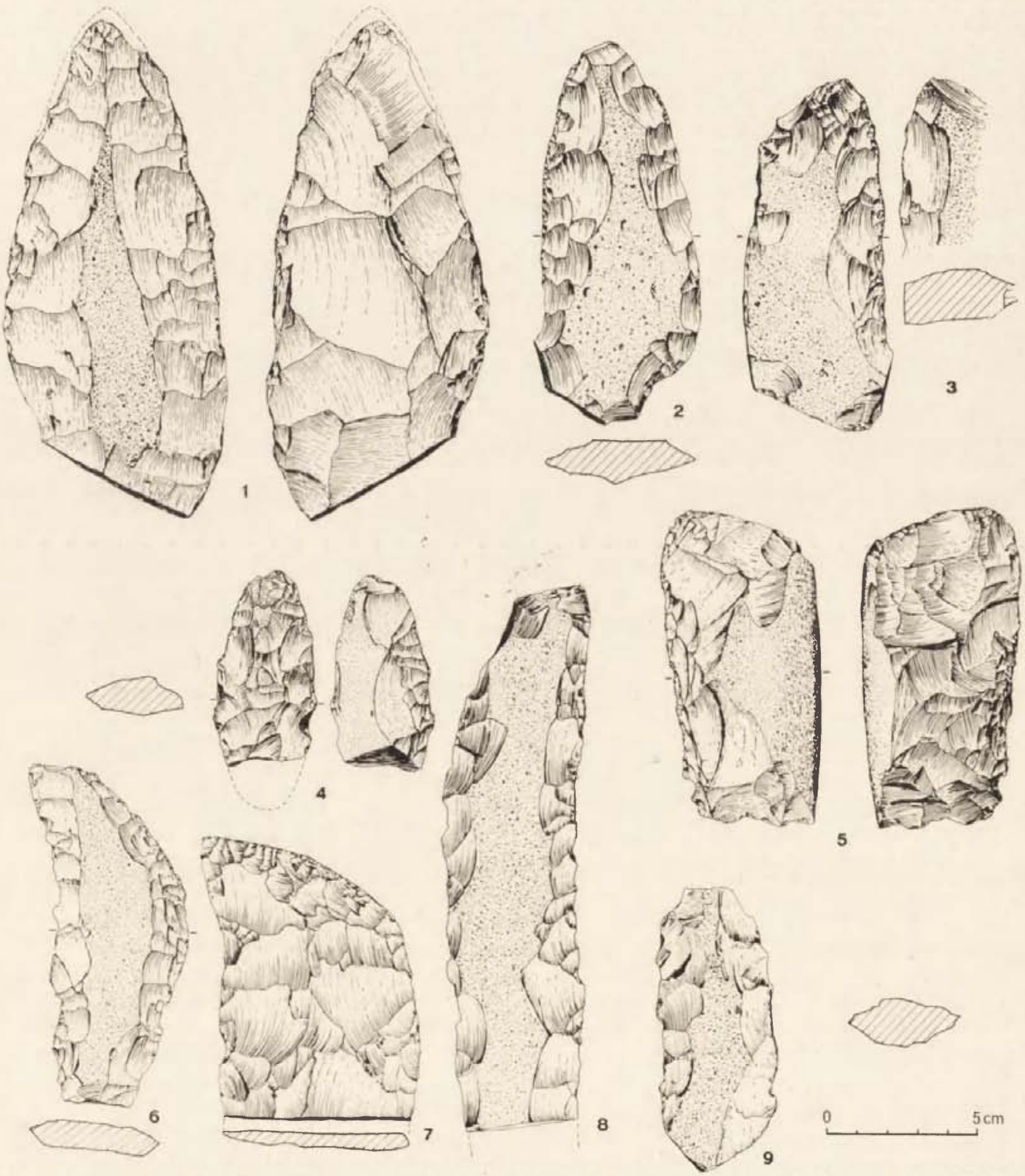

Fig. 26. Baiersdorf, Kelheim dist. Trends of raw material treatment

After M. Moser

Fig. 27. Rijckholt—St. Geertruid, Maastricht dist. Flint mine. Trends of raw material treatment, following P. J. Felder.
Photo by J. Lech

Fig. 28. Rijckholt — St.Geertruid. Flint mine. A hoard of flint picks at the bottom of a shaft
a — picks; *b* — hammerstone After P. J. Felder and P. C. Rademakers

In the northern part of West Volhynia, the flint mine at Polowla, near Sarny, Rovne dist., was sited right in the area of the settlement from the Zdovbicya culture (Svešnikov 1967; 1969-I; 1974, 84 f., 97–99). Recent research has discovered new flint workshops from the Strzyżów culture in this region. A workshop in which bifacial axes were prepared was found in the settlement at Pereveredov village, Rovne dist., on the right bank of the Ikva river. Another workshop producing bifacial sickles and sub-triangular spear heads with a tang was discovered at Mlynov, Rovne dist., about 500 m from the related settlement. An ellipsoid accumulation, measuring 1.47 × 3.62 m, was the remains of the workshop. We may accept on the basis of this evidence that there were workshops producing various kinds of core tools in the neighbourhood in the same period (Svešnikov, Konopla 1976; 1977).

The workshops on the middle reaches of the Dnestr were mainly linked with the Tripolye complex. These were mainly situated inside dwellings or between dwellings. According to E. K. Černyš, separate workshops began to develop in this region when the Tripolye complex communities mastered the technique of preparing chopping tools from flint — i. e. mainly axes. This may be dated in the B I phase. The Tripolye communities reached the area between the Styr and Horyn rivers, where they obtained the local Volhynian type flint (Černyš 1967-I, 63–65).

In the south of the Franconian Jura and Danubian Bavaria, on the site of mines and in the related work-

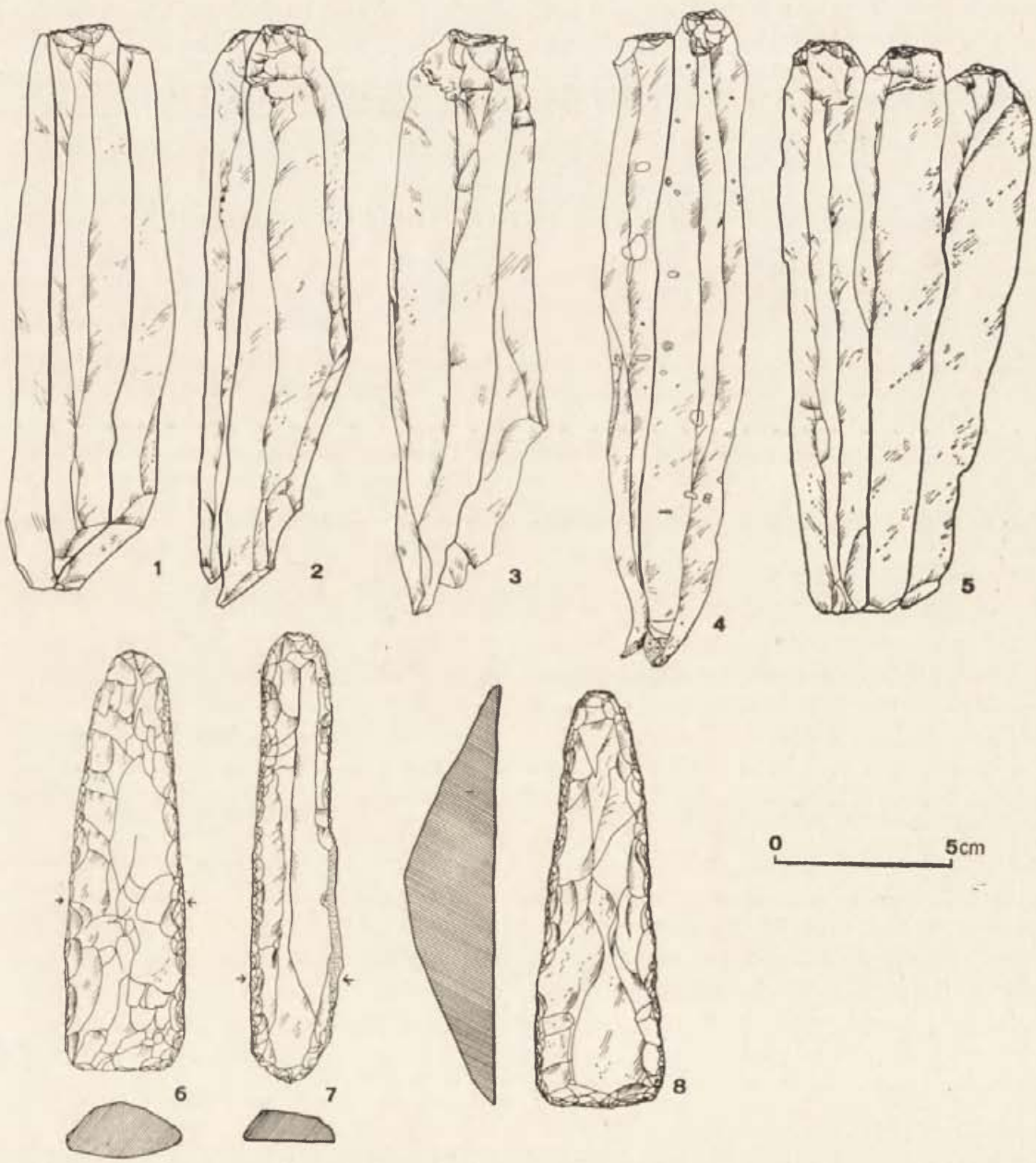

Fig. 29. Rijckholt–St. Geertruid. Flint finds from the mine area

1–5 – A hoard of blades; *6–8* – tools

After M. Ophoven and J. Hama-Nandrin

shops both pre-cores, blade and flake cores were prepared and also various bifacial tools (Reisch 1974-I, 36–44; Moser 1978-I). Pre-core forms and cores suitable for obtaining blade and flake blanks, were prepared to varying extents throughout the whole period when these deposits were exploited. The production of bifacial tools from *Plattensilex* began at the end of the 4th millennium b.c. and continued to the beginning of the 2nd millennium b.c., although the scale at this time has not been determined. Production includes bifacial sickles (Fig. 26:6–8), naturally backed bifacial knives (Fig. 26:3–5) and axes (Fig. 26:4, 9). Specimens of this type have been found at the Lengfeld mine and raw materials exploitation point at Baiersdorf, Kelheim dist.

The workshops on the site of the Rijckholt—St. Geertruid mine produced blade blanks (Fig. 29:1, 5) and probably forms from which these could be obtained elsewhere from the flint extracted. Used cores were often made into picks and axes.[8] The mass use of picks in mining operations, on a scale so far not found at any of the other mines discussed, suggests that there were special workshops preparing these tools (Fig. 27: 1,3–5, 28). Apart from picks, axes were also made from Rijckholt flint, mainly bifacial (Fig. 27:6–9). Axes were among the most important tools produced in the workshops. Other core tools include specimens of the *tranchet-rabot* (Fig. 29:8) and *ciseau* types (Fig. 29:6). The large quantity of materials from workshops obtained on the site of the mine during excavations carried out some years ago has not been studied yet. Only a very interesting hoard of 21 blades has been published and deserves attention (Ophoven, Hamal-Nandrin 1955). This gives an idea of the type of blade blanks which were taken from the site of the mine (Fig. 29:1–5). Blades similar to those from Rijckholt flint are known from the Michelsberg culture settlement, for example. As Rijckholt flint was used on a mass scale among the LBK communities in Limburg and the Aldenhovener Platte, we may expect that workshops connected with this will be found on the sites of settlements and mines or in the vicinity of mines.

V. CONCLUSIONS AND FUTURE LINES OF RESEARCH

The review given earlier (Lech 1981a) of Central European deposits, exploitation methods, known mines and exploitation points, has shown that mining was generally practiced among the early farming communities in this region. Radiocarbon data and indirect evidence confirm that mining took place from the end of the 5th millennium b.c. (LBK) to the 15th century b.c., and in some areas probably over a longer period. The description of production trends in the chipping industries given in other article reveals the significance of the raw materials exploited in the culture of the communities which used them (Lech 1982/1983). One tendency was to adapt the chipping industry to regional possibilities of obtaining raw material, and another, lasting from the LBK to the Bronze Age, was the long-distance distribution of attractive raw materials. However, definition of the scale, mechanisms and significance of this distribution requires further research.

The analysis of workshops on the sites of mines and their vicinity and in settlements is an important element in the reconstruction of the organization of mining work and the distribution of raw materials. This is linked with a problem which has been the subject of controversy for years: work specialization among the early farming communities. Flint mining is generally considered to be the area of activity which was most clearly separated off in everyday life at that time, and which at the same time produced attractive products to exchange and barter. These products were prepared by workshops. But the state of research into flint industry workshops over the whole area of Europe lies far behind research into shafts and methods of raw material exploitation. Some progress has been made in recent years, making it possible to present the results of some new research in this field. In some other cases only the general trends of production in workshops on the site of mines and in their vicinity have been given.

The materials and arguments presented in these three articles pose an interesting problem on the scale of primitive mining, the level of production and the labour intensity of the tasks linked with raw materials exploitation and processing on the site of the mine. I would like to examine these questions in the near future. By taking into account the distribution of raw materials, and the location of settlements and mines against a more general background, it will be possible to discuss anew the social aspects of flint mining among the early farming communities.[9]

Warsaw, June—August 1980

Translated by Emma Harris

[8] Materials in the Museum in Liège and the collection of Ing. P. J. Felder at Cadier en Keer, whom I thank for making this material available to me.

[9] I would like to express my gratitude to Dr. Richard J. Harrison from the University of Bristol for the stylistic revision of the English translation.

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* For other abbreviations see: Lech 1981a, p. 51 f.

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