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THE NEOLITHIC FLINT INDUSTRIES IN THE VISTULA AND ODRA BASINS

In this publication we present 13 flint industries connected with the Neolithic cultures which developed in the Vistula and Odra basins in the Polish lands and the neighbouring west Ukraine. By investigating these industries, including their comparative analysis, we can reconstruct the development of flint processing in the Neolithic in these lands, determine the relations between the archeological culture and the flint industry and present a number of conclusions about the prehistory of the Vistula and Odra basis in the Neolithic.

The purpose of the publication is to present a brief, synthetic outline of the flint industries distinguished by the author as a result of research on the materials of the Neolithic "ceramic" cultures in the Vistula and Odra basins. Even quite recently, in investigations on the Neolithic, ceramics played the major role, while the flint materials were treated only in passing. In Poland this was subject to change, particularly beginning with the 1970s, as a result of the development of specialist research on the flint industry in particular Neolithic cultures. Its results were summed up in a paper which attempted to present the flint processing throughout the Neolithic in the Polish lands (Balcer 1983). In it, the author distinguished the flint industries connected with the ceramic cultures. On the other hand, he considered the Neolithic flint processing there in chronological order, with the framework of the now accepted units of the cultural classification of the Neolithic in the Polish lands (*Prahistoria* 1979), where the criteria and names are mainly based on ceramics. In addition, the main assumption was the conviction of the superiority of the notion and range of the archaeological culture over the flint industry. The archaeological culture is, at least theoretically, distinguished on the basis of the whole of the relics of many fields of man's activity, whereas we make the flint industry distinct on the basis of one of them only – flint processing. Thus, the industry is one of the elements of the culture, no matter what rank it had in the past or what significance we assume that it has now.

In the course of the research it appeared that the "ceramic" cultures did not coincide with the flint industries (Balcer 1983). Therefore, the basic, general cultural systematization of the Neolithic in the Vistula and Odra basins is different from that of the industries as determined only on the basis of the flint materials. Accordingly, it is useful to present separately the industrial systematization irrespective of the systematization of the "ceramic" cultures, but, because of the superiority of the archaeological culture over the flint industry, it is moreover necessary to connect the names of the industries with those of the "ceramic" cultures connected with them.

The industrial systematization given in this paper is slightly different from that presented a few years ago (Balcer 1983). As a result of comparative research, we have introduced some partial modification, linking some industries which previously were considered separate (Balcer 1986b).

Because of the nonuniform degree of knowledge and research on the flint materials from particular Neolithic cultures, the results of their classification given here should be treated as a preliminary working proposal in this field.

I. FLINT INDUSTRY AS A TAXONOMIC UNIT IN THE NEOLITHIC RESEARCH

1. GENERAL IDEA OF THE INDUSTRY

In the Neolithic research, the industry means two things: 1) the field of hand-made work – one of the manufacturing industries – flint processing; 2) a taxonomic unit in the systematization of archaeological materials. In the archaeological literature on the Polish Neolithic, most researchers discuss the former

meaning of it. The present author understands the industry to be a taxonomic unit which is distinguished on the basis of a group of flint finds subject to multi-aspect classification (Balcer 1975, 25 ff.). They are first subject to raw material and typological classifications. As a result of these, we can determine the raw material structures, typology, the stylistics of the artifacts and the numerical structures of whole sets and groups of tools. The data in this range are the features and elements of the higher-order taxonomic units, namely the flint industries.

From studies on the Neolithic materials, we recognize as the main features distinguishing the flint industries in the Neolithic: 1 – morphological, metric and stylistic features of artifacts (typology); 2 – the raw material structure of the assemblages; 3 – the numerical structure of tool groups – in terms of percentage and also a numerical hierarchy of particular kinds of tools in their groups.

An important feature is the determination of raw materials used to a varying degree is some industries in contrast to others. They typology of artifacts is, however, of most significance in the industrial classification. What is significant in this range are the morphological features of cores and blanks, blade cores and blades in particular, semi-finished core tools and all varieties of tools. Among the artifacts which are the typological elements of the industries, among tools in particular, we can distinguish the leading forms, the most characteristic ones, and reshaped ones which occur in a large number of industries or are infrequent in assemblages.

From the particular stylistic features, we can distinguish the same kinds of artifacts of the different industries. They include: 1 – general dimensions, proportions , linear and angular values of the artifacts (measurable features); 2 – the characteristic general forms of pre-cores and cores; 3 – the various morphological details and kinds of retouch of so-called "small" tools from flakes and blades; 4 – the general shape and particular morphological features of some elements (working edges, backs) and the technique of polishing the core tools.

2. STYLISTIC-METRIC STAGES OF THE NEOLITHIC FLINT INDUSTRIES

The fundamental stylistic feature, noticeable in observing large groups of artifacts of particular industries, are their general dimensions. There are distinct differences between e.g. the artifacts of the Mesolithic Chojnice-Pieńki culture, Cracow Industry and the Lesser Poland Industry. We can speak of the general stylistic-metrical stages of the flint industries. They are determined by the size of precores, cores, blanks, semi-finished pieces and tools in the original forms, since the reshaped froms are most frequently much smaller.

Two undefined notions: microlithic and macrolithic, have universally been used. In the Neolithic research, they are not sufficient, therefore we introduce here the notion of the intermediate stage of the mediolithic. Below we define these three terms.

Microlithic – very small dimensions of artifacts, up to 3 cm long.

Mediolithic – small dimensions, 3 to 10 cm long, most frequently, however, about 4–8 cm long.

Macrolithic – large and very large dimensions of artifacts, more than 10 cm long, in practice, in the Neolithic in the Vistula and Odra basins, up to 30 cm long. We define as the moderate macrolithic the stage where the artifacts are as much as about 12–15 cm long, while the maximum macrolithic involves objects more than 15 cm long.

Most frequently, the Neolithic industries were not stylistically uniform. This was caused by the need for the diverse function of the variable sized tools. Therefore, apart from mediolithic ones, microlithic and macrolithic elements may have occurred. The macrolithic represented the technical possibilities and achievements, but apart from large ones, small and tiny tools would be used. Most generally, we can, however, quite readily define the dominating style from most core forms, blanks and semi-finished core tools.

3. COGNITIVE POSSIBILITIES OF THE NEOLITHIC INDUSTRIES

The raw material, stylistic and typological tendencies, observable even in small assemblages of artifacts, determine the industries to a larger extent than the so-called "statistical features" meaning the data from the range of the numerical structure, groups of tools in particular. These structures are frequently unstable, because of the small size of the sets or the functional diversification of the Neolithic sites. The industry reflected the means, course and purposes of the flint production at the specific stages of the development of this field in connection with the stages of the economic development.

The all-sided characterization of the industries is made possible by sites where flint was processed and at the same time tools were used. They mainly include settlements situated close to the flint deposits where

nothing hindered the flint processing. They can function as the leading sites.

At other sites, the industry can only be represented by some elements. They are fragments of artifact groups specific of them. At the mines, they are relics of the earliest production stages, most often in amorphous forms of nonstandard atypical waste (negative choice). In graves or cache stocks, we mainly find selected tools blanks (positive choice). In settlements far from the deposits and in camps, we find traces of not only some stages of the production process, lost or abandoned artifacts in the finished shape, or as reshaped or residual forms of specialized tools, and also atypical direct-use tools. Because of this, we speak of the different "facies" of the industries. To our mind, the materials from the different kinds of sites do not justify the distinguishing of separate taxonomic units. They are incomplete or residual assemblages of artifacts of the same industries which are here represented in fragments, whereas elsewhere they manifest themselves fully. Such assemblages can provide the basis for the reconstruction of the industry by listing its features and elements scattered at the different objects, which, however, represent the same means and purposes of the flint production – the very same industry.

At times, it is necessary to reconstruct the industry on the basis of a small set of flint artifacts. This is particularly the case of the „grave" cultures – mainly represented by finds at graves (e.g. CWC in contrast to cultures with rich settlement finds, such as LPC and TRB).[1]

The industrial classification which is carried out irrespective of the general cultural classification, has a positive meaning in that it orders flint materials. The determination of the features of the industries enriches the cultural characterization by assemblages of the features of flint artifact accompanying ceramics and other materials. It permits the investigation of the relations between the flint processing and the whole of a culture and the use of the flint materials to study such basic prehistorical problems as the origin and relations between the particular "ceramic" cultures. By confronting the cultural systematization based on ceramics with the industrial systematization, we can take a stand about the contents of the cultural divisions made only on the basis of flint materials, e.g. in the research on the Paleolithic and Mesolithic.

II. CHARACTERIZATION OF THE INDUSTRIES

1. THE CRACOW INDUSTRY IN LINEAR POTTERY CULTURE AND LENGYEL-POLGAR COMPLEX

The now accepted range of industry contains the three originally separated industries: the Cracow industry in the LPC, the Opatów and the Brześć Kujawski industries in LgPl (Balcer 1983). As a result of comparative analysis (Balcer 1983, 257–259), we consider it legitimate to connect these industries within one unit. The three previously separated industries represent only the chronological phases and territorial varieties of the very same industry. Its name comes from the name of the Cracow agglomeration, where the leading sites occur for the research of it in the LPC and LgPl.

The industry represented the older period in the typological-technical development of the flint processing in the Danubian cultures, from the beginning of the LPC to the early Eneolithic technological breakthrough at the Saspów industry. The Cracow industry had the greatest range and technological scope of all the industries considered in this paper. It occured in the whole variety of the regional groupings of the Danubian cultures with the different chronology. Most artifacts of the industry indicate a large typological-stylistic similarity. The assemblages show the same raw material tendencies. Most of the same forms can be defined more accurately in terms of culture and chronology only from the ceramic contexts.

Within the industry there were differences between the uplands in the South and the Lowlands, because of the latter's distance from the original flint deposits. As the industry developed, the raw material situation changed. This applied to a lesser degree to the forms of artifacts. We can distinguish two essential forms of industry in two territorial zones: the southern and the northern. The industry had basically two development phases: the older in the LPC and the younger in the LgPl, but within the latter's scope we can speak of the oldest assemblages of the industry in late Lengyel groupings.

The finds of the industry come from a large number of sites. They have been discussed in many papers on the flint processing in the LPC and other

[1] Abbreviations:
CWC – Corded Ware culture,
GAC – Globular Amphora culture,
LPC – Linear Pottery culture,
LgPl – Lengyel-Polgar complex,
RPC – Radial Decorated Pottery culture,
TC – Tripolye culture,
TRB – (Trichter Becher Kultur)Funnel Beaker culture.

Table 1. The percentage proportions of raw materials in the south zone of the Cracow industry

Raw materials	Older phase						Younger phase		
	Cracow-Mogiła site 63	Rzeszów-Piastów	Kormanice	Tarnoszyn Zamość Dist.	Włostowice Lublin Dist.	Skoroszowice	Opatów	Cracow-Mogiła site 48	Cracow-Pleszów
Jurassic-Cracovian flint	**95.2**	**40.5**	9.9	–	–	**75.9**	0.17	**98.0**	**88.85**
Chocolate flint	0.8	3.5	1.3	2.21	**48.1**	–	94.26	1.0	1.54
Świeciechów flint	0.6	21.0	1.3	0.21	13.5	–	0.13	–	0.36
Volhynian flint	–	13.5	**55.0**	**87.90**	15.4	–	–	–	–
Dniester flint	–	X?	2.6	–	–	–	–	–	–
Baltic flint	–	5.5	–	7.47	11.5	24.1	0.26	–	–
Obsidian	3.4	15.5	10.6	–	–	–	5.00	0.9	9.23
Radiolarite	–	0.5	–	–	–	–	–	–	–
Indefinite and others	–	–	19.2	2.21	11.5	–	0.18	–	–
Total	100.0	100.0	99.9	100.00	100.0	100.0	100.00	99.9	100.00

Bold type denotes percentages of the dominating raw materials.
X – occurring in indefinite, small percentage.

linear cultures (J.K.Kozłowski 1970; Kaczanowska, Lech 1977; Lech 1979; Kaczanowska 1985). The artifact groups of the industry are very different in number, most frequently small with unstable structures. This makes it difficult to carry out a general characterization of the industry. The industry appears most complete in the south zone in the uplands in the Upper Vistula basin.

THE CRACOW INDUSTRY IN THE SOUTHERN ZONE. OLSZANICA-OPATÓW VARIETY

This variety of the industry comparises all the regional groupings of the LPC and the early LgPl and the few finds of the Stroked Pottery Culture in the basins of the upper Vistula and the upper Odra in the Lesser Poland uplands, the Lublin region and the loess country in Upper and Lower Silesia.

THE OLDER, OLSZANICA PHASE

The starting point for the characterization of the industry is the discussion of its older stage throughout the whole development of the LPC (about 4600–4000 BC). From the leading site at Cracow-Olszanica (Milisauskas 1976), we called it the Olszanica phase.

RAW MATERIALS

A few varieties of flint were used (Table 1)[2]. The situation changed with the passing of time. In the oldest assemblages in Lower Silesia, the local erratic Baltic flint dominated (Lech 1985). Slightly later, no doubt, the greatest significance was achieved by the Jurassic-Cracow flint. It dominated even close to the chocolate flint deposits, which later increased in proportion. In eastern Lesser Poland, in the Bug basin, Volhynian flint was the main raw material, and Dniester flint also reached there. Świeciechów flint was locally used on a small scale. Cretaceous erratic Baltic flint complemented the fossil materials.

ARTIFACTS AND ASSEMBLAGES OF ARTIFACTS

Most artifacts in the studied zone and stage occur over the whole range of the industry in analogical forms. Therefore, after discussing them in this subsection, we can only refer to the subsection.

PRODUCTION WASTE AND BLANKS. They include cores, flakes and blades.

a. *Blade cores* have some varieties:

A – formed by cores with narrow flaking surfaces, from flattish modules: A1 – flattish cores (Fig. 1:16)[3] with flat sides and points; A2 – carina-

[2] In the numerical tables, we used data published in the followin works: BALCER 1975; 1983; 1985; BOGUCKA-ŚLASKA 1977; CABALSKA 1963; DOMAŃSKA 1974; 1982; DOMAŃSKA, KOŚKO 1983; DZIEDUSZYCKA-MACHNIKOWA, LECH 1976; GRYGIEL 1979; KACZANOWSKA 1985; KACZANOWSKA, LECH 1977; KACZANOWSKA, J.K.KOZŁOWSKI 1971; A.KEMPISTY 1978; E.KEMPISTY, WIĘCKOWSKA 1983; KOSKO, PRINKE 1977; KOWIAŃSKA-PIASZYKOWA, KOBUSIEWICZ 1966; J.K.KOZŁOWSKI 1959; 1970; 1972; KRÓL 1978; LECH 1986; LECH, NOWORYTA 1979; MACHNIK 1966; MAJCHRZAK 1978; MILISAUSKAS 1976; 1978; MŁYNARCZYK 1982; NIESIOŁOWSKA-ŚRENIOWSKA 1980; TUNIA 1979; UZAROWICZOWA 1970; WIĘCKOWSKA 1971; WIŚLAŃSKI 1966; WOJCIECHOWSKI 1981; ZAKOŚCIELNA 1981.

[3] The figures were plotted after: BALCER 1975; 1977; 1983; 1985; BIBIKOV 1953; BOGUCKA-ŚLASKA 1977; DOMAŃSKA 1974; DOMAŃSKA, KOŚKO 1983; KACZANOWSKA, J.K.KOZŁOWSKI 1971; A.KEMPISTY 1978; E.KEMPISTY, WIĘCKOWSKA 1983; KOŚKO, PRINKE 1977; KRÓL 1978; LECH, NOWORYTA 1979; MAJCHRZAK 1978; MŁYNARCZYK 1982; UZAREWICZOWA, KOWALCZYK 1973; WAGA 1931; WIĘCKOWSKA 1971, and on the basis of the original finds in the course of excavations by L.Gabałówna, R.Grygiel, K. Jażdżewski, S. Milisauskas and J. Kruk, J. Pavelčik, W. Tetzlaff, the Institute of Archaeology of the Ukrainian Academy of Sciences, the Nowa Huta Branch of the Archaeological Museum in Cracow and the Kujawy Research Group at the Institute of Archaeology, Adam Mickiewicz University in Poznań. The figures were drawn by B.Balcer and by W.Gawrysiak and H.Łęgowiecka.

ted and subcarinated pieces (Fig. 1: 20), with the sides converging on edgy or rounded tops. They are characterized by rich working. Pre-cores from such cores are only known from the younger phase of the Cracow industry in the southern zone. The greatest of the discussed cores are 6–7 high, 12–13.5 cm thick-long (from the flaking surface to the back), and about 5.5 cm wide. As they were much shortened during the use, they came to resemble the subconical cores.

B – cores with wide flaking surfaces: B1 – subconical (Fig. 1: 1) with a circular flaking surface and pointed tops, or rounded tops, with small heights up to 7 cm, diameter up to 5 cm: B2 – semiconical, resembling cone sections with flaking surfaces on the wider sides of modules. They are wider but thinner than subconical cores.

C – other blade cores: box-like, cylindrical, amorphous. The blade cores were altered. As a result of a change in orientation, a few two-platform cores occur. They were also transformed into flake cores.

b. *Flake cores* ordinary and counter shock, bipolar pieces arose from flint pieces without working. Approximately, the best-formed are subconical ones. There are a few discoidal ones with circular flaking surfaces. There dominate amorphous, multi-sided and

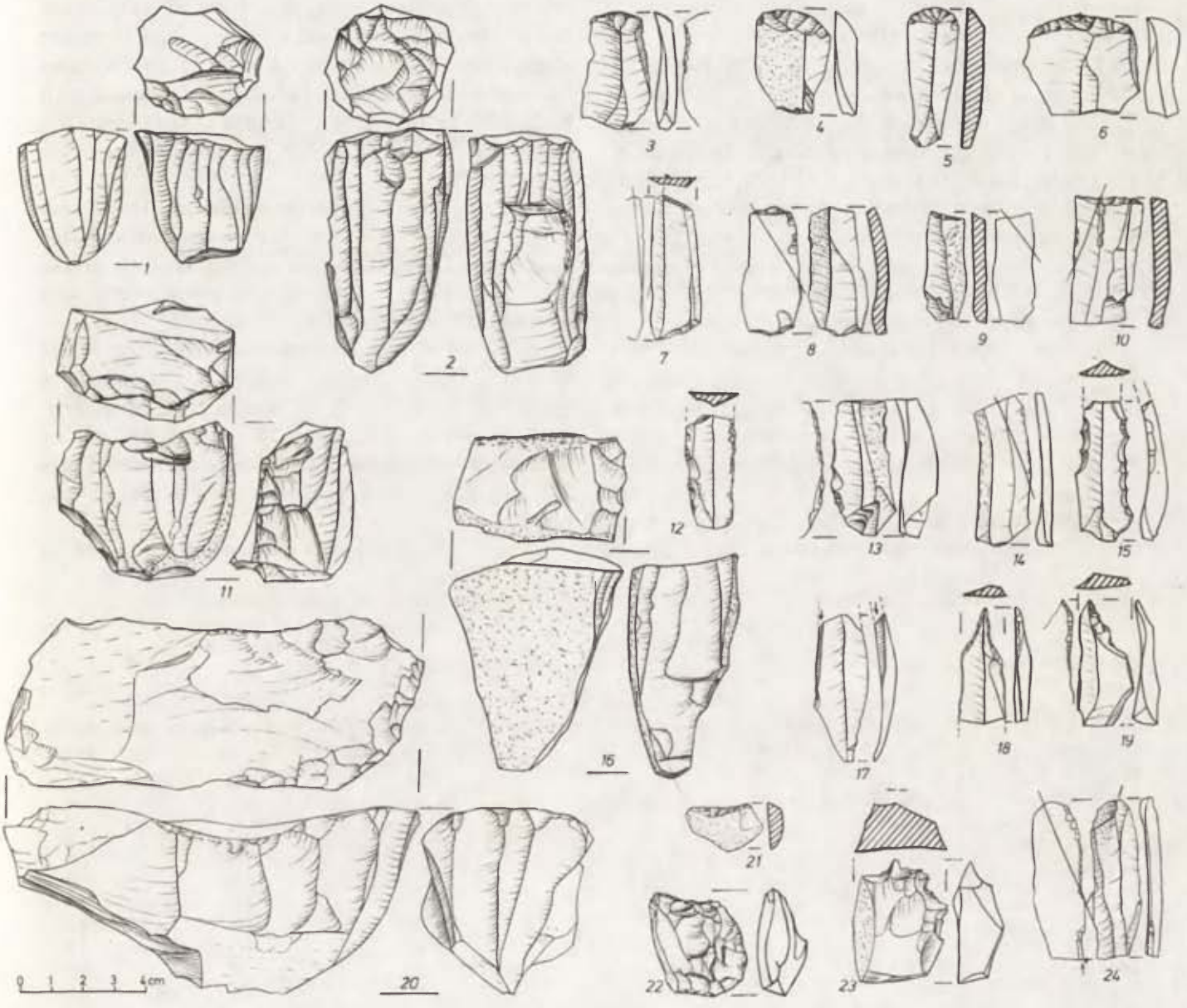

Fig. 1. Cracow industry, south variety, older, Olszanica phase. Artifacts from Volhynian (*1, 3, 4, 6–9, 11–13, 24*), chocolate (*5*), Jurassic-Cracovian (*16, 20*), Świeciechów (*10, 14*), Cretaceous Baltic (*15, 18, 19, 22–24*) flints and obsidian (*2, 17, 21*)

1–4, 8, 13, 14, 16, 17, 20, 21 – Kormanice, Przemyśl District; *5, 6, 9, 10, 11, 24* – Rzeszów-Piastów; *7, 12, 22* – Tarnoszyn, Zamość District; *15, 18, 19, 23* – Pietrowice Wielkie, Katowice District (see Footnote 2)

multi-platform cores after orientation changes with diameters of about 3–5 cm. Bipolar cores exploited by the counter bipolar technique, mainly used in the case of poor raw material supply in Lower Silesia, are known from the settlement at Skoroszowice, Wrocław District (Wojciechowski 1981, 47, 55).

c. *Blanks.* The basic blanks were blades, greatly differentiated, 3 to more than 10 cm long. Of the blades from the Olszanica settlement most are 45–53 cm long (Milisauskas 1976, 39). Other sites most often yielded small blades, 3–5 cm long, 10–15 mm wide and 2–5 mm thick, which are typically mediolithic. There are also small microlithic blades. On the other hand, there are distinct blades from Volhynian flint, 6–10.5 cm long, known from the Bug basin.

Blanks were also blades with broken off curved tops of pieces of blades. The technique of alteration of blades by snapping (Dzieduszycka-Machnikowa, Lech 1976) persisted as long as the industries of the Danubian cultures existed.

The flakes came from the processing of pre-cores and cores and also from a purposeful use of cores. They were most often small and very small, up to 3 cm long. Mostly larger flakes were used as blanks. Of the largest ones, the on-site forms emerged.

Tools. We discuss them in the order of numerical hierarchy established from an analysis of tool groups from a number of sites (Table 2).

a. *Endscrapers* on blades, elongated and short, with medium or weakly rounded scrapers dominate (Fig. 1: 3–6). There are distinct endscrapers with converging sides (Fig. 1: 5). There are quite few endscrapers on flakes. Some of the endscrapers have retouched sides.

b. *Retouched blades and those with traces of use* (Fig. 1: 12–15). The small dimensions of the blanks made it difficult to apply any firmer retouch. Therefore, there are infrequent blades with a continuous retouch. We know notched blades, with retouched notches, with an utilitarian retouch, polished as a result of their use as sickle insets. There are infrequent small blades retouched on the bottom sides and denticulated blades (Fig. 1: 15).

c. *Truncations and pointed* arch backed blades are rather slim or strictly slim, most often 3–5 cm long, and 1–2 cm wide (Fig. 1: 7–10). Their oblique backs are most often inclined at an angle of 50–70° with respect to the axis. There are double and trapezoid truncations (Fig. 1: 7), and the quite infrequent truncations on snapped blades without end retouch made by the planes of the snap faces. From the Rzeszów region we know truncations with transverse, slightly indented or straight, backs (Fig. 1: 10) with analogues in the Mesolithic Janisławice culture. And there are single specimens where the retouch of the tops enters the side and which have the shape of pointed arch backed blades (Fig. 2: 7) 80 percent of the objects are polished indicating that they were used as the sickle insets.

d. *Perforators — groovers and borers.* Tools from blades and flakes. Groovers have retouched one-face points but borers have alternating retouch points (Fig. 1: 19). There are characteristic specimens with thin separated points (Fig. 1: 18).

e. *Retouched flakes side-scrapers and denticulated tools* (Fig. 1: 23). They are tools from the differently retouched flakes, mostly worked in part, irregularly. The specimens with continuous steep retouch or semi-steep one can be defined as sidescrapers. There are also flakes with notched and denticulated retouch.

f. *Other tools* are quite a few of them and in

Table 2. The percentage structure of tool groups in the south zone of the Cracow industry

Tools	Older phase						Younger phase			On average
	Cracow-Olszanica	Cracow-Mogila Site 63	Rzeszów-Piastów	Kormanice	Tarnoszyn	Skoroszowice	Opatów	Cracow-Mogila Site 48	Cracow-Pleszów	
Endscrapers	34.1	64.9	61.4	23.8	46.5	33.0	20.93	45.7	17.8	38.7
Retouched blades and those with use traces	11.2	21.6	3.5	30.9	18.6	29.6	34.02	11.0	23.6	20.5
Truncations, backed pieces	11.7	5.0	17.6	16.7	14.0	12.2	7.48	24.8	37.4	16.3
Retouched flakes	12.9	–	–	11.9	7.0	14.8	17.57	7.6	5.6	9.2
Perforators	2.5	3.5	10.5	7.1	–	6.0	2.46	1.0	1.0	3.8
Sidescrapers	16.7	1.7	3.5	–	2.3	–	–	2.1	4.1	3.4
Burins	5.1	1.7	3.5	4.7	7.0	0.9	0.56	2.4	3.1	3.2
Denticulated tools	–	–	–	4.7	2.3	–	–	–	2.5	1.1
Trapezes	–	–	–	–	–	0.9	1.68	1.3	–	0.3
Picks	–	–	–	–	–	–	–	0.5	0.8	0.1
Others and indefinite	5.8	–	–	–	2.3	2.6	15.31	3.7	4.0	3.5
Total %	100.0	99.9	100.0	100.0	100.0	100.0	100.00	100.0	99.9	100.0
Tools number	760	57	57	42	43	115	535	383	393	2367

Table 3. The general structure of the Cracow industry flint material assemblages

Artifacts varieties	South zone						North zone				
	older phase				younger phase		older phase			younger phase	
	Cracow-Olszanica Regions B1,D3	Kormanice	Tarnoszyn	Skoroszowice	Opatów	Cracow-Mogila Site 48	Brześć Kuj. LPC features	Żalęcino Szczecin District	Konary Bydgoszcz District	Brześć Kuj. LgPL features	Tynrec Maly settlement
Core forms*	3.00	13.3	6.6	4.8	1.10	7.0	10.3	3.6	4.4	8.5	6.2
Blades	92.39	8.0	18.4	18.8	27.00	22.2	14.6	6.4	10.1	17.5	37.2
Flakes		50.7	41.9	43.8	62.70	57.6	54.5	59.9	55.3	55.8	22.5
Tools	4.61	28.0	33.1	32.6	9.20	13.2	20.7	30.1	30.2	18.2	34.1
Total	100.00	100.0	100.0	100.0	100.00	100.0	100.0	100.0	100.0	100.0	100.0
P index**	20.7	2.8	2.0	2.1	9.8	6.6	4.7	2.3	2.3	4.5	1.9
Artifacts number	22,000	151	136	356	5796	2893	213	329	159	423	129

* These forms include pre-cores, flake, blade and counter shock bipolar cores.
** *P* index – the ratio of the amount of the production waste and blanks to tools.

general they are hardly distinct burins, at times multiple ones, sometimes made from truncations. Sporadically, combined tools occur: endscraper + truncation, retouched blade + burin (Fig. 1: 24). Blade cores, flake cores or pieces of unprocessed flint were used as hammer stones, therefore these forms are most often not included in the intentionally formed tools. From some sites there come trapezes from pieces of blades and scaled pieces (Fig. 1: 22).

g. *Sickle insets.* Most often, they were truncations, probably produced for the purpose of being used as segments of the blades of early agricultural sickles, made up from 3–5 flint insets (Fig. 1: 7–10). Substitute insets were also small endscrapers, raw blades or retouched ones (Fig. 1: 14) or even other kinds of tools and flakes. This is indicated by traces of the sickle-like use on these tools.

h. *Obsidian finds.* They are usually microlithic. The Olszanica small blades are 4–29 mm long and about 10 mm wide (Milisauskas 1976, 46 ff.). Kormanice, Przemyśl District (research by M. Proksa) gave mediolithic obsidian blade cores, 77 and 43 mm high (Fig. 1: 2), and one of the blades was 50 mm long. The few obsidian tools are blades and partly retouched flakes, sidescrapers (Fig. 1: 21), denticulated tools, a burin (Fig. 1: 17) and a truncation – a sickle inset.

Assemblages of artifacts. Usually, there are quite small assemblages of finds at the LPC sites, and there are only greater ones at settlements near the deposits of Jurassic-Cracovian flint, such as the Cracow-Olszanica settlement (Milisauskas 1978). The general structure of these assemblages is characterized by the productivity index *P* (Table 3)[4]. For settlements close to the deposits it is high, namely 5.9–20.7 and for settlements far from the deposits it is low, namely 2.1–2.81.

Usually, the tool groups are quite small. J. K. Kozłowski (1970, 84) found the lack of stability in the numerical structures of the flint tool groups of the LPC. In the numerical hierarchy of these groups, endscrapers came first, and so did retouched blades and truncations, totalling at 80–90% They were the basic forms, ones that were commonly encountered and those that reflected the stylistics of the industry – the mediolithic with elements of the microlithic.

THE YOUNGER OPATÓW PHASE

It covers the finds from the early LgPl in the Samborzec, Pleszów and Malice groups, however, excluding the materials from the Lublin District. We connect the latter, which A. Zakościelna (1981, 6, 10–12) assigned to the Malice group, with the Sąspów industry. This stage dates from the period between about 4000–3800 and 3500–3300 BC. The largest group of finds comes from the settlement of the Samborzec group at Opatów, Tarnobrzeg District (Więckowska 1971). There are smaller of the settlements at Site 48 in Cracow-Mogiła (Kaczanowska, J. K. Kozłowski 1971) and in Cracow-Pleszów (Cabalska 1963). This stage probably involved part of the materials from Jurassic flint mines at Sąspów, Cracow District (Dzieduszycka-Machnikowa, Lech 1976; Lech 1981a, 68–76) and of the chocolate flint at Tomaszów, Radom District (Schild, Królik, Marczak 1985).

We can include in the earlier stage of the Cracow industry the flint materials from the Lengyel culture settlement at Zarzyca, Wrocław District (Burdukiewicz 1982), situated in Lower Silesia, on the west border, within the range of the southern version of the industry.

[4] P (production) index illustrating the ratio between the number (of specimens) of production waste and the number of tools.

The flint finds from the early LgPl in the southern zone indicate only slight evolution changes compared with the older ones (Balcer 1983, 257ff.), but they represent the same industry. In terms of raw materials, the role of chocolate flint had grown, as, close to the deposits at least, it became the basic raw material.

Witht the discussed stage, we connect pre-cores, up to 10cm high, with rich working, known from settlements and mines (Dzieduszycka-Machnikowa, Lech 1976; Schild, Królik, Marczak 1985, 56–58), meant for blade cores, with narrow flaking surfaces, subcarinated and subconical. Blade cores (Fig. 2: 1), flake cores, blanks and most tools, such as endscrapers (Fig. 2: 2–4), retouched blades (Fig. 2: 18, 21, 22), truncations (Fig. 2: 5, 6), a backed piece (Fig. 2: 7), perforators (Fig. 2: 8, 9, 14, 20), do not differ from those from the older phase. According to our calculations, there was an increase in the size of the blades by about 8%. Specimens 8 to about 10 cm long are more frequent.

Among the tools (Fig. 2: 2–26), there are sporadic blades with distinct continuous retouch, on one or both sides and with retouch along the entire perimeter (Fig. 2: 15, 16). The first blades appeared with oblique parallel retouch (Fig. 2: 15) and there were also specimens with pointed tops (Fig. 2: 17, 19). There are still very few burins (Fig. 2: 24), and denticulated fools (Fig. 2: 25).

From settlements, graves and mines, there come small three-wall and four-wall picks (Fig. 2: 23) with pointed tops (Lech 1980). From the Opatów settlement we know a hoe-like tool (Fig. 2: 26).

In the tool groups there was a distinct increase in the number of trapezes (Fig. 2: 10–14; Zakościelna 1985). The material from settlements showed a relatively high index $P = 6–10$ (Table 3).

THE CRACOW INDUSTRY IN THE STROKED LPC

This culture is very poorly represented in the basin of the Upper Odra in Lower Silesia. An assemblage of more than 30 Jurassic flint artifacts comes from the settlement at Wąwolnica (former Strzelin County: Bukowska-Gedigowa, Gediga 1963). It included two subconical blade cores, about 35 mm high, 14 blades, 25–54 mm long, 17 flakes and chunks, and a truncation and a small retouched bladelet – probably a sickle inset.

A small assemblage of finds comes from the settlement at Niemcza, Wałbrzych District (Lech 1981b). Baltic flint dominated there, and a subcarinated core, counter shock, bipolar core endscrapers and truncations occurred (Lech 1981b, 45, Fig. 2). The Stroked LPC finds are not different from the flint artifacts of the LPC and the early LgPl. J.K. Kozłowski and S.K. Kozłowski (1977, 268) already suggested this.

THE CRACOW INDUSTRY IN THE NORTHERN ZONE. THE BRZEŚĆ KUJAWSKI VARIETY

The finds from the Linear cultures in Kujawy and Greater Poland, the Pyrzyce region in West Pomerania and the Jordanów group in the Silesian Valley in Lower Silesia, in the foreland of the Lowlands have been assigned to this variety. In the northern zone the

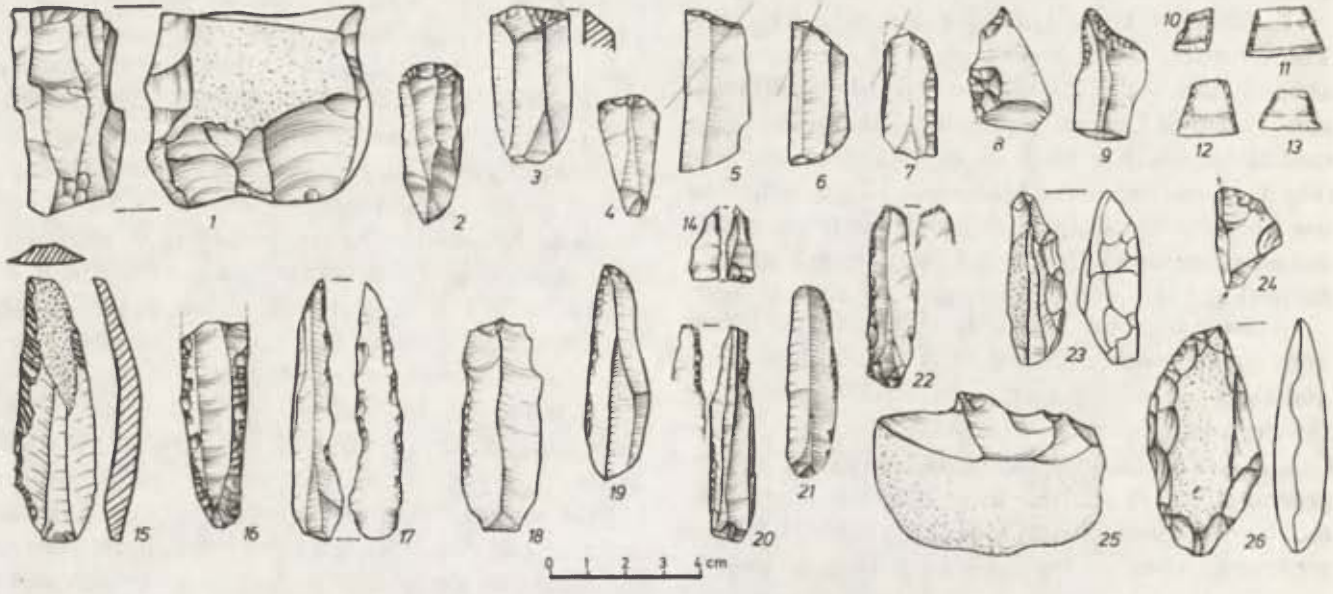

Fig. 2 Cracow industry, south variety, younger, Opatów phase.

1, 3, 5–7, 12, 17–19, 23, 25 – Cracow-Nowa Huta-Mogiła, Site 48 (Jurassic-Cracovian flint); *2, 4, 8–11, 13, 14, 16, 20–22, 24, 26* – Opatów, *15* – Zawichost, Pieczyska site, Tarnobrzeg District (chocolate flint)

Cracow industry developed in the Lowlands far away from the original flint deposits. There is no doubt that the shortage of raw materials had an impact on the large significance of the counter shock bipolar technique in this version. Usually, the assemblages of flint finds from sites within the zone are very small. Larger ones come only from the settlements at Brześć Kujawski, Włocławek District.

R. Grygiel (1979) considered the development of the Linear cultures in Kujawy in three periods equivalent to the LPC and the early and late Lengyel culture, and according to L. Czerniak (1980), to the LPC and stages I and II–III of the so-called late LPC. Initially, we connected with them two industries: the Cracow industry in the LPC and the Brześć Kujawski industry in the late Lengyel group of the same name. Following comparative research (Balcer 1983, 258 ff.), we now believe that what occureed here was the same Cracow industry, and that the previously differentiated Brześć Kuj. industry represented its earliest phase.

THE OLDER PHASE

It coincided with the whole time of existence of the LPC and the early Lengyel culture. The flint materials of the two cultures come from Kujawy and LPC finds occur only in the Pyrzyce region.

RAW MATERIALS

The situation in terms of raw materials was differentiated and variable. In the LPC, in Kujawy, chocolate flint dominated, which was brought from a distance of about 250 km. In the Pyrzyce region the basic raw material was the local erratic Baltic flint (Balcer 1985). Chocolate and Jurassic flints reached there from a distance of 450–470 km. There were also distinctly large finds of chocolate and Jurassic flints at early Lengyel sites. Later on their imports decreased and stopped.

ARTIFACTS AND ASSEMBLAGES OF ARTIFACTS

There are fewer typological elements here compared with the Olszanica-Opatów variety.

Chipping Waste and Blanks. There are a few subcarinated and subconical blade cores (Fig. 3: 21, 26). The flake cores are ordinary and counter shock bipolar (Fig. 3: 23). There was a conspicuous cycle of using in turn pieces of the raw material to make a blade core → flake core → counter shock bipolar core. The counter shock bipolar technique was of primary significance in the maximum use of small pieces of erratic flint and imports. This involves the problem of the functional interpretation of counter shock bipolar cores. Thinned-out, flat counter shock bipolar cores with sharp edge poles from flat pieces, flakes, blades and blade tools could be used as cutting tools. This was confirmed by the experimental and comparative research by W. Migal (1987). On the other hand, the few tools from chips indicate that in the northern variety of the Cracow industry counter shock bipolar were also flake cores. They, too, could have been used later as tools. Because it is impossible to distinguish between scaled pieces – tools and counter shock bipolar cores from the LPC settlements in the Pyrzyce region, I include all of them in the tool group (Balcer 1985, 18, 25 ff.).

Blanks. Small and very small flakes, up to 4 cm long, dominate. Most blades are 30–40 mm long, 10–15 mm wide and 5–6 mm thick. On the other hand, the tools indicate that greater blades, 40–80 mm long and about 20 mm wide, were used (Fig. 3: 24, 25).

Tools. Flake and blade endscrapers are the most numerous (Fig. 3: 1–5, 7). The universally met objects include retouched blades and those with traces of use (Fig. 3: 11, 19, 24, 25), truncations (Fig. 3: 8–11) and backed pieces (Fig. 3: 12). There are also characteristic perforators and groovers (Fig. 3: 6), and retouched flakes, sidescrapers (Fig. 3: 13, 22), burins, denticulated tools (Fig. 3: 20) and trapezes. In the Pyrzyce region there was a particularly large proportion of chisel-like scaled pieces (Fig. 3: 15–18), also known from Kujawy. The sickle insets were, apart from forms known from the southern zone, raw (Fig. 3: 14) and retouched flakes, and even a denticulated sidescraper, probably because of shortage of appropriate blanks for truncations. What dominated were the mediolithic stylistics bordering on the microlithic with some part of microlithic elements. The indexes *P* were small 1.8–4.7.

THE YOUNGER PHASE

It was connected with the late Lengyel groups of Brześć Kujawski and Jordanów in Kujawy and Lower Silesia. Previously we assigned those finds to the Brześć Kuj. industry (Balcer 1983, 116, ff.), but now we connect them with a variety of the Cracow industry of the same name. The flint processing in these contemporary late Lengyel groups was distinctly connected by a number of raw material and typological-technical trends, which were at the same time characteristic of the Cracow industry, and slightly different from those found for the Sąspów industry (see p. 60–64).

RAW MATERIALS

A characteristic fact was the distinct domination of the varieties of erratic Baltic flint (Table 4). The

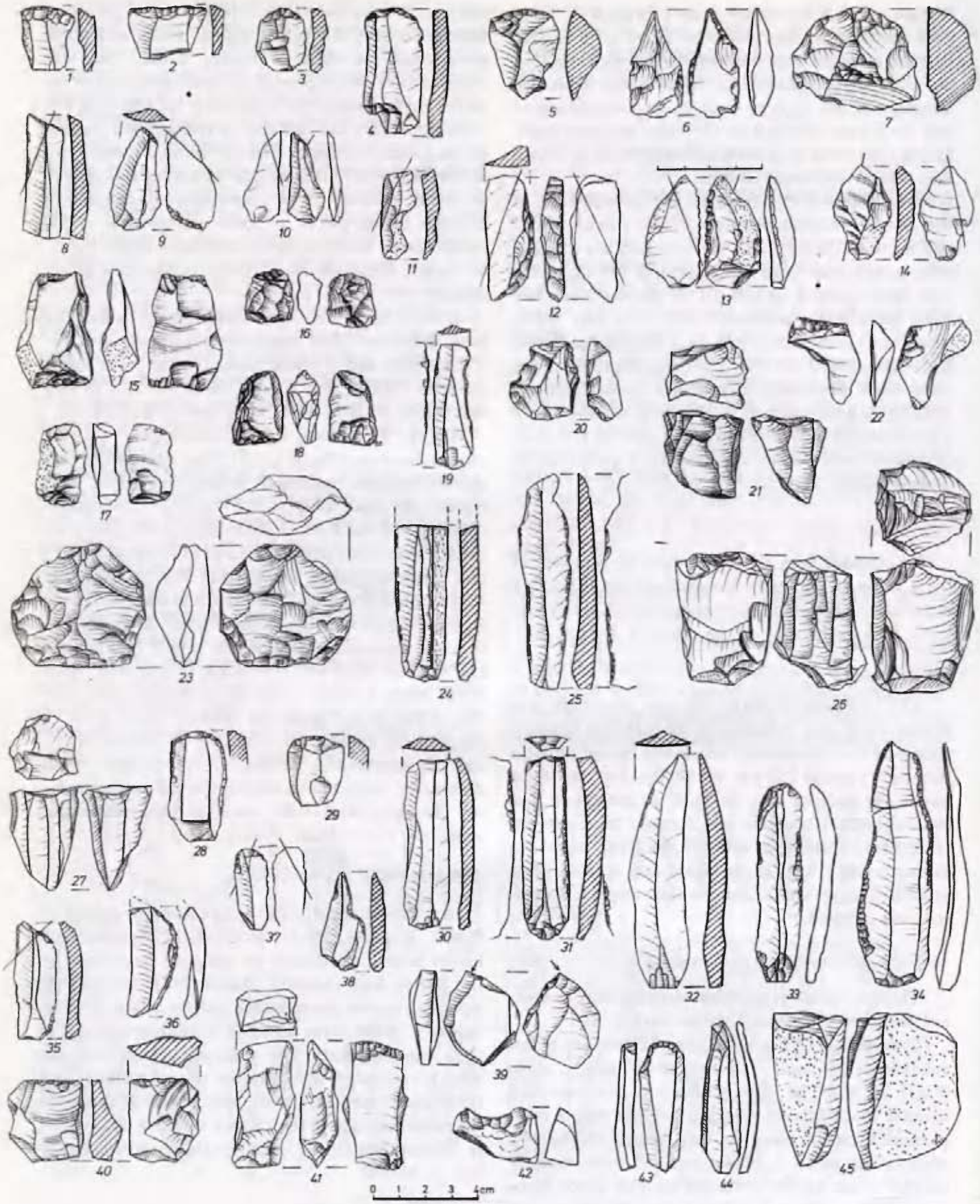

Fig. 3. Cracow industry, north Brześć Kujawski variety, older (*1–26*) and younger (*27–45*) phase. Artifacts from chocolate (*1, 2, 8, 9, 19, 21, 24, 26, 37*), Jurassic (*25, 31*?) and Baltic (others) flints

1, 2, 8, 9, 19, 23, 26–32, 35–42 – Brześć Kujawski, Włocławek District; *3–5, 7, 10–12, 14, 20–22* – Żalęcino, *6, 13, 15–18* – Żuków, Szczecin District *24, 25* – Radziejów, Site 5, Włocławek District; *33, 34* – Dobkowice, *43–45* – Tyniec Mały, Wrocław District

Table 4. The raw material structure of the flint materials of the Cracow industry, Brześć Kujawski variety, in the north zone

Flint	Older phase					Younger phase				
						early LgPl		late LgPl		
	Brześć Kujawski		Radziejów Kujawski Włocławek Dist.	Żalęcino Szczecin Dist.		Radziejów Kuj.	Konary	Brześć Kujawski		Tyniec Mały settlement
	total	tools	total	total	tools	total	total	total	tools	total
Baltic	36.6	15.9	19.6	**95.7**	**93.9**	9.8	90.1	93.3	79.2	99
Chocolate	**59.6**	**77.3**	**78.3**	3.3	5.1	90.2	8.6	4.3	12.5	–
Jurassic-Cracovian	–	–	–	0.9	1.0	–	1.3	2.2	6.9	1
Świeciechów	1.4	6.8	–	–	–	–	–	0.2	1.4	–
Indefinite	2.4	–	2.1	–	–	–	–	–	–	–
Total	100.0	100.0	100.0	99.9	100.0	100.0	100.0	100.0	100.0	100.0

Bold type denotes percentages of the dominating raw materials.

imports of raw materials from Lesser Poland greatly decreased or even stopped. Use was e.g. made of the better varieties of the Baltic flint. In the Brześć Kujawski group this was grey-bluish flint occurring in relatively large pieces in the Noteć basin, and in the Jordanów group it was Silesian-Moravian flint from secondary deposits more than 100 km distant (Balcer 1977, 7).

ARTIFACTS AND ASSEMBLAGES OF ARTIFACTS

Very small assemblages of artifacts come from most sites in Kujawy (Domańska 1982). In 1978, R. Grygiel was kind enough to provide me with 390 specimens from cottages and dug-outs at Brześć Kuj. 218 specimens come from graves and settlement at Tyniec Mały and Dobkowice, Wrocław District, of the Jordanów group (Lech, Noworyta 1979; Górecka, Noworyta 1980; Lech 1986).

The artifacts have analogous forms, the same or slightly larger dimensions than those of the older development period of the Cracow industry in the same zone. From Brześć Kuj. there come two blade cores, one subconical (Fig. 3: 27) and another barrel-like, 30–37 mm high, from Tyniec Mały there come subcarinated cores, including a specimen with 59 × 40 × 27 mm (Fig. 3: 45) and subconical cores (Lech 1986, 81). There are known small flake cores with changed orientation and counter shock, bipolar cores.

Blades were the basic blanks. Their length was 20–131 mm, and most were still small. 58% of blades from the settlement at Brześć Kujawski and 60% of the blades at the settlements at Tyniec Mały (Lech 1986, 78, Plate 7) were 30–60 mm long. In these two settlements, blades 10–20 mm wide (Fig. 3: 44) dominated. Apart from small mediolithic blades bordering on the microlithic, there were, however, much larger blades and blade tools, 75–131 mm long. From Brześć Kujawski we know 3 such blades 65–90 mm long and 17–30 mm wide (Fig. 3: 32). From sites of the Jordanów group there come blades and blade tools, 75–131 mm long (Lech 1986). Among the distinctly selected 45 blades from Tyniec Mały, 60–131 mm long, most (31%) of whole objects are 90–100 mm long, with mode of 93 mm, and their width is 20–25 mm (Lech 1986, 78–83). The largest blade is 131 × 26 × 9 mm, and one blade tool is 124 × 22 × 8 mm (Lech 1986, 82). These blades and blade tools from Brześć Kuj. and Tyniec Mały and the specimen from Dobkowice, more than 90 mm long (Lech, Noworyta 1979), distinctly reflect the tendency to an increase in the sizes of blanks and tools at the decline of the Cracow industry.

The tools are not different from those known from the older phase. There is a higher proportion of truncations with backed pieces (Fig. 3: 35,36)

Table 5. The percentage structure of tool groups in the Brześć Kujawski variety, north zone of the Cracow industry

Tools	Older phase			Younger phase	
	Brześć Kujawski	Żalęcino	Konary	Brześć Kujawski	Tyniec Mały settlement
Endscrapers	40.9	40.4	37.5	28.6	25
Retouched blades and those with use traces	29.5	6.1	X	15.6	20
Truncations, backed pieces	11.4	10.0	–	22.1	20
Retouched flakes	6.8	5.1	X	14.3	11
Perforators	–	5.1	–	2.6	9
Burins	6.8	1.0	–	5.2	9
Sidescrapers	–	3.0	10.4	2.6	–
Trapezes	–	–	2.1	–	–
Chisel-like scaled pieces	4.6	27.3	x?	9.1	x?
Others and indefinite	–	2.0	50.0	–	6
Total	100.0	100.0	100.0	100.0	100.0
Specimen number	44	99	48	77	44

X – occurring in small, indefinite percentage.

in the numerical hierarchy behind endscrapers (Fig. 3: 28, 29, 37, 43), and in the materials from Brześć Kuj., before retouched blades and with traces of use (Fig. 3: 30–34). In the tool assemblages from the leading sites, these three kinds of tools show almost the same proportion of 65–66% (Table 5). Moreover, there are common retouched flakes and those with concave retouch (Fig. 3:42), perforators with groovers (Fig. 3:38) and burins (Fig. 3:39), sidescrapers and endscrapers and chisel-like scaled pieces (Fig. 3: 40,41), partly included among the tools from Brześć.

The general structures of the artifact assemblages from Brześć Kuj. and Tyniec Mały (Table 3) are much more different than their raw material and typological structures (Tables 4 and 5).

In the whole Cracow industry there were relics of just one direction in flint processing related to the production of tools from blades and flakes. On the other hand, until its end no flint celts were produced at all. The mediolithic stylistics with elements of the microlithic continued. Even in the LPC there were single, unique, moderately macrolithic blades or blade tools, about 10 cm long. At the end of the Cracow industry, in the Brześć Kuj. variety, there were distinct tendencies towards an increase in the flake blanks to the submacrolithic dimensions (100–130 mm). In the contemporary Sąspów industry this was a dominating phenomenon, which, apart from other typological-technical features determined the separate character of this industry. In the Cracow industry, until its decline, there was the predilection to the flint processing traditions in the range of technique and the production of basic tools in analogous forms, with almost unchanged dimensions and a similar percentage presence in the inventory of the sites.

2. THE SĄSPÓW INDUSTRY

This industry covered the flint materials from the earlier period of the flint processing development of the Danubian cultures in the late LgPl, in the phases/groups of Modlnica, Lublin-Volhynia, Ocice and Wyciąże-Złotniki. Because of the characteristic domination of burins in the tool assemblage, we connect with them also those materials which A. Zakościelna (1981, 10ff.) included in the Malice group. The industry occurred in the basin of the Upper Vistula in Lesser Poland, together with the Lublin region, in Volhynia and Upper Silesia. Its name comes from the locality of a Jurassic flint mine from which most artifacts of the industry come (Dzieduszycka-Machnikowa, Lech 1976). It is with this industry that we connect most materials from the chocolate flint mine at Tomaszów (Schild, Królik, Marczak 1985). Outside the mines small assemblages of finds were discovered. More than 1000 objects are known just from the settlement at the Grodzisko site at Złota, Tarnobrzeg District. Of primary significance are the materials from Węzerów settlement (J. K. Kozłowski 1959), Modlnica (Kaczanowska 1985, 151–161), Złotniki (all in Cracow District; Dzieduszycka-Machnikowa 1977), the cemeteries in Cracow-Wyciąże (J. K. Kozłowski 1971) at Racibórz-Ocice, Opole District (J. K. Kozłowski 1972), and that at Strzyżów, Zamość District (Zakościelna 1981).

RAW MATERIALS

The Jurassic-Cracow and chocolate flint still retained their primary significance (Table 6). In the Bug basin the primary raw material was Volhynian flint, whose significance increased – it penetrated much farther to the west than in the Cracow industry. In Upper Silesia the Silesian-Moravian erratic Baltic flint dominated (Balcer 1977, 7).

ARTIFACTS AND ASSEMBLAGES OF ARTIFACTS

PRE-CORES. From the mines there come pieces of the raw material with the facts of preliminary working and pre-cores. They are semicircular, and subsemi-circular with good preparation, with pre-flaking surfaces on the narrower sides of the modules. The Jurassic flint specimens are 10–15 cm high, whereas the largest of the platey pieces of chocolate flint and nodules of Volhynian flint is 17.5 cm high.

Table 6. The proportion of flint raw materials in the features of the Sąspów industry

Flint	Sandomierz Upland		Lublin Upland	West Volhynian Upland	Western Lesser Poland	
	Złota st. Grodzisko		Antopol Lublin Dist.	Werbkowice Zamość Dist.	Iwanowice Cracow Dist.	Kraków-Wyciąże
	total	tools	total	total	total	total
Jurassic-Cracovian	0.19	0.93	–	–	**99.2**	**100.0**
Chocolate	**96.63**	**90.19**	**41.7**	4.0	0.8	–
Volhynian	1.73	7.48	19.4	**81.3**	–	–
Świeciechów	1.35	0.93	12.5	2.7	–	–
Baltic	0.10	0.47	26.4	12.0	–	–
Total	100.00	100.00	100.0	100.0	100.0	100.0

Bold type denotes percentages of the dominated raw materials.

Blade and flake cores. Blade cores are mostly known from mines (Kowalski, J. K. Kozłowski 1958: Dzieduszycka-Machnikowa, Lech 1976, 62–75; Schild, Królik, Marczak 1985, 58 ff.). Single-platform from subcarinated blade cores dominate (Fig. 4: 26) and there are fewer semiconical and subconical ones with wide flaking surfaces (Fig. 4: 27). We know double-platform specimens with orientation changes. Most Sąspów cores are 10–12.5 cm high, with flaking-surface widths of 3–6 cm. The thicknesses--lengths of subcarinated cores are 7–12 cm and those of the other varieties of cores are 4–6 cm. The core angles are most often acute. The largest cores from the Złota settlement are 8–10.5 × 4.4–7.6 × ×9.8–11.3 cm.

Ordinary and bipolar counter shock flake cores do not differ essentially from cores in the Cracow industry.

Blades and flakes. In the assemblage of 6322 blades and their fragments from Sąspów (Dzieduszycka-Machnikowa, Lech 1976), most specimens are 60–100 × 15–40 × 6–14 mm, and 81 mm long on average. For the facets of blades on cores this mean is 100 mm, whereas their maximum length is 145 mm and the maximum width is 25–35 mm. Blades shorter than 10–11 cm and less than 20–30 mm wide and 8–12 mm thick were left at the mine (Dzieduszycka-Machnikowa, Lech 1976, 118). Most blades from Sąspów are broken pieces of fragments of blades which were still altered by snapping.

The blades from the chocolate flint of the Lublin-Volhynia group are 5–12 cm long, most often 6–8 cm, 15–25 mm wide, and the largest are 10–12 cm long and up to 3 cm wide. The largest blades in the industry are specimens from Volhynian flint (Fig. 4: 1, 2). From the graves at Strzyżów, there come blades 128–200 mm long, 21–30 mm wide and 5–8 mm thick (Zakościelna 1981, 12). Tools from such blades are 11–15 cm long and up to 35 mm wide (Fig. 4: 3–6, 20). Blades much less than 3–8 cm long were also used.

The flakes resulted from good working and repairs of blade cores, and from a purposeful use of flake cores.

Tools. We defined over 11 varieties of tools (Table 7).

a. *Burins.* In many assemblages they are the most numerous. Most of them were produced from pieces of other tools, retouched blades in particular (Fig. 4: 17, 24) and also from truncated blades (Fig. 4: 18). Burins on truncations dominate (Fig. 4: 18, 23) and there are less frequent dihedral burins (Fig. 4: 17), burins on snap (Fig. 4: 19, 25) and single blow burins. There are known double burins (Fig. 4: 23) and multiple ones on truncations, or combinations of those on truncations with dihedral pieces and those on snap. Burins are most often short and elongated (1: 1–1: 2), 2–3 cm wide.

b. *Endscrapers.* Most often there are short and bulky blade tools (Fig. 4: 13, 14) with raw and retouched sides, and they are usually more solid than those known in the Cracow industry, namely 21–35 mm wide. Also short flake endscrapers occur.

c. *Retouched blades.* The use of more solid blades than those in the Cracow industry made it possible to apply better continuous retouch and to alter the retouched blades by secondary retouch. Already shortened and narrowed retouched blades and fragments are most frequently known. We can distinguish between three varieties of these tools: A – the widest, directly retouched (Fig. 4: 3, 16); B – narrowed, secondarily retouched half steeply (Fig. 4: 4, 5); C – with maximum narrowing, steeply retouched (Fig. 4: 6). The largest retouched blades. A from

Table 7. The structure of flint tool groups in the materials of the Sąspów industry

Tools	Złota		Werbkowice		Modlnica	Węzerów	Racibórz Ocice	Average proportion
	number	%	number	%	%	%	%	
Burins	84	39.25	18	33.3	43.3	58.7	32	41.3
Endscrapers	26	12.15	8	14.8	24.3	8.0	26	17.0
Truncations and backed pieces	21	9.81	4	7.4	19.6	25.3	22	16.8
Retouched blades and those with use traces	51	23.83	14	25.9	–	–	10	11.9
Retouched flakes	6	2.80	6	11.1	–	–	–	8.9
Perforators	7	3.27	1	1.9	1.9	1.3	5	2.7
Hammer stones	7	3.27	1	1.9	–	5.3	–	2.1
Sidescrapers	–	–	–	–	3.5	1.3	5	2.0
Trapezes	3	1.40	1	1.9	–	–	–	0.6
Chisel-like scaled pieces	3	1.40	–	–	–	–	–	0.3
Blunt borers	2	0.93	–	–	–	–	–	0.2
Others and indefinite	4	1.87	1	1.9	7.4	–	–	1.5
Total	214	100.00	54	100.0	100.0	99.9	100	

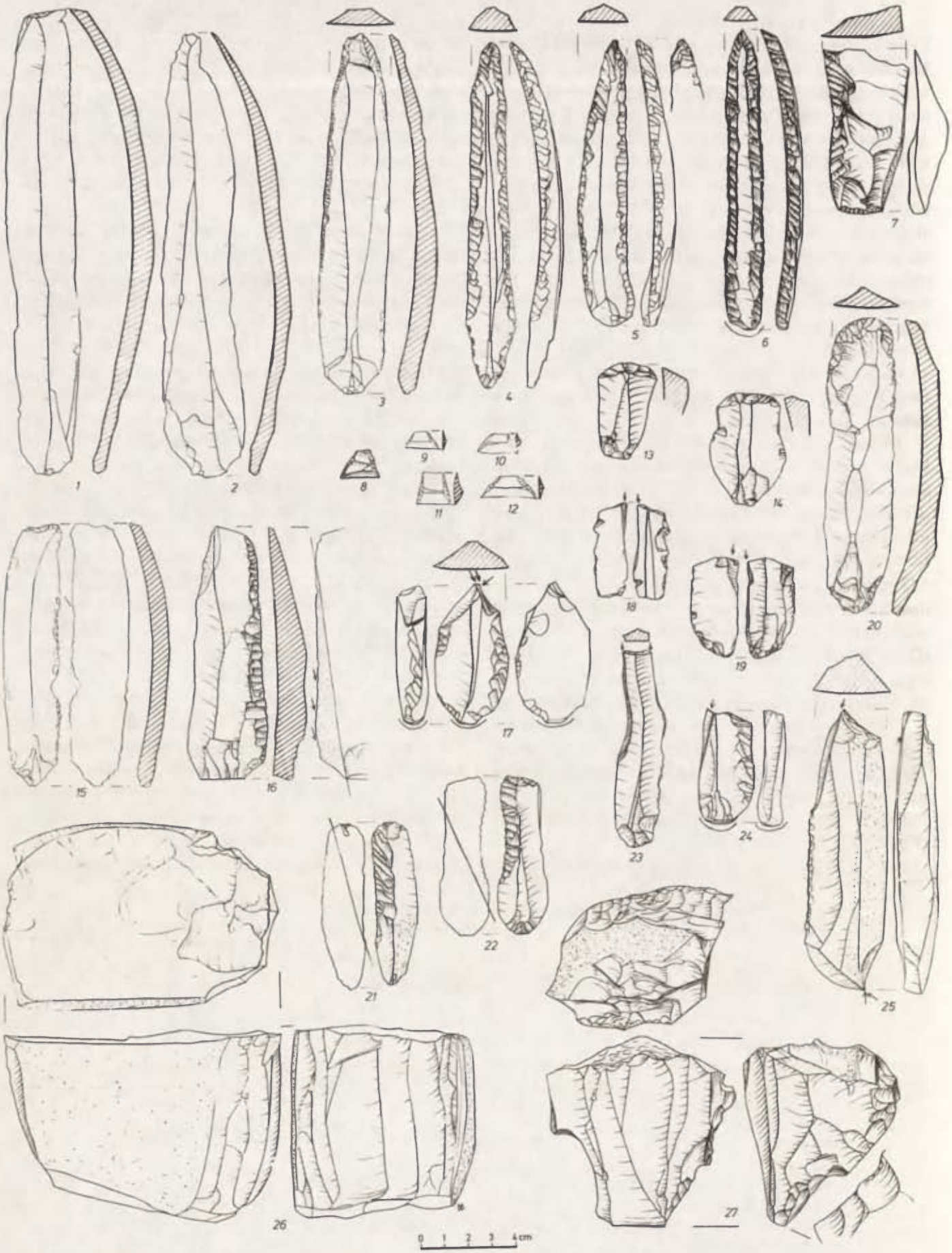

Fig. 4. Sąspów industry. Artifacts from Volhynian (*1–6, 9–12, 15, 17, 20, 24*) and chocolate (others) flints
1–5, 15, 20 – Strzyżów, Zamość District; *1–12* – Jaszczów, Lublin District; others – Złota, Tarnobrzeg District

Volhynian flint are more than 15 cm long and up to 30 mm wide. The retouched blades B and C are 122–147 mm long and 15–20 mm wide. The retouched blades from other raw materials are smaller – up to 12 cm long. At least some of the retouched blades were worked with a characteristic oblique parallel retouch and their sides converged on pointed tops (Fig. 4: 4–6).

d. *Truncations*. Usually they have forms analogous to those known already from the Cracow industry. On the other hand, there also occur larger truncated blades, having the side edges with oblique, parallel retouch (Fig. 4: 22) and interesting arch backed pieces. A moderatly macrolithic truncated blade, 11 cm long is known (Fig. 4: 15).

e. *Other tools* are retouched flakes, perforators and groovers, chisel-like scaled pieces and trapezes (Fig. 4: 8–12) which do not differ from those known in the Cracow industry (Zakościelna 1985), A side- and an endscraper with oblique parallel retouch (Fig. 4: 7) are distinct. There occurred the first, poorly worked tools with polished, rounded tops, sometimes with alternating retouch, which we defined as blunt perforators. In the USSR they are considered punch and/or pressure flaking flint points (Bibikov 1953). In the Sąspów industry they were usually the altered forms of retouched blades or occurred in connection with endscrapers and truncated blades which had characteristically circularly removed platform parts (Fig. 4: 17, 24).

We can define the largest flake tools as workshop forms. There were infrequent combined tools – endscrapers + truncated blades, blunt perforators + burins (Fig. 4: 17, 24).

f. *Sickle insets*. They are mainly truncated blades and blade tools up to 7 cm long (Fig. 4: 21, 22). There still occurred, on the other hand, the earliest much longer sickle insets with single, continuous blades, such as the truncated blade from Strzyżów, 11 cm long (Fig. 4: 15) or the blade tool from Złotniki, 10.5 cm long (Fig. 4: 16), both with characteristically polished sickle traces.

Assemblages of Artifacts are greatly differentiated in terms of number and structure (Table 8). In the tool assemblages burins distinctly dominate (Table 7), being the original feature of the Sąspów Industry assemblages. The tools which dominate in the Cracow industry come, on the other hand, next to them. Trapezes still occur. It is particularly interesting to note the emergence of blunt perforators.

Just as in the Cracow industry, in the Sąspów industry the flint processing continued in just one direction. There came, however, a distinct increase in the dimensions of blades and blade tools. Macrolithic elements occurred along with the dominating mediolithic, and also microlithic, artifacts.

The increasing macrolithicization of blades and blade tools was connected with the onset of a technological breakthrough to be seen over the broad range of the later groupings of the LgPl, also South of the Carpathians (Dzieduszycka-Machnikowa, Lech 1976, 144–149: Kaczanowska 1985. 151–181) and in the TC (see p. 79–81). In the Sąspów industry the changes were manifested by such features/elements as: 1 – the moderate, and in the Lublin-Volhynia group even the maximum, macrolithicization of initially worked blades, keeping the same forms of cores; 2 – the use of oblique, parallel retouch, the popularization of pointed blade tools and the emergence of blunt perforators; 3 – the increased significance of Volhynian flint whose arrival in the Upper Vistula basin indicated at the same time that the breakthrough influences came from the southeast, through the range of the Tripolye and Tisapolgar cultures; 4 – the domination of burins in the tool groups, defined by M. Kaczanowska (1985) as the „burin current".

The early metallurgy became widespread, coinciding with changes in the flint processing, and this

Table 8. The general structure of artifact groups in the Sąspów industry

Artifacts varieties	Saspow Pits 1 and 3		Złota Grodzisko site		Werbkowice		Węzerów	
	number	%	number	%	number	%	number	%
Core forms	986	4.27	14	1.3	9	5.8	12	1.5
Blades	6322	27.37	119	11.5	26	16.9	110	13.4
Flakes	15,745	68.16	681	65.5	63	40.9	607	74.0
Spalls	–	–	11	1.1	2	1.3	16	2.0
Tools	48	0.20	214	20.6	54	35.1	75	9.1
Total	23,101	100.00	1039	100.0	154	100.0	820	100.0
P index	480.3		3.86		1.85		9.93	

meant the beginning of the Eneolithic. On the other hand, in the Danubian cultures flint celts were not produced until their decline. The technological breakthrough did not come until the TC and in the Lesser Poland group of the TRB in the uplands.

3. SARNOWO INDUSTRY IN THE EARLY FUNNEL BEAKER CULTURE (TRB)

This industry represented the older, "early-beaker" period in the development of the TRB flint processing in its eastern group in Kujawy, in the oldest stage AB – the Sarnowo one and the early Wiórek phase. The characterization is based on the settlement materials from the Sarnowo cemetery, Włocławek District, from under Grave 8, hence comes the oldest ^{14}C data for the TRB (3620 ± 60 BC; Gabałówna 1970). These materials were elaborated by E. Niesiołowska-Sreniowska (1980), who believes (private communication) that it is only with those that we can connect the oldest TRB industry. We believe that the Sarnowo industry was an "early-beaker" industry, with a slightly wider range, exceeding the stage AB, at least up to the early Wiórek phase. Irrespective of the relative chronology, it involved those assemblages whose most significant features were the domination or the very large proportion of chocolate flint, particularly in tool groups and the presence of truncated blades with a simultaneous lack of flint celts. In addition to these groups, it also comprised the assemblage of finds from the still unpublished settlement at Sarnowo, the relatively numerous materials from Sierakowo, Bydgoszcz District (Kośko, Prinke 1977), and also the very few assemblages at least from some Kujawy graves at Sarnowo and Leśniczówka, Włocławek District (Młynarczyk 1982), and from the settlement at Łącko, Bydgoszcz District (Domańska, Kośko 1983).

RAW MATERIALS

Chocolate flint was the basic raw material (Table 9). It dominates throughout the material or just in tool assemblages. The local erratic Baltic flint was usually of secondary importance. What is particularly significant is the presence of a few artifacts from Volhynian flint. From the Sierakowo settlement we know artifacts from Świeciechów flint and doubt-raising ones from Jurassic flint, since the latter may also have been local erratic flint.

ARTIFACTS AND ASSEMBLAGES OF ARTIFACTS

Core forms. They include pieces of raw material with traces of initial working, ordinary single- and multi-platform flake cores after orientation changes, counter shock, bipolar and blade cores. The latter were turned into much smaller flake and counter shock bipolar cores, therefore, we meet them so seldom. From Sarnowo there come two blade cores of chocolate flint: one with a narrow flaking surface, 60 × 44 × 38 mm, which arose as a result of shortening a subcarinated core (Fig. 5: 1), and a semiconical one, 63 × 51 × 25 mm, used after an orientation change. We can suppose that the basic form was the subcarinated blade core. From Łącko we know 2 microlithic cores (Domańska, Kośko 1983; Fig. 5: 26).

The counter shock bipolar technique dominated in the use of small chunks of Baltic flint and strongly exploited blade cores. The full cycle: pre-core → blade core → flake core → counter shock, bipolar core was analogous to the north variety of the Cracow industry.

Blades and Flakes. The tool groups show a relatively balanced proportion of blade and flake blanks. Among blades, chocolate flint specimens dominate. Preserved as a whole, they are 26–95 mm long, 68.7 mm on average, 17.2 mm wide and 4.9 mm thick. On the basis of the blades and blade tools, we can assume that blades 45–80 mm long (Fig. 5:3)

Table 9. The percentage proportions of raw flint varieties in the materials from the sites of the Sarnowo industry

Flint	Sarnowo under Grave 8		Leśniczówka		Sierakowo		Łącko	
	total	tools	total	tools	total	tools	total	tools
Chocolate	**84.6**	**86.8**	**74.6**	**53**	29.7	**42.7**	25.8	23.1
Baltic	14.5	10.5	16.4	20	**55.3**	31.3	**58.4**	30.8
Volhynian	0.2	0.9	1.5	7	–	–	1.1	7.7
Swieciechów	–	–	–	–	8.4	13.0	–	–
Jurassic	–	–	–	–	6.4	13	9.0	**38.5**
Indefinite and others	0.7	1.8	7.5	20	0.2	–	5.6	–
Total	100.0	100.0	100.0	100	100.0	100.0	99.9	100.1

Bold type denotes percentages of the dominating raw materials.

were most frequently made, whereas blades 60–80 mm were meant for tools. Pieces 90–95 mm long are exceptional. Most blades and blade tools are 11–20 mm wide, the greatest number of tools were, however, produced from wider blades, 16–20 mm wide.

Bladelets and blade-like flakes from Baltic flint are smaller, up to 50 mm long and up to 20 mm wide, and also microlithic, up to 30 mm long.

Among flakes, small chips dominate, up to 20 mm long, there are fewer small flakes, 2–4 cm long, infrequent medium-size ones, 40–60 mm long, and exceptionally, large ones, 60–80 mm long.

Tools. We defined 12 varieties of tools (Table 10).

a. *Endscrapers* ((Fig. 5: 12, 27, 28, 31, 36) dominate in tool groups. Most blade endscrapers come from cemeteries, most flake ones are found at settlements. Endscrapers from blades are elongated and short, up to about 20 mm wide. Some, like blades, have completely retouched sides, therefore, H. Młynarczyk (1982) defined them as "retouched blade-like end-scrapers". Most endscrapers narrow beneath the scraping surfaces (Fig. 5: 28, 31), and only some widen (Fig. 5: 27). Most short and bulky flake endscrapers also have retouched sides. The scraping surfaces of endscrapers in the Sarnowo industry were retouched at an angle of 75–90°. We know combinations of an endscraper with a point and endscrapers with platforms used as blunt perforators.

Table 10. The flint finds from the leading sites of the Sarnowo industry, TRB

	Find varieties	Sarnowo under Grave 8	Leśniczówka	Sierakowo	Total
Raw material, production waste and blanks	Natural chips and pre-core forms	15	–	–	15
		12	–	–	12
	Blade cores	1	–	–	1
	Ordinary flake cores	6	2	17	25
	Counter shock bipolar flake cores	11	3	37	51
	Blades and their fragments	47	11	45	103
	Flakes, chunks	238	36	353	627
	Altogether	330	52	452	834
Tools*	1. Endscrapers	8	6	44	59
	2. Retouched flakes	27	3	26	53
	3. Retouched blades	26	1	13	45
	4. Perforators	23	2	–	25
	5. Burins	6	–	7	14
	6. Sidescrapers	7	–	1	8
	7. Truncations, backed pieces	5	2	–	7
	8, 9. Chisel-like scaled pieces	3	–	–	3
	Denticulated tools	3	–	–	3
	10. Hammer stones	1	1	–	2
	11, 12. Trapezes	1	–	–	1
	Blunt borers	1	–	–	1
	Others and indefinite	3	–	1	4
	Combined tools	(2)			
	Altogether	114	15	92	225
	Total	444	67	544	1059

* The tools are enumerated in the order of numerical hierarchy of all tools in Table 10.

Numbers in brackets are not subject to summation.

b. *Retouched blades and those with use traces.* The more solid blade blanks made it possible to use more solid retouch in retouched blades from chocolate (Fig. 5:2,4) and Volhynian flints. There are a distinct retouched blade from Leśniczówka is 121 mm long and a fragment of a retouched blade with oblique, parallel retouch (Fig. 5: 13). Small blades had partly micro- and fine retouch, and they were notched (Fig. 5: 5, 24, 37). The latter were used as sickle insets with platforms worked upwards.

c. *Retouched flakes and sidescrapers.* Partly retouched flakes dominate among flake tools (Fig. 5: 17, 18, 35). Some of them can be defined as scrapers or sidescrapers, whereas some small specimens are multiple scrapers (Fig. 5: 18).

d. *Perforators* and groovers. Small groovers from blade fragments with points retouched on one face dominate (Fig. 5: 14). There are also short – point borers with alternating retouch, including very small ones (Fig. 5: 16) with points thinned by the burin technique (Fig. 5: 15).

e. *Truncations.* Common truncations with retouched backs and also those on snapped blades formed by snap faces (Fig. 5: 19, 20). We know a backed piece (Fig. 5: 23). There are original specimens with arched backs (Fig. 5: 11, 22). The truncations were used as sickle insets.

f. *The other tools.* Probably, some or even most scaled pieces with sharp edged poles were used as tools (Fig. 5: 21). There are also blunt borers with ends rounded by use (Fig. 5:33,34); denticulated tools from flakes (Fig. 5:30); hardly distinct single blow burins and those on snap (Fig. 5: 10, 29, 32); core hammer stones; trapezes from flake fragments (Fig. 5: 7–9, 25); an endscraper + groover (Fig. 5: 14).

g. *Microlithic forms.* Because of differences between the applied properties of raw materials, the tools (Fig. 5:21). There are also blunt borers with forms, including trapezes, micro-retouched bladelets, multiple scrapers, some perforators and groovers, and a truncation (Fig. 5: 6).

Assemblages of Artifacts. The general structure of the find assemblages from the leading sites of the industry is similar (Table 11). The structure of the usually very small assemblages of tools is, on the other hand, unstable. The different varieties of tools dominate in particular assemblages. Under Grave 8

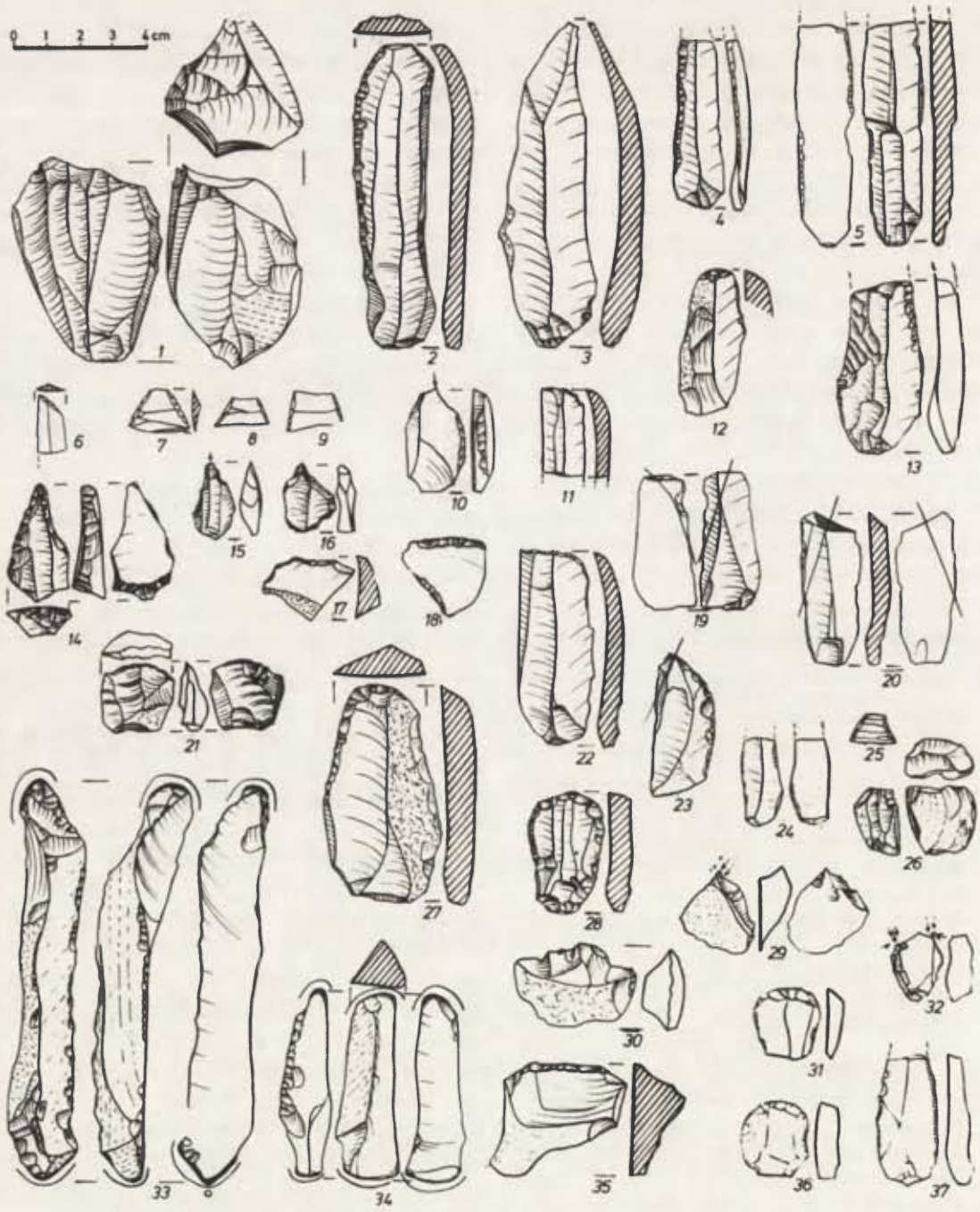

Fig. 5. Sarnowo industry. Artifacts from chocolate (*1–5, 10–23, 27–29, 33, 34*) Baltic (*30–32, 35*), Świeciechów (*36, 37*) and indefinite (*6–9, 24–26*) flints

1–22, 27, 28, 30, 33–35 – Sarnowo, *23* – Leśniczówka, Włocławek District; *24–26* – Łącko, *29, 31, 32, 36, 37* – Sierakowo, Bydgoszcz District

at Sarnowo they are flakes and retouched blades, at the Sierakowo settlement they are endscrapers. By summing up tools from a few sites we can try to establish the numerical hierarchy of tools characteristic of the Sarnowo industry (Table 10). The proportion of microlithic forms, readily to be seen in the leading assemblage from under Grave 8 at Sarnowo, is in fact small, namely about 5–8% of the tool assemblage. The assemblage from the Łącko camp is, on the other hand, almost fully microlithic (Domańska, Kośko 1983).

Table 11. The general percentage structure of the flint materials from the sites the Sarnowo industry, TRB

Artifacts varieties	Sarnowo under grave 8	Leśniczówka	Sierakowo	Łącko
Core forms	7.0	7.5	9.9	7.9
Blades	11.0	16.4	8.3	9.0
Flakes	55.4	53.7	64.9	68.5
Tools	26.6	22.4	16.9	14.6
Total	100.0	100.0	100.0	100.0
P index	3.76	3.5	4.9	4.7

For various reasons the Sarnowo industry was very nonuniform. This resulted from: 1 – two directions of the production based on chocolate flint and local Baltic one, with different properties and usefulness; 2 – the presence of contemporary elements with varied styles – mediolithic, archaic microlithic of the Mesolithic type and macrolithic auguring the Eneolithic technological change. A very significant fact was a lack of knowledge of flint axes. As in the industries of the Danubian cultures, the production still proceeded in one direction. In the Sarnowo industry, the early manifestations of the change to be observed already in the Sąspów industry were represented by the presence of the first macrolithic blade pieces, including those of Volhynian flint, and specimens with oblique, parallel retouch, and also blunt perforators.

The Sarnowo industry was related to the crystallization of the TRB in the Lowlands as a result of the Neolithicization of the Epimesolithic communities. A number of the strictest analogies of the Sarnowo industry to be seen in the Cracow and Sąspów industries indicate the dominating role of the linear culture communities in this process.

4. THE LESSER POLAND INDUSTRY IN THE FUNNEL BEAKER CULTURE AND THE RADIAL DECORATED POTTERY CULTURE

The industry was distinguished from materials of the southeast, Lesser Poland group of the TRB (Balcer 1975, 139). Essentially, it represents the whole younger period in the development of the TRB flint processing and that of the RPC. It covered a very large territory and a long chronological span. It mainly occurred in the Upper Vistula basin in the Lesser Poland, Lublin (Libera 1982) and West Volhynian Uplands. It was also represented in Kujawy and Chełmno Land. In its development, we can distinguish two phases: the basic – classical beaker – phase and the decline, later phase in the "Badenized" TRB and the RPC.

THE LESSER POLAND INDUSTRY IN THE CLASSICAL BEAKER PHASE OF THE TRB

The point of issue for the characterization of the industry was the materials of the TRB from the Sandomierz Uplands (Fig. 6), from settlements at Ćmielów, Zawichost and Kamień Łukowski, Tarnobrzeg District (Balcer 1975, 139–146). All of them represent the classical beaker phase of the development of the TRB – Bronocice II and III, according to J. Kruk and S. Milisauskas (1981). Among the leading sites, we also include the settlement at Gródek Nadbużny, Zamość District. At that time, we analyzed some of the materials from J. Kowalczyk's excavations (Balcer 1975, 139–146). The settlement gave the oldest ^{14}C date for the south group of the TRB, namely – 3100 ± 160 BC (Kowalczyk 1968). The dates for Bronocice, Kielce District, Phase I (Kruk, Milisauskas 1977, 251; 1981, 85), correspond to it. These dates indicate that the TRB occurred in Poland as early as the early Wiórek phase. W. Gumiński, who analyzed the whole of the flint materials from Gródek, identified there a number of properties/elements which we can recognize as older than those of the classical beaker ones. They include truncations (Fig. 7: 10, 11), burins (Fig. 7: 6), assemblages of bladelets and tools with analogues in the Sąspów and Sarnowo industries. They co-occur along with finds which are most typical of the Lesser Poland industry in the classical beaker phase. Because there are no bases for distinguishing strictly the early beaker flint finds from latter ones, we do not discuss them separately.

RAW MATERIALS

Świeciechów, Volhynian and Jurassic flints from the original deposits were used (Table 12). They dominated in the settlement regions nearby, whereas Świeciechów and Volhynian flints were, along with the banded one, propagated more than about 500 km from the deposits. The banded flint was of secondary importance, even in the production of axes (Balcer 1975). Deposite the ample mining raw materials, also erratic Baltic flint was used. An important property was a lack of basic varieties of chocolate flint tools, indicating the nonapplication of this raw material, contrary to the industries of the linear cultures.

ARTIFACTS AND ASSEMBLAGES OF ARTIFACTS

Pre-cores and Cores. Pre-cores were processed into cores. Because of the demand for blades about 15 cm long, even quite large cores were left over, and the latter were quite frequently processed into axes (Fig. 6: 16) or flake cores. Therefore, we meet only seldom pre-cores and blade cores. The fundamental forms were single-platform blade cores with wide flaking surface on the longer and wider walls of modules (Fig. 6: 1). They are semi-conical, triangularish in outline, with ogival or rounded tops. They came from four-wall rectangular-piped or pyramidal pre-cores with dilligent preparation. Blades 20–30 cm long (Fig. 7: 1) indicate the large size of pre-cores and cores. The height of rather greatly applied blade cores

Table 12. The percentage proportions of raw flint in the Lesser Poland industry materials in the southeast zone of the TRB

Flint	Sandomierz Upland				West Volhynian Upland		Western Lesser Poland				
	Zawichost		Ćmielów		Gródek Nadbużny		Książnice Wiel.		Brenocice		Zawarża
	total	tools	total	tools	total	tools	total	tools	total	tools	total
Świeciechów	**96.07**	**90.40**	37.86	**69.65**	8.84	25.97	1.60	1.61	9.0	7.5	12
Banded-Krzemionki	1.29	2.81	**62.10**	28.76	1.48	1.40	–	–	0.8	1.0	–
Volhynian	0.41	1.64	X	0.18	**78.55**	**68.60**	2.14	5.84	0.1	1.5	**52**
Jurassic	0.05	–	0.02	0.70	0.09	0.17	**96.26**	**92.54**	**90.0**	**89.0**	25
Chocolate	0.25	–	0.01	0.35	0.37	0.17	–	–	–	–	5
Baltic	0.72	3.74	0.01	0.18	0.46	0.35	–	–	0.1	1.0	5
Others and indefinite	1.21	1.40	X	0.18	10.20	3.33	–	–	–	–	–
Total	100.00	99.99	100.00	100.00	99.99	99.99	100.00	99.99	100.0	100.0	99

Bold type denotes percentages of the dominating raw materials. X – proportion above 0.01%

from Świeciechów flint is about 10.5–20.5 cm, 17.3 cm on average, while the width is on average 8.8 cm, and the thickness is 4.8 cm. Flake cores from small flint chunks or those that arose as altered or residual forms of blade cores (Fig. 7: 16) are most frequently amorphous with enanged orientation. There are also counter shock bipolar flake cores.

Roughouts and Semi-finished Axes. They belong to core forms known from mines and settlements. Roughouts with faces of initial working can be close to or even indistinguishable from pre-cores. Among the semi-finished pieces, we can include specimens already showing the form of axes, and also that of basically prepared, but unpolished axes (Fig. 7: 12).

Blades and Flakes. Blades were the fundamental blanks. In this industry we distinguish between two categories of blades: 1 – irregular-shaped, thick, with angled sides, often cortical, relatively short; 2 – exquisite, regular, long, with parallel or slightly converging sides. They were the main objectives of preparation. They were exchanged, as is indicated by the expansive propagation of blades from Świeciechów and Volhynian raw materials. Irregular-shaped blades were extra products. The length of exquisite blades from Świeciechów flint is up to 30 cm, 14.6 cm on average, with the length of irregular blades, on average, of 12 cm. Among the selected exquisite blades, there dominate specimens 16–18 cm long, 17.4 cm on average, 3.2 cm wide and 0.8 cm thick. The largest specimens 27 and 30 cm long are record long in the Neolithic in the basins of the Vistula and Odra basins (Fig. 7: 1). Blades from Volhynian flint are slightly smaller, with the average dimensions of 16.1 × 3.2 cm. The length of the largest blades from Jurassic flint exceeds 20 cm, and their width is as much as 5 cm, whereas the thickness exceeds 1 cm. Use was also made of smaller blades, up to 10 cm long, from smaller blade and flake cores, including altered forms, even from damaged axes. In most assemblages, there dominate flakes from the different stages of preparation and repair of blade cores, working of axes, and the projected use of ordinary and counter shock, bipolar flake cores. On the other hand, it had a secondary importance. Blanks may have been flakes from forming blade cores and axes, in the working of which 70–100 flakes emerged.

Tools. In our first elaboration of the Lesser Poland industry, we distinguished 17 varieties of tools, divided into kinds and subkinds, on the one hand, and grouped in some groups, on the other hand (Balcer 1975, 89–139). Now, we slightly reduce the number of tool varieties (Table 13).

a. *Retouched blades and those with use trace.* The macrolithic blanks admitted firm primary retouch and the repair of retouched blades by the secondary chipping of them. We distinguish here between three varieties of retouched blades: A – originally directly and continuously retouched on one or both sides completely unilateral and partly so (Fig. 6: 2–4); B – half steeply and steeply retouched, slightly narrowed with respect to variety A (Fig. 6: 5); C – highly narrowed, steeply retouched, residual with respect to variety A (Fig. 6: 6). Retouched blades have raw and retouched tops: arched as in endscrapers, or ogival and pointed (Fig. 6: 10, 7: 14), as in perforators and groovers. In addition to typical retouched blades, there are micro-denticulated, partly retouched and also raw blades, however, the latter bear use traces, mainly sickle polish. Sickle insets of a new type with uniform, long blade edges were mainly micro-denticulated blades and retouched blades. A with subtle retouch (Fig. 7: 23). They had raw or retouched ends, after the curved tops have been broken off. They should not be mistaken for endscrapers with their wider and more solid scraping surfaces. Sickle

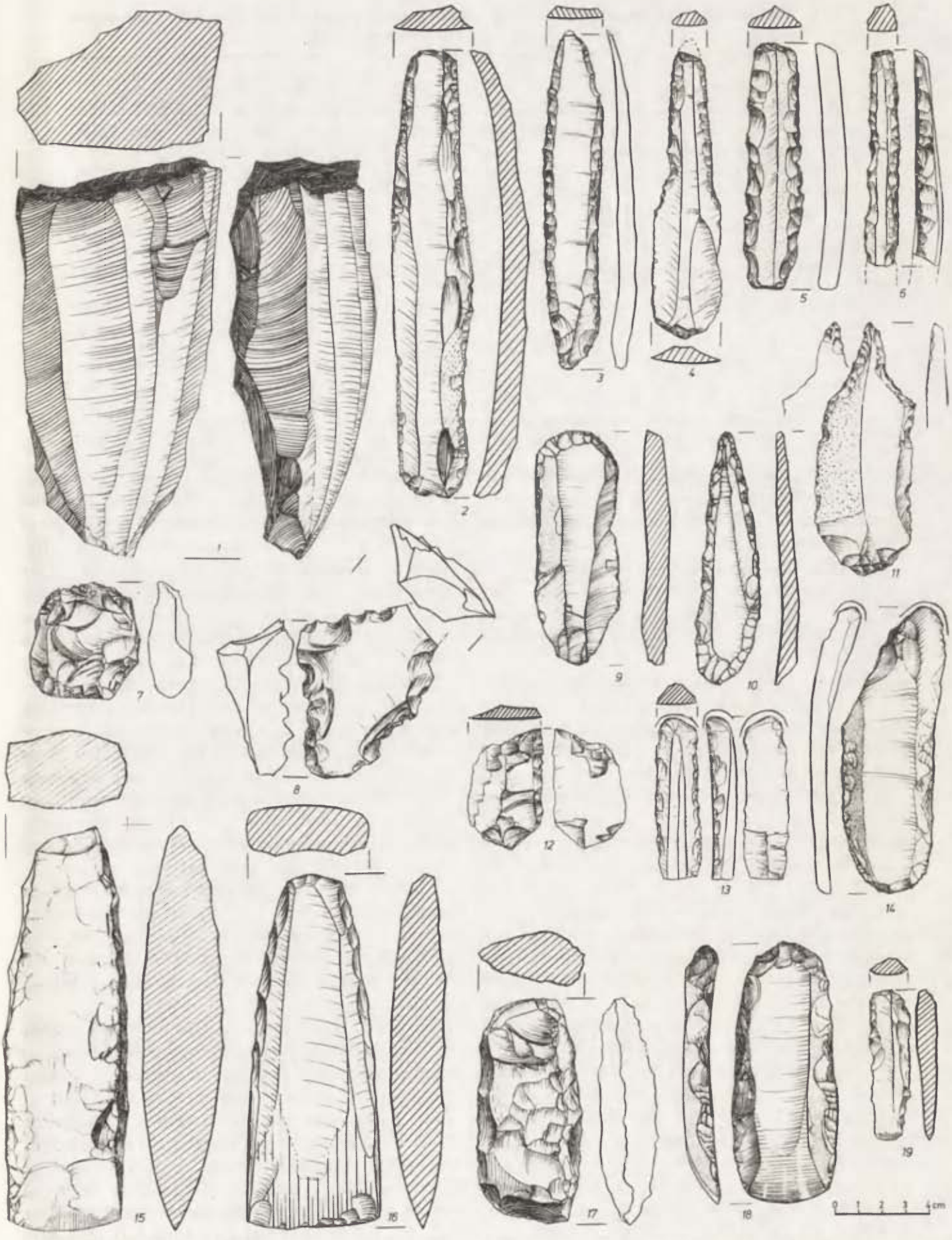

Fig. 6. Lesser Poland industry. TRB artifacts of Świeciechów flint

1, 9, 11, 14, 16–19 – Zawichost, *2* – Krzeczkowice, *3–7, 10* – Kamień Łukawski, *8* – Cmielów, Tarnobrzeg District; *12* – Gródek Nadbużny, Zamość District; *13* – Szewna, Kielce District; *15* – Świnna, Piotrków Trybunalski District

Table 13. The structure of tool groups from the leading sites of the Lesser Poland industry in the TRB. The succession as determined from the total number of tools

Tools varieties	Zawichost		Ćmielów		Kamień Łukawski		Gródek Nadbużny		Total	
	number	%	number	%	number	%	number	%	number	%
Retouched blades and those with use traces	115	26.93	155	27.19	54	31.95	138	24.25	463	26.67
Chisel-like scaled pieces	49	11.48	41	7.19	42	24.85	164	28.82	296	17.05
Retouched flakes	78	18.27	138	24.21	6	3.55	56	9.84	278	16.01
Endscrapers	49	11.48	80	14.04	24	14.20	48	8.44	201	11.58
Hammer stones-grinders	38	8.89	51	8.95	17	10.06	12	2.11	118	6.80
Axes and axe-like tools	32	7.49	34	5.96	13	7.69	32	5.62	111	6.39
Perforators	21	4.92	15	2.63	4	2.37	25	4.39	65	3.74
Denticulated tools	22	5.15	24	4.21	1	0.59	4	0.70	51	2.94
Blunt borers	6	1.41	11	1.93	4	2.37	16	2.81	37	2.13
Burins	1	0.23	7	1.23	2	1.18	7	1.23	17	0.98
Bifacial tools	7	1.64	4	0.70	–	–	3	0.53	14	0.81
Arrowheads	–	–	–	–	–	–	14	2.46	14	0.81
Sidescrapers	3	0.70	3	0.53	1	0.59	6	1.05	13	0.75
Others and indefinite	6	1.41	7	1.23	1	0.59	44	7.73	58	3.34
Total	427	100.00	570	100.00	169	99.99	569	100.00	1736	100.00

insets can be divided into three varieties: A – raw; B – micro-denticulated; C – retouched. Specimens of varieties B and C are particular cases of retouched blades of variety A.

b. *Endscrapers.* There dominate blade endscrapers in two varieties: A – elongated ones (Figs. 6: 9, 7: 13); B – bulky and short. Most often, they have retouched sides. Endscrapers A with retouched sides are similar to retouched blades (Fig. 7: 7). Double endscrapers are infrequent. Sometimes there are specimens with converging sides. A large number of endscrapers arose as altered forms of macrolithic blade tools: sickle-destined, retouched blades and their fragments. Flake endscrapers are infrequent.

c. *Perforators and groovers.* There are groovers with solid points retouched on the one sides and borers with delicate, separate points (Fig. 6: 11), with alternating retouch or one on the one side, but on the bottom one.

d. *Blunt borers.* We gave this name to tools with circularly ground and polished ends, sometimes with alternating retouch. They were mainly altered forms arising from fragments of retouched blades of varieties B and C (Fig. 6: 13) also A (Fig. 7:22). Researchers of the TC defined these forms as punch and/or pressure flaking flint points for processing flint.

e. *Axes and axe-like tools.* We divide core axes into the varieties: A – dihedral ones, narrowing from the edges to the backs (Figs. 6: 16, 7: 15); B – stubby ones with edges and backs narrower than the shafts (Fig. 6: 15), which dominate – 60% of specimens in the axe group. Usually, the axe backs are weakly separated, at times the walls are very thin. Axes of variety A are more carefully made, their walls are flat and edges straight. Axes of varieties A and B in their unaltered forms are large, 16 cm long on average, 5 cm wide and 3 cm thick. Small flattish axes and triangular ones (Fig. 7: 18) with average dimensions of 10 × 4 × 16 cm, defined as variety C, are less frequent. The fundamental forms were axes, on the other hand, there were also triangular ones and, very seldom, celts (Figs. 6: 17, 7: 20). They arose rather randomly from irregular-shaped half-modules or as a result of repairs or alteration of the originally larger axe apecimens. The axe-like tools include: 1 – elongated core micro-axe chisels up to 100 mm long and 20 mm wide; 2 – small axes, micro-axes or chisels from blades and flakes (Fig. 6: 19). Some asymmetrical ones can be defined as carpentry tools (Fig. 6: 18). Axes and axe-like tools in the industry in question are usually only partly polished close to the edges. A large number of them show deformations resulting from careless final working.

f. *Basic flake tools.* Partly retouched flakes are the most numerous. We can distinguish sidescrapers with more careful continuous retouch or ones with such half-steep retouch. Denticulated (Fig. 6: 8) and bifacially worked tools from thick, large flakes belong to workshop forms.

g. *Chisel-like scaled pieces.* We have long defined as tools – cutters, pushers or intermediate pieces – bipolar, bifacially worked and thin scaled pieces with sharp poles which quite often are altered and residual tools, particularly blade ones (Fig. 6: 7, 12; Balcer 1975, 130). On the basis of experiments and comparison of the forms which the former gave with the relics from the TRB settlement at Ćmielów, W. Migal (1987) believes that most counter shock, bipolar pieces in the Lesser Poland TRB industry may have been cutting tools. In the case of the discussed

Table 14. The general numerical structure of flint material groups of the Lesser Poland industry in the TRB

Artifacts varieties	Cmielów		Zawichost		Kamień Łukawski		Gródek Nadbużny		Świeciechów
	number	%	number	%	number	%	number	%	%
Roughouts and semi-finished axes	216	0.56	14	0.25	–	–	–	–	0.75
Pre-cores and cores	19	0.05	28	0.50	3	0.83	6	0.19	4.75
Blades	1417	3.69	284	5.04	18	4.99	129	4.02	2.35
Flakes	36,188	94.22	4877	86.63	171	47.37	2506	78.04	91.54
Tools	570	1.48	427	7.58	169	46.81	570	17.75	0.61
Total	38,410	100.00	5630	100.00	361	100.00	3211	100.00	100.00
P index	66.38		12.18		1.14		4.68		162.9

industry this seems to be particularly probable, since a lack of tools made by the counter shock, bipolar technique appears to exclude the role of counter shock, bipolar pieces as flake cores.

h. *Other tools.* They are 1 – hardly distinct burins on snap and exceptionally dihedral ones from flakes and blades; 2 – the infrequent triangular arrowheads, to be met only in the West Volhynian and Lublin Uplands (Fig. 7: 4, 5) with burins (Fig. 7: 6) and truncations (Fig. 7: 10, 11); 3 – pointed or dihedral picks known from flint mines. Very few multiple tools are most often combinations of endscrapers and perforators, or endscrapers and blunt borers (Fig. 6: 14). Pointed retouched blades (Fig. 6: 10) and elongated endscrapers with retouched sides (Fig. 7: 7) combine the morphological elements of retouched blades endscrapers and perforators.

Tool Groups. The inventories from particular sites are greatly differentiated in terms of the general structure (Table 14). There are contrastive differences between the production settlements and the users' settlements and camps (Balcer 1975, 178 ff; 1980, 97 ff.). The former are characterized by a large number of finds with production waste greatly dominating over tools, whereas the latter show small numbers of finds with relatively high proportions of tools. This is best reflected by the differences in the *P* indexes (Table 14). This differentiation indicates that group specialization grew in the TRB flint processing in the south group. Irrespective of the above-mentioned differences in the character of settlement features, the structures of tool groups (Table 13) from the leading sites of the industry are very close (Balcer 1975, 140 ff.). This is particularly the case with tool groups which were the leading forms of the industry, and we recognized as such retouched blades, endscrapers, perforators, blunt borers, axes and axe-like tools (Balcer 1975, 143 ff.). The structures of groups of these tools at the former sites show the greatest similarity compared with tool groups from the sites of the other industries discussed in this paper.

ARTIFACTS OF THE LESSER POLAND INDUSTRY IN THE EAST TRB GROUP

As a result of an organized system of contacts and distribution, the artifacts of the Lesser Poland industry reached in great numbers, probably mainly over the Vistula artery, the territory of the eastern group, Kujawy in particular, Chełmno Land and eastern Greater Poland. Axes and select blades from Świeciechów (Fig. 7: 1, 12), Volhynian, banded and even Jurassic flints were processed there and applied to a maximum degree in the same forms as those in Lesser Poland (Fig. 7: 2, 3, 9).

In quantitative terms, in the groups of finds, there dominate artifacts from the local Baltic flint (92.5–98%). They are the few flake cores and counter shock bipolar cores, retouched flakes, sidescrapers, truncations, arrowheads, leaf-like projective points, tools and small blade knives with bifacial and bilateral invasive retouch (Fig. 7: 8). Some of these artifacts in analogous forms were already known in the Sarnowo industry and also encountered in later industries. There is a small number of local artifacts, which for the most part represent typological and technical elements which are commonly found for the different industries. Because of the role of the artifacts from the south fossil raw materials, the region in question was included within the Lesser Poland TRB industry, as no grounds have been found for distinguishing a separate industry there. We could even speak of the Kujawy variety of the Lesser Poland industry,[5] which is characterized by

[5] J. Małecka-Kukawka voiced a different view (in her paper „Wytwórczość kamieniarska TRB na ziemi chełmińskiej" – The TRB flint processing in Chełmno Land, delivered at a symposium in Toruń on 11 November 1986). On the basis of recently gathered materials, we can now characterize probably with greater accuracy the industry of the younger TRB phases in the Lowlands and define the degree of its independence from the Lesser Poland industry in the uplands. It is interesting to note that more than 12 years ago I suggested that a younger Kujawy TRB industry existed in the Lowlands (Balcer 1975, 276). Above, we defined the older industry as the Sarnowo industry.

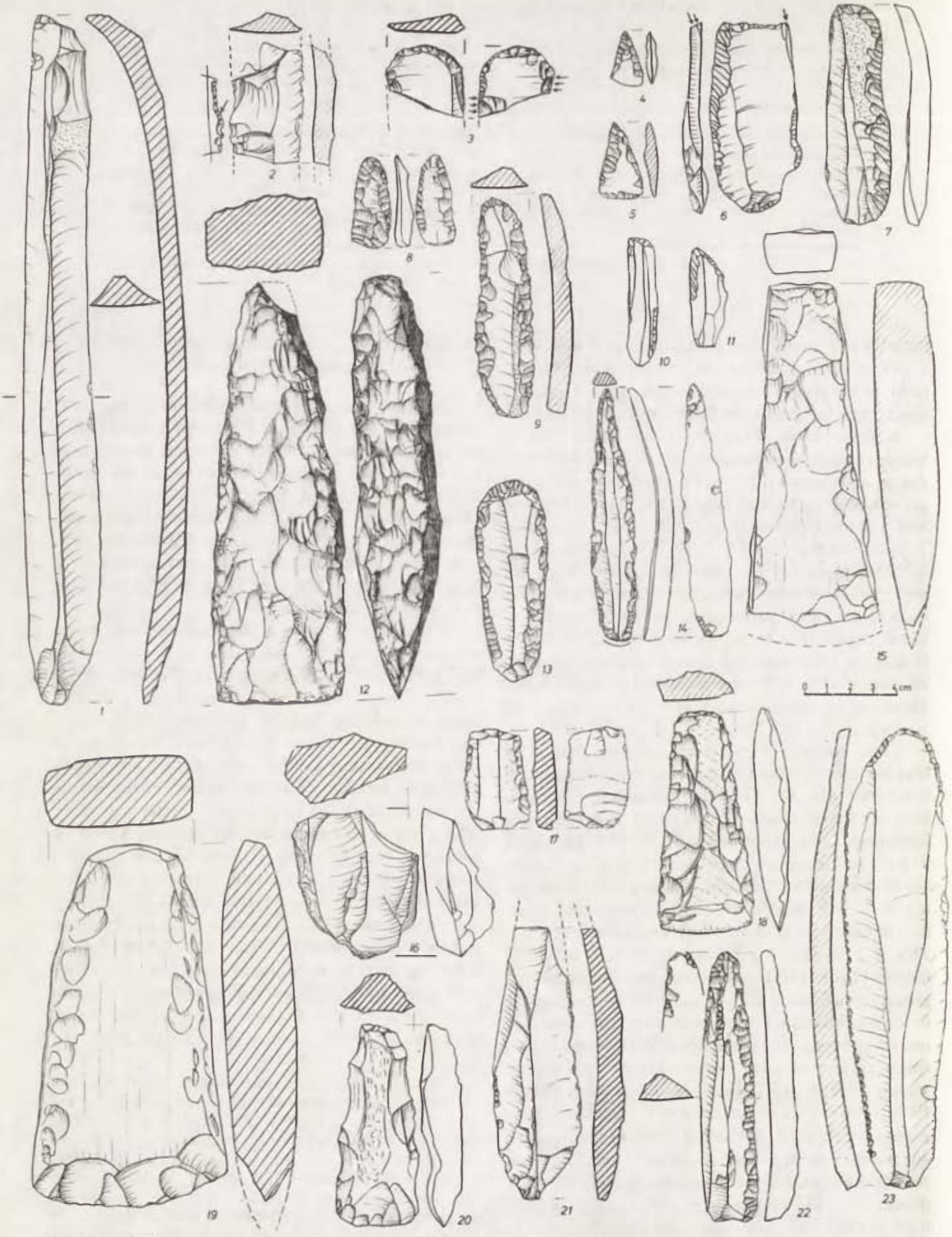

Fig. 7. Lesser Poland industry. TRB (*1–15*, *18*, *22*, *23*) and RPC (*16*, *17*, *19–21*) artifacts from Świeciechów (*1*, *3*, *12*), Volhynian (*4–7*, *9–11*, *13–15*), Baltic (*8*) and Jurassic (others) flints

1 – Radziejów, Włocławek District; *2* – Tarkowo, Bydgoszcz District; *3* – Rzęczkowo, Toruń District; *4*, *7*, *10*, *11*, *14* – Gródek Nadbużny, Zamość District; *8* – Grębocin, Toruń District; *9* – Gaj, Konin District; *12* – Włoszanowo, Bydgoszcz District; *13* – Wietrzychowice, Konin District; *14* – Las Stocki, Lublin District; *16,17*, *20* – Cracow-Zesławice; *19*, *21* – Cracow-Nowa Huta-Mogiła; *18*, *22*, *23* – Bronocice, Kielce District

numerical domination of Baltic flint and greater significance of the ordinary flaking and counter shock bipolar techniques is using it.

THE LESSER POLAND INDUSTRY IN A LATER PERIOD IN THE TRB AND RPC

The late development period of the industry was connected with the decline of the "Badenized" TRB in the Bronocice IV–V phases (Kruk, Milisauskas 1981) and with the RPC in the classical and late horizons, according to Z. Sochacki (1980). The range of the industry was then restricted to uplands in western Lesser Poland, defined by J. Kruk as "western loess uplands".

It will only be possible to characterize the late stage of this industry after the materials from Bronocice have been elaborated. J. Kruk and S. Milisauskas (1981) already noted the characteristic phenomenon of a cessation in the flow in of artifacts from Świeciechów, banded and Volhynian flints, of the limitation to the use of Jurassic flint, and, thus the role of the latter grew. Blades of this raw material are particularly wide and thick, and blade tools are massive (Fig. 7:23). Among axes, there dominate specimens of variety A with very wide edges (Fig. 7:19). They were worked into celts or even triangular ones. This particular massive nature, of at least some of the tools, distinguishes the late period artifacts from the "classical beaker" ones from eastern Lesser Poland.

The flint artifacts of the TRB and the RPC do not show any more distinct stylistic and typological and technical differences (Fig. 7:16–21). Within the RPC, they are known from the settlements of the Zesławice-Pleszów group in the area of Cracow-Nowa Huta (Godłowska 1976, 65–67, 81–83) and from cave sites near Cracow (Rook 1980). Almost entirely varieties G and A of Jurassic flint were used (Kaczanowska, J. K. Kozłowski 1976, 207 ff., 214). We only know small flake cores, some from fragments of axes (Fig. 7:16). We can only draw conclusions about blade cores and blades from blade tools 140–155 mm long, 29–48 mm wide, most often 30–35 mm, and 8–14 mm thick. In small tool groups, there dominate partly retouched blades (Fig. 7:21), also used as sickle knives. There are other tools: blade and flake endscrapers, a pointed borer, hammer stones, retouched flakes, a scaled piece (Fig. 7:17) and axes. Among them, there are the distinct axes, almost fully polished, 6–16 cm long. The greatest of them had very wide blades (8 cm – Fig. 7:19) and narrowed considerably to the backs (3 cm wide). Just as in the TRB, they were reworked into celts or triangular ones (Fig. 7:20). The maximum width of smaller axes is 35–60 mm, and they are 13–25 mm thick. A few axes with oval cross-section come from caves. Triangular specimens can be recognized as intermediate forms from axes to celts with edged sides. We know a small axe from a massive blade.

Within the Lesser Poland industry, we can distinguish local stylistic differences. In the southeast peripheries, there are tools with oblique parallel retouch (Fig. 7:6, 7) and axes with widened bits (Fig. 7:15) of Volhynian flint analogous to the artifacts of the TC. In western Lesser Poland, there are very massive, wide axes, blades and blade tools of Jurassic flint.

The Lesser Poland Industry already showed the results of the Eneolithic technological breakthrough, only just initiated in the circle of the linear cultures by the Sąspów industry. The flint production had already two trends because of the introduction of core tools in the form of macrolithic axes. This breakthrough was followed by the maximum macrolithicization of blades and blade tools. Sickle knives – sickle insets with uniform, single blade edges – became common. At the same time, truncations began to vanish. Chocolate flint lost its significance. The need for macrolithic artifacts added to the development of the exploitation of fossil flints and to the specialized, mass productions of semi-finished axes and blades, distributed more than 500 km from the deposits (Balcer 1975).

5. THE PIETROWICE INDUSTRY IN THE FUNNEL BEAKER AND RADIAL POTTERY CULTURES

This industry occurred in the basins of the Upper and Lower Odra in two cultures: in the TRB in the Silesian-Moravian, Ustowo and western Greater Poland groups, representing mainly the younger phases of the development of this culture and those of the RPC in its early Boleraz development period in Moravia and Upper Silesia.

The industry and its name were derived from the TRB materials from Site 8 at Pietrowice Wielkie, Katowice District (Bukowska-Gedigowa 1980). They were completed with materials from other TRB settlements on the Głubczyce Plateau and in Moravial (Bukowska-Gedigowa 1975; Balcer 1977). The very same industry is represented in the key settlement of the RPC, at Hlinsko, Přerov District, while a number of its elements occur at mixed (heterogeneous) sites in Moravia.

In the materials from Pietrowice Wielkie, it is difficult to distinguish precisely between the flint finds of the TRB and the RPC and the co-occurring

materials of the LPC and LgPL, belonging to the Cracow industry. Small groups of flint finds come from other TRB sites. This makes it difficult to determine the numerical structure of the Pietrowice Industry assemblages, and its characterization is more superficial than those of the above-discussed industries. After distinguishing the industry in the Upper Odra basin, it appeared that its properties/elements were also represented in the late TRB groups in the Lower Odra basin in Western Pomerania and western Greater Poland. Thus, within the range of the industry, there are two distinct main zones: the south – Silesian-Moravian one, and the north – Pomeranian-Greater Poland one. The basic differences between them are mainly quantitative, so much in the number of finds as in that of the represented typological elements.

RAW MATERIALS

Throughout the range of the industry, the basic raw material was Baltic erratic flint, from deposits that were secondary but rich in relatively large flint nodules of better quality than that commonly found in the Lowlands. In the south zone use was made of erratic Silesian-Moravian Cretaceous flint nodules of which permitted the production of artifacts 10–13 cm long. Slightly lesser possibilities were provided by erratic flint from the Warta and west Pomeranian regions. The proportion of Baltic flint artifacts in the assemblages is 95–100%. In the south zone, the proportion of artifacts from imported flints, particularly Jurassic and Świeciechów, reached several percent. Traces of imports of Świeciechów flint also occur in the north zone in western Greater Poland.

TRB ARTIFACTS IN THE SOUTH ZONE PIETROWICE INDUSTRY

Pre-cores and Cores. Pre-cores are pyramidal and subconical, with rounded or pointed tops, with rich preparation up to 12 cm high. They were meant for semi-conical or subconical blade cores with wide flaking surfaces (Fig. 8: 1) or with circular flaking surfaces. Greatly used blade cores are 8–9 cm high, while the axes from such cores are 7–10 cm long. We know small residual cores up to 5 cm high. Most often, the flake cores are amorphous, exploited without preparation, and multi-platform after orientation changes. The largest are 7–8 cm high, the most numerous specimens are 2–4 cm high. There are also small counter shock bipolar and tetrapolar flake cores. From the production centres, there come the few roughouts and semi-finished core axes and also such flake axes and cutter tools.

Flakes and Blades. Flakes were the basic blanks. The raw ones are usually small, 2–4 cm long, less frequently medium, 4–6 cm, and very infrequently large ones, up to 10 cm long. The largest blades of Silesian-Moravian and Baltic flint are 8–13 cm long, between 15 to more than 30 cm wide and 5–10 mm thick (Fig. 8: 2). Smaller blades dominate, on the other hand, about 60 mm long and up to 20 m wide on average.

Tools. We defined 11 varieties of tools.

a. *Endscrapers.* They are greatly differentiated in terms of the used raw material, size and morphological details. Flake endscrapers distinctly dominate. Two varieties of them known from Pietrowice Wielkie are particularly characteristic: A – with parallel or slightly converging sides and arched scraping surfaces (Fig. 8: 4); B – with sides having notches, with ogival scraping surfaces, less often arched ones (Fig. 8: 5, 6). The other endscrapers are common, more or less regular, e.g. with oval outlines. Blade endscrapers are small or more massive, short, thick or rather elongated with raw and retouched sides. Some of them are from fragments of sickle insets.

b. *Continuously and partly retouched blades micro-denticulated and those with use traces* are greatly differentiated in terms of size and the character of the edge. There are retouched blades of varieties A. B and C (see p. 68) from the largest blades (Fig. 8: 3). Smaller blades were retouched only partly, micro-denticulated or used without working as side insets (Fig 8: 10). There are few but characteristic small ones bifacial and bilateral invasive retouch (Fig. 8: 13). Sickle insets were the longest raw blades, micro-denticulated or retouched, as in the Lesser Poland Industry, and also small (5–8 cm long) raw and micro-denticulated blades worked over the striking platforms upwards, as is indicated by the arrangement of applicatory polish (Fig. 8: 7).

c. *Truncations.* The common forms with oblique backs (Fig. 8: 8, 9), which in the south zone cannot be distinguished from the common forms of the Cracow industry, are, on the other hand, also met in the north zone at the pure TRB sites.

d. *Perforators and groovers.* These are specimens retouched on one side or with alternating retouch from flakes and blades, and one from an axe fragment, too (Fig. 8: 7).

e. *Retouched flakes and sidescrapers.* In the group of flakes tools, only some can be defined as sidescrapers with continuous retouch. Some belong among large workshop-produced forms.

f. *Picks and sticks* are elongated core tools, with four or more walls, 7–9 cm long and 17–30 mm wide/thick. Compared with pointed or wedge-shaped picks (Fig. 8: 16), there are more numerous specimens with blunt rounded ends, defined as sticks (Fig. 8: 17). They were probably altered pick forms reshaped

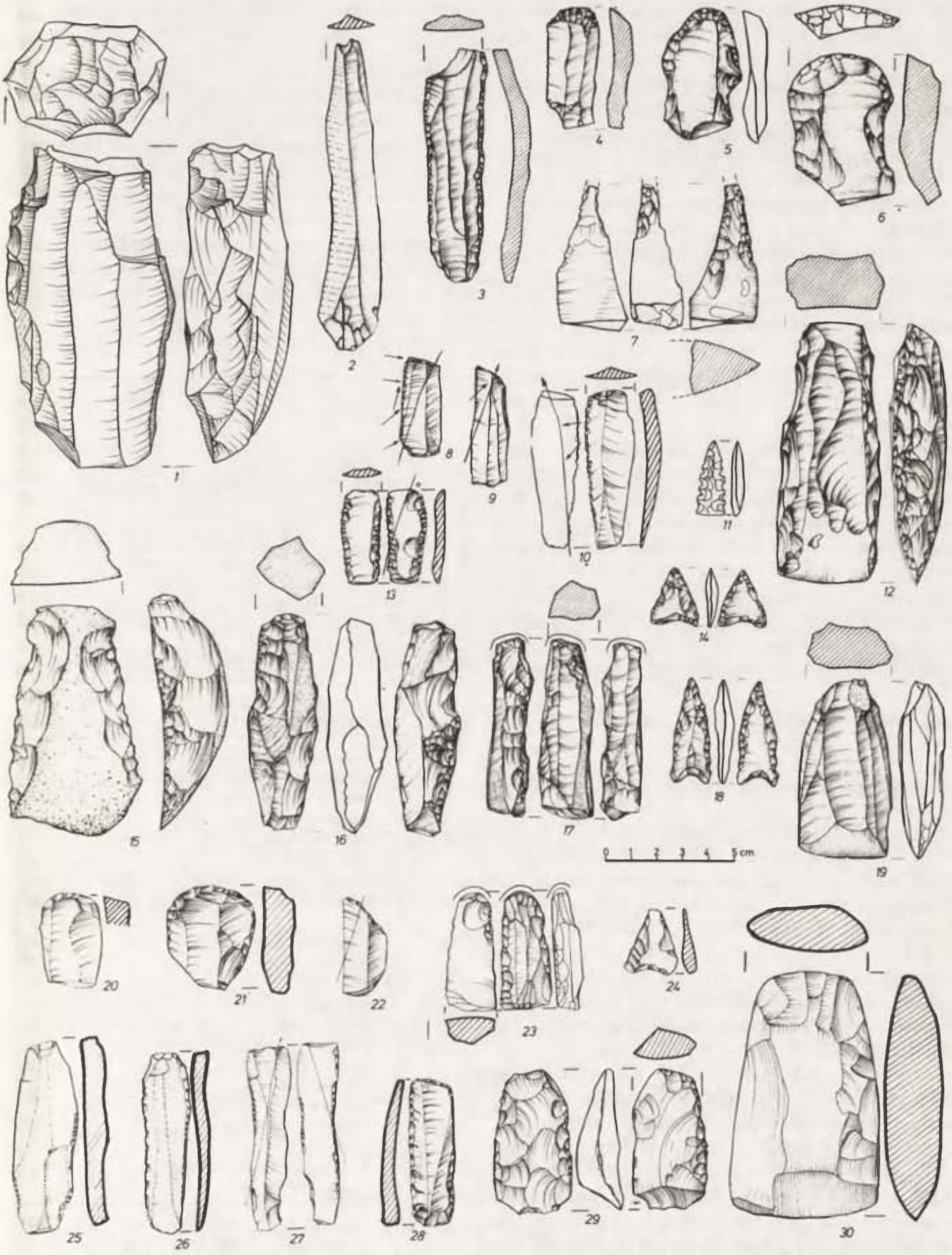

Fig. 8. Pietrowice industry in the south zone. TRB (*1–19*) and RPC (*20–30*) artifacts of Silesian-Moravian Baltic Cretaceous flint

1, 11 – Raków, Opole District; *2–10, 12–19* – Pietrowice Wielkie, Katowice District; *20–30* – Hlinsko, Přerov District (Czechoslovakia)

through use. Their ends are used up as in blunt borers (see p. 70).

g. *Core axes* are mostly axes (Fig. 8: 12), also triangular or oval ones (Fig. 8: 19), and celts, which are small, 6–13 cm long, with bit widths of 33–47 mm, and 20–30 mm thick. There are few altered and residual forms of them coming from repairing the original forms.

h. *Flake axes and adze-like tools.* The tools from the smallest natural or processed flakes have symmetrical or asymmetrical longitudinal cross-sections and trapeze outlines (Fig. 8: 15).

i. *Chisel-like scaled pieces.* In both zones of the industry there are scaled pieces, at least some of them may have been tools (see p. 70–71). They are four-walled or sub-oval, bipolar and tetrapolar, most often bifacial ones from flakes, fragments of blades and blade tools.

j. *Arrowheads.* Triangular arrowheads are infrequent (Fig. 8: 11, 14, 18). There is a distinct elongated arrowhead with slightly S-shaped sides (Fig. 8: 18). Stump-like arrowheads come from Moravia.

k. *Other tools* are hardly distinct burins, hammer stones – grinders, denticulated tools, bifacial tools and blunt borers from blades. There are infrequent multiple tools in the form of combinations of a sidescraper and a burin, an endscraper and a borer and a burin, and a sidescraper and a notched piece.

ARTIFACTS OF THE PIETROWICE INDUSTRY IN THE RPC

The determination of them is based on the finds from the relatively homogeneous settlement at Hlinsko (Pavelčik 1972). Blade tools 5–10 cm long dominate. There are retouched blades and micro-denticulated blades (Fig. 8: 25–28), truncations (Fig. 8: 22), elongated, thick and short endscrapers (Fig. 8: 20, 21), blunt blade borers (Fig. 8: 23), adze-like tools (Fig. 8: 29), a triangular arrowhead (Fig. 8: 24) and an axe with oval cross-section (Fig. 8: 30). Micro-denticulated blades were sickle insets. The Lesser Poland imports are represented by a broken blade piece – a sickle inset of Świeciechów flint. An endscraper from a fragment of a sickle knife of this raw material comes from the Stary Zamek site at Jevišovice. At this site, and at the other site of the RPC, there are the particular typological elements of the Pietrowice industry. These artifacts are the same as those of the TRB on the Głubczyce Plateau. The situation is similar in terms of raw materials. Therefore, we cannot distinguish the flint materials of the discussed culture which occur at the mixed sites of the two cultures, confirming their origin from the same industry.

ARTIFACTS OF THE PIETROWICE INDUSTRY IN THE NORTH ZONE

Most of them come from two settlements in western Greater Poland at Site 3 in Poznań-Lasek (earlier Luboń; Jażdżewski 1936, 64; Kowiańska-Piaszykowa, Kobusiewicz 1966) and at Mrowino, Poznań District (Tezlaff 1978). There, the basic raw material was Baltic flint from the secondary deposits on the Warta. Świeciechów flint flakes are traces of imports from the South. The largest artifacts – axes of Baltic flint – are 9–10 cm long. We know only one, conical, blade core (Fig. 9: 1). There dominate

Table 15. The list of finds of the Pietrowice industry in the north zone

	Artifacts varieties	Poznań-Lasek	Mrowino	Szczecin-Ustowo	Cedynia	Tools total
Raw material, production waste and blanks	Raw lumps and with working traces	X	31	–	–	
	Ordinary and counter shock bipolar flake cores	63	61	27	11	
	Blade cores	–	3	–	–	
	Initially worked pieces and semifinished axes	1	3	–	–	
	Flakes and chunks	1162	437	359	80	
	Blades and their fragments	67	18	5	14	
	Altogether	1293	553	391	105	
	Percentage	95.7	92	82	68	
Tools	1. Endscrapers	35	20	11	33	99
	2. Retouched flakes	–	7	45	4	56
	3. Blades and blade like flakes, worked and with use traces	16	4	7	7	34
	4. Sidescrapers	–	2	21	5	28
	5. Axes	1	2	2	–	5
	6,7. Adze-like tools	4?	–	–	–	4?
	6,7. Burins	–	4	–	–	4
	8. Perforators	1	2	–	–	3
	9-11. Truncation and backed piece	–	2	–	–	2
	9-11. Picks	1	1	–	–	2
	9-11. Chisel-like scaled pieces	–	2	–	–	2
	12,13. Multiple scraper	–	1	–	–	1
	12,13. Sharp-pointed borer + burin	–	1	–	–	1
	Altogether	58?	48	86	49	241?
	Percentage	4.3	8	18	32	
	Total	1351	601	477	154	
	P index	22.3	11.5	4.4	2.1	

ordinary and counter shock bipolar flake cores, most often small ones – 2–4 cm high, the largest 7–8 cm high. At the preliminary exploitation stages, they could serve to produce bladelets.

The most frequent are small flakes (2–4 cm), less frequently there are medium-size ones (4–6 cm) and single large specimens (up to 7 cm long). Blades are 29–79 mm long, 10–28 mm wide and 4–9 mm thick. Most often, they are 40–50 mm long, 15–18 mm wide and about 6 mm thick.

Table 15 contains a list of tools from the above-mentioned settlements (Fig. 9: 2–6, 9). All of them have their counterparts in the south zone of the Pietrowice industry. What is particularly significant is the presence of a celt (Fig. 9: 5) and an axe with triangular cross-section (Fig. 9: 14), picks (Fig. 9: 4), adze-like tools, sickle insets in the form of micro-denticulated bladelets and a truncation (Fig. 9: 2) with stylistic properties also specific of the south variety of the Pietrowice industry. There are also flake end-scrapers (Fig. 9: 6, 9) and borer + burin (Fig. 9: 3).

The flint finds of the Ustowo group of the TRB come from the three main sites of this group east of the Odra (Siuchniński 1981). The basic raw material was Baltic flint from the moraines of the Pomeranian lake district. There were no imports from the South, while within the Ustowo group there are loose finds of macrolithic four-walled and oval axes from Rugian flint which were imports from the southwest processing centres in the region of the coastal, southwest Baltic outcrops of Cretaceous flint. Large artifacts of this flint, such as flakes up to 10 cm in diameter and blades and blade tools up to 35 mm wide and more than 10 mm thick, known from the settlement in Szczecin-Ustowo (Fig. 9: 10, 11; Bogucka-Ślaska 1977) are distinctly more massive than the artifacts of erratic Baltic flint from the settlement at Cedynia, Szczecin District (Fig. 9: 7, 8, 12; Majchrzak 1978).

The largest number of finds comes from the settlement in Gorzów Wielkopolski, but has not been elaborated yet (Szczurek 1981). In it, there dominate flake endscrapers (Fig. 9: 13), and retouched blades, small axes and celts about 70 mm long, and a group of dozen-odd lanceolate projectile points 40–50 mm long, with surface retouch on both sides (Fig. 9: 15, 16) are known. From other sites we know in addition sidescrapers and retouched flakes. In all, only a few typological elements of the Pietrowice industry are represented by them.

Assemblages of Artifacts. The assemblages of finds from the particular sites are greatly differentiated in terms of number and the general structure. In the south zone, just as within the range of the Lesser Poland industry (see p. 71) there is a distinct division into the production settlements (the settlements at Pietrowice, $P = 27.2$, Raków, $P = 13.3$) and the users' settlements (Wojnowice, $P = 4.7$, Polska Cerekiew, $P = 4.4$) last three in Opole District. In the north zone, the materials from the settlements in Poznań-Lasek

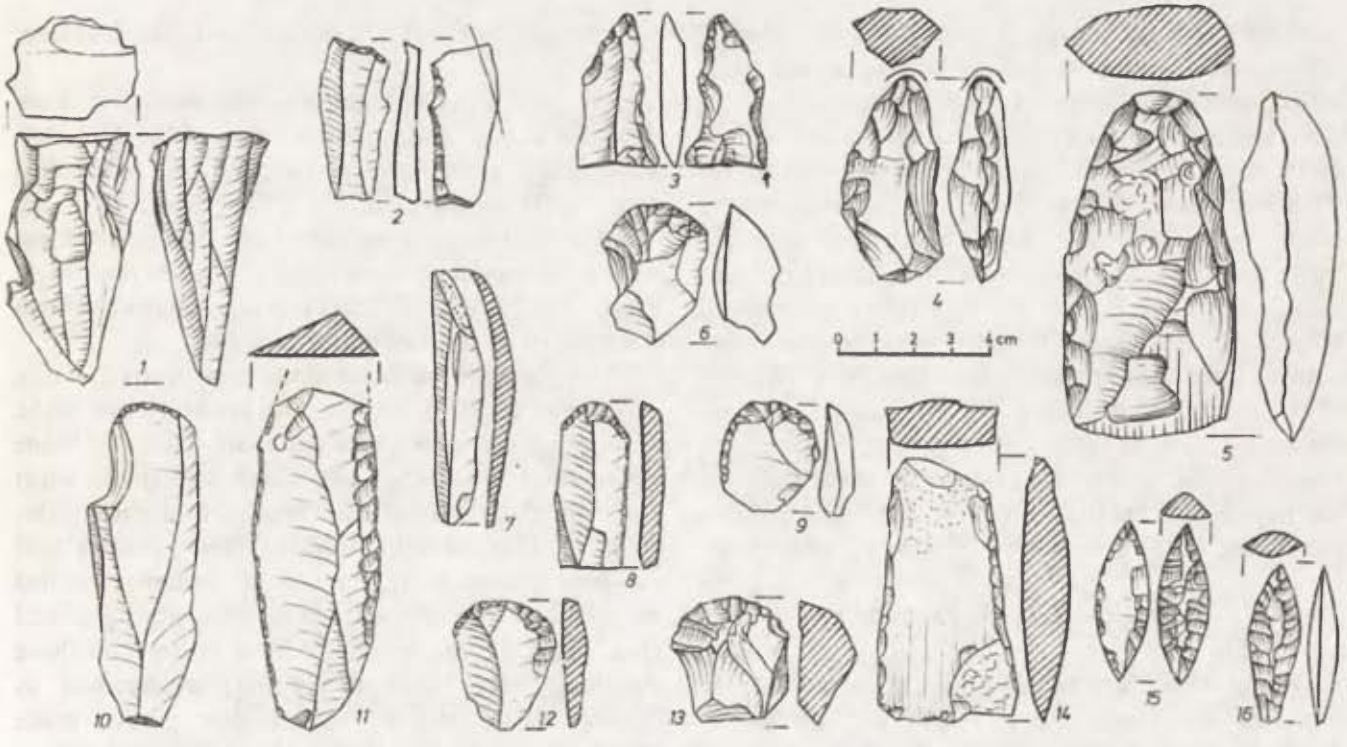

Fig. 9. Pietrowice industry in the north zone. TRB artifacts of Baltic Cretaceous flint

1–6, 9 – Mrowino, Poznań District; *7, 8, 12* – Cedynia, Szczecin District, *10, 11* – Szczecin-Ustowo; *13–16* – Gorzów Wielkopolski

and Mrowino also have high P indexes: $P = 22.3$ and $P = 11.5$. For many sites there are no bases for determining the general structure of the assemblages and tool groups. We can, however, say that the most numerous and frequent pieces include endscrapers, particularly from flakes, retouched blades, perforators and groovers, truncations, retouched flakes, sidescrapers, axes, arrowheads and projectile points. The other specimens, which are infrequent or known only from Pietrowice Wielkie are sticks and picks, adze-like tools, variety B flake endscrapers, and bifacial and denticulated tools. They represent the original forms reflecting the specific character of the industry under study.

The artifacts of the Pietrowice industry are mediolithic and moderately macrolithic. They show, on the other hand, the effects of the Eneolithic technological breakthrough. Parallel to them, there occur the macrolithic imports from the Lesser Poland and the north TRB groups. The artifacts from erratic flints also illustrate the tendency towards macrolithicization, but one restricted by the dimensions of nodules of the available raw materials (specificity). What determined the separate nature of the Pietrowice industry was, however, the other than raw material specificity, resulting from the cultural conditions of the development of the industry in the area of the Moravian Gate and in regions farther north of the Lowlands. In these regions, the southern and western influences clashed with northern and eastern ones. The range of the industry included the Epimesolithic communities of the so-called Bobrza group (Bagniewski 1982) and those of the epi-Linear cultural cycle. The late Lengyel groups were superimposed upon by the TRB with the artifacts of the Lesser Poland industry, and in turn the early RPC imposed itself on the TRB. It is with its interactions that we connect the appearance of celts as the youngest element. At the same time, however, there were archaic elements: tools, sticks and picks and adze-like tools with analogues in the Mesolithic products in the Lowlands (Kobusiewicz 1973) and truncations with analogues in the industries of the Linear cultures.

Within the range of the industry, in the regions dividing the Silesian-Moravian group from the Ustowo TRB, in Lower Silesia there were TRB settlements almost without flint finds (Wojciechowski 1973). Probably, they utilized a slight number of flint tools of imported blanks, which were particularly protected from being lost. Their absence among the settlement remnants need not indicate that flint artifacts were not used. In the conditions of a shortage of raw material, their functions may have also been fulfilled by tools from crystalline rocks, but this has not been determined, either.

6. FLINT INDUSTRIES IN THE TRIPOLYE CULTURE

In the younger phases of its development, the TC propagated to the northwest as far as the Bug basin on the southeast corner of the Vistula basin. There, the ranges of the Lublin-Volhynian group in the LgPl, the TC and the Lesser Poland group of the TRB overlapped. Within the TC, in that region there occurred the Volhynian industry, derived from the older industries of this culture, and, therefore, they require some description. We drew information about these industries directly from the materials on monuments in the USSR and Poland (Balcer 1983, 196). This information is fragmentary. There are no data about the raw material and typological structures, therefore the characteristics of the TC industries have the nature of general information and will require in the future to be made more precise or corrected.

THE BIERNASZEWKA INDUSTRY

Along with the Łuka Wróblewiecka industry, it represents the older phase in the TC flint processing development. It was distinguished on the basis of finds of the early Stage A in Florešti, Biernaszewka and Sabatinowka II (Moldavia and the Ukraine, USSR).

The sole raw material was Dniester flint from deposits around the middle course of the Dniester. The blade cores are single-platform subconical (Fig. 10:27), semiconical (Fig. 10:20), barrel-like and, a few subcarinated ones; some are double-platform after orientation change, small, 45–100 mm high, most often 50–80 mm. There are small multi-platform flake cores after orientation changes.

The blanks were flakes and cores up to 115 mm long, most often 50–60 mm, and about 15 mm wide.

Among the tools, there dominate flake and blade endscrapers (Fig.10:5–9, 17), which are thick, short and slightly converging. There are arched sidescrapers (Fig. 10:4), ordinary and denticulated retouched blades, fragments of micro-retouched blades and those sickle-like obliquely polished (Fig. 10: 10, 22–25), few single blow burins and those on snap, core sticks (Fig. 10: 21), determined as punch and/or pressure flaking flint points, made mainly from residual conical blade cores, hammer stones from cores and few microlithic pieces,

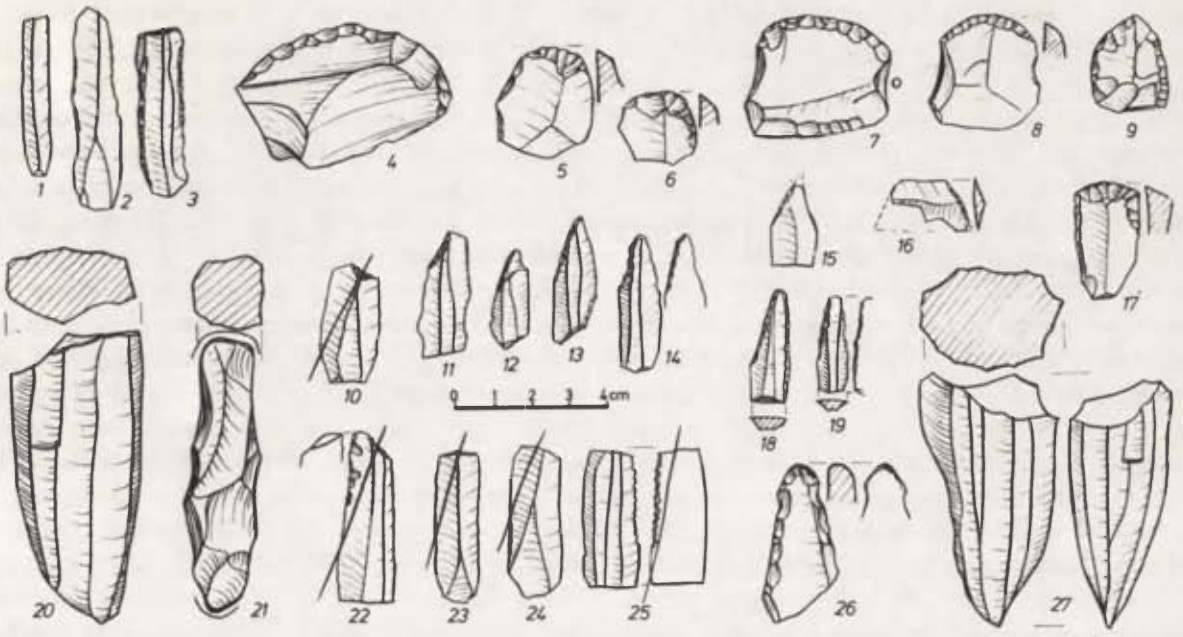

Fig. 10. Biernaszewka industry. Artifacts of Dniester flint
1–6, 10–14, 20–25 – Biernaszewka; *7–9, 15–19, 26, 27* – Sabatinowka, Ukraine, USSR

truncations (Fig. 10: 11, 15), rhombi (Fig. 10: 12, 13), trapezes (Fig. 10: 16), micro-retouched bladelets or perforators and groovers (Fig. 10: 14, 18, 19). The products of the industry are slight and small, typically mediolithic and microlithic.

THE ŁUKA WRÓBLEWIECKA INDUSTRY

It includes the TC phenomena from the turn of phases A and B to the onset of phase B2. It still represented the older phase in the TC flint processing

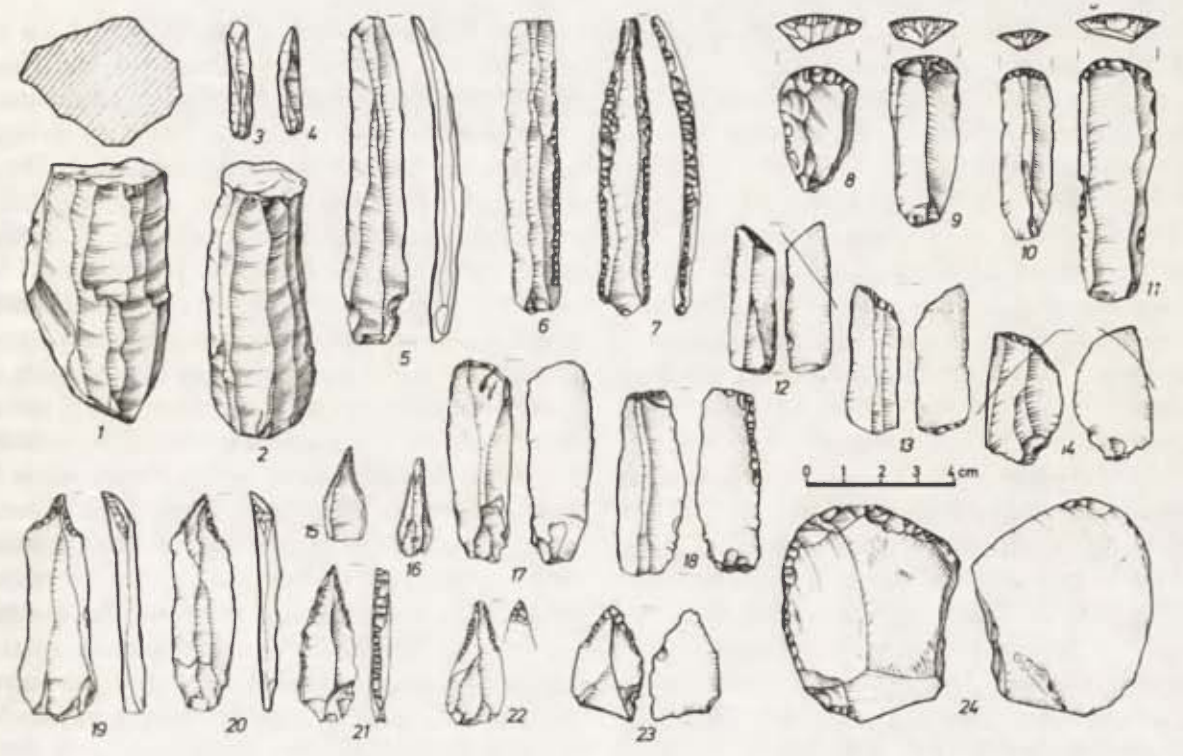

Fig. 11. Łuka Wróblewiecka industry. Dniester flint artifacts from Łuka Wróblewiecka, Ukraine, USSR

development. It was distinguished and named after the settlement at Łuka Wróblewiecka, USSR (Bibikov 1953).

The basic raw material was still Dniester flint. The blade cores are conical (Fig. 11:1), cylindrical (Fig. 11:2) and subconical, 40–120 mm high, most often 60–80 mm. The blades (Fig. 11:3–5) are up to 115 mm long, most frequently 60–80 mm.

The tools include: 1 – elongated (Fig. 11:9–11) and short, convergent (Fig. 11:8) blade endscrapers; 2 – flake endscrapers; 3 – sidescrapers, including converging, pointed ones; 4 – retouched blades (Fig. 11:6,7); 5 – perforators and groovers with sharp points (Fig. 11:15,16,19–23); 6 – truncations and short blade fragments – raw or micro-denticulated – used as sickle insets (Fig. 11:12–14,17,18); 7 – sticks and picks (punch and/or pressure flaking flint points); 8 – arrowheads and projectile points. Moreover, there are single pieces: hoe-like tools, bifacial tools, macro-endscrapers (Fig. 11:24) and large sidescrapers, with the latter being workshop forms.

In the tool assemblages, there dominate endscrapers and sidescrapers. There is increased proportion of retouched blades, truncations and punch and/or pressure flaking flint points. The tools are mediolithic, there are already no microlithic pieces, but flint axes are still not there.

THE VOLHYNIAN INDUSTRY

It covered the whole younger period of the TC flint processing development from phase B2 to the end of the culture. Over this period, there were fully distinct effects of the technological breakthrough, in the form of macrolithicization of artifacts and popularization of flint axes. The TC spread most towards the northwest up the Dniester and into the Horyń and upper Bug basins. Its range included the rich Volhynian flint deposits. It became the basic raw material; in the TC it spread over a 200–250 km radius. Use was also made of other varieties of southeastern – Dniester and Podole – Cretaceous flints.

The image of the Volhynian industry is, made up of artifacts from on-site workshops, production and users' settlements and cemeteries.

Production Waste and Blanks. The blade cores are conical, subconical and barrel-like, 75–250 mm high, most of them 120–140 mm (Fig. 12:9). They yielded blades over 200 mm long and 25–35 mm wide (Fig. 12:5). They are known from a number of caches, where also pre-cores and cores occurred.

The production waste also consists of semi-finished and roughed out axes and celts, with the largest known to me having the dimensions 215 × 105 × 50 mm.

Tools. There are ten varieties of tools: a – ordinary retouched blades (A, Fig. 12:6), narrowed ones (B, Fig. 12:7) and very narrowed ones (C, Fig. 12:8) with arched, sharp-arched and characteristically pointed ends (Fig. 12:7,8) – varieties A and B were used as sickle insets with uniform blade edges; b – blade endscrapers (Fig. 12:1,2), most of them short and fairly elongated, slightly converging; c – perforators borers and groovers with sharp points (Fig. 12:3), d – flake sidescrapers; e – blunt borers defined as punch and/or pressure flaking flint points, which are most often reshaped forms of retouched blade pieces (Fig. 12:4) which were used earlier as sickle insets; f – axes, wedged-shaped with flat backs and, most often, with slightly diverging bits (Fig. 12:14,15), very carefully worked. Only, their wider sides were polished, most often partly; the oldest TC axes were 100–110 mm long, in phase C they were much larger. There occurred small core axes (Fig. 12:13), micro-axes from blades and few celts; g – triangular arrowheads with straight or inbent bases (Fig. 12:10–12); h – hardly distinct burins.

The character of the Volhynian industry is shown by the macrolithic blade tools and axes. In terms of quantity, blade pieces dominate. Their parallel oblique retouch is very characteristic. The industrial tools are very imposing technologically, while the axes are particularly carefully made. The aesthetic nature of the artifacts was affected by the high values of Volhynian flint.

The flint industries in the TC can be a model example of a gradual development of the Neolithic flint processing. In them, there was a transition from the mediolithic with microlithic elements, through the mediolithic, to the maximum macrolithic. The same kind of blade cores, the same assortment of tools from flakes and blades, were still kept. A qualitative jump, related to the Eneolithic technological breakthrough, lay in increasing the dimensions of blades and blade tools and in introducing another trend in production – the manufacturing of core tools in the form of axes recognized as imitations of the metal prototypes. As the blades increased, the retouch on retouched blades became richer. Small sickle insets were replaced by macrolithic blade edges. There was a decrease in the proportion of endscrapers and sidescrapers, and an increase in that of retouched blades. These was an increase in the number of harvesting tools. In the youngest period, apart from axes, celts appeared. In all the industries, there was the characteristically large proportion of punch and/or pressure flaking flint points – tools for flint processing.

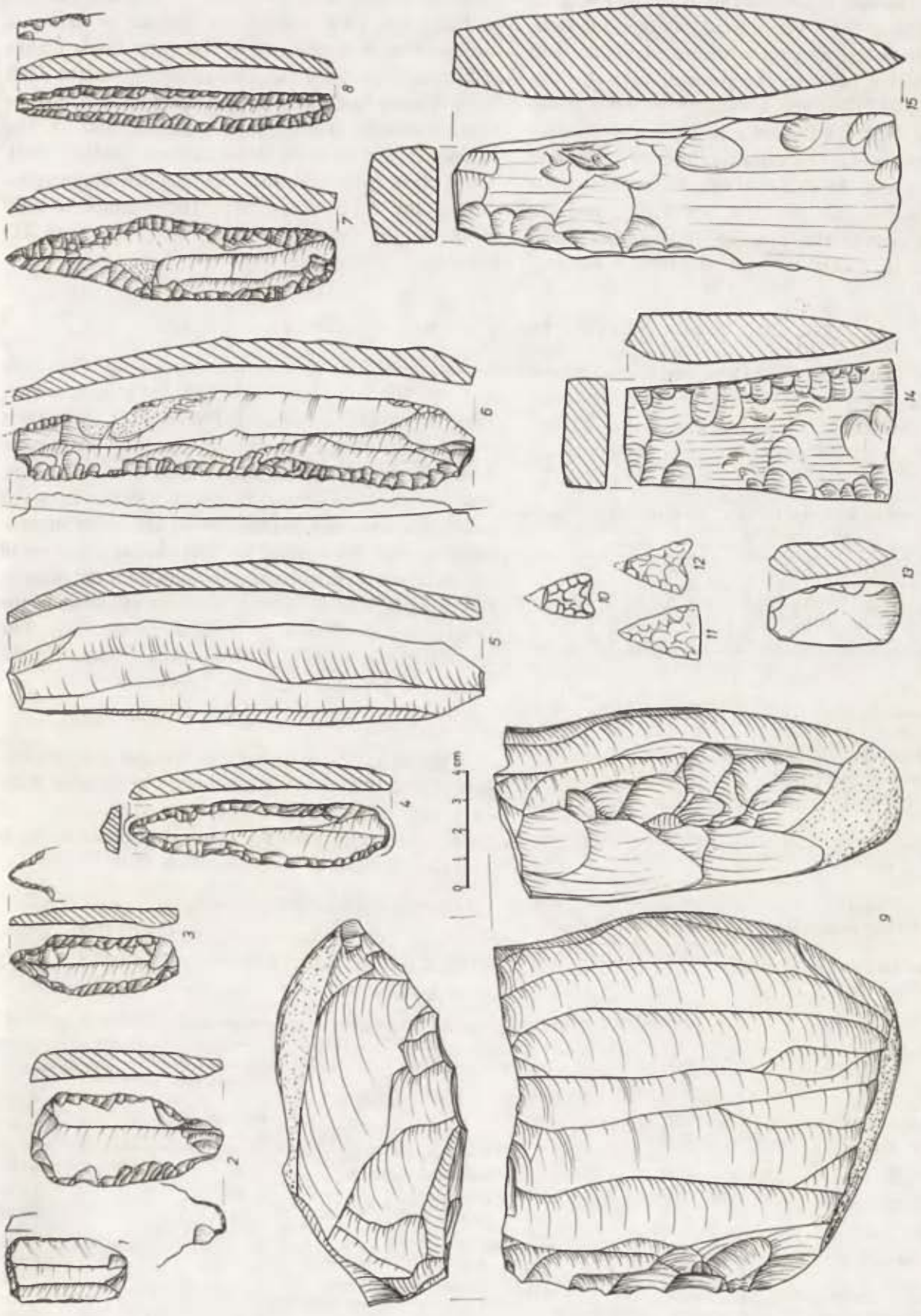

Fig. 12. Volhynian industry. Volhynian flint artifacts

1–4, 6–8, 15 – Bilcze Złote, *5, 13, 14* – Listwin, *9* – Sapanów, *10–12* – Czerwony Hutor, Ukraine, USSR

Traces of massive flint processing in the form of production waste concentrations occurred in the areas of mines and at settlements (Černyš 1967). In the older phase, they were found in semi-dug-outs, next to their walls and on working platforms laid with clay within huts. In the younger period, there were on-site and domestic workshops – on a group basis in the courts of the settlements, and individual ones at homesteads. There are no data with which to determine exactly the structure of artifact groups, but we can assume that for the materials from the production centres the *P* index is probably much higher than 10. In the terms of the flint processing, the TC was most "industrialized". The artifacts of the Volhynian industry were the objects of distribution not only within the range of the TC, but also reached probably the TRB territory. A number of data can indicate that at least some of the select blade blanks and semi-finished axes of Volhynian flint in the TRB in the Vistula basin may have come from an exchange with communities of the TC, carried out in the contact region between these cultures (Balcer 1981). The finds of Volhynian flint in the southeast peripheries of the TRB range have the distinct stylistic properties of the artifacts of the Volhynian TC industry.

7. THE GIERCZANKA INDUSTRY IN THE GLOBULAR AMPHORA CULTURE

The flint materials of the GAC are known above all from graves (Wiślański 1966), where there occur selected artifacts, mainly axes and chisels (Fig. 13: 31–35). The very low number of settlement finds prevents a characterization of the flint processing. It is only from the younger phase of the GAC at Mierzanowice, Tarnobrzeg District (Balcer 1963; 1976) that about 900 flint artifacts come (Table 16). They permit the determination of one industry within the GAC range. The name of the Gierczanka industry comes from the small river on which Mierzanowice and other superficially studied settlements lie. The characterization of this industry is enriched by the finds from the mine at Krzemionki, Kielce District, while its influence in the Lowlands is confirmed by some cemetery finds. The few settlement finds in Kujawy provide data on the local flint production in the Lowlands.

Table 16. Flint materials from the GAC settlement at Mierzanowice, Site 1

	Artifacts varieties	Banded Krzemionki	Świeciechów	Chocolate	Ostrów	Baltic	Indefinite	Total	
Production waste and blanks	Pre-cores	1	1	–	–	–	–	2	
	Flake cores	3	2	3	–	1	–	9	
	Blade cores	–	1	1	–	–	–	2	
	Counter shock bipolar pieces	2	2	1	–	–	–	5	
	Initially worked axes	7	1	–	–	–	–	8	9
	and semifinished chisels	1	–	–	–	–	–	1	
	Flakes	483	147	90	5	–	21	746	
	Blades	2	25	1	–	–	–	28	
	Altogether	499	179	96	5	1	21	801	
	Percentage	62.30	22.35	11.99	0.62	0.12	2.62	100.00	
Tools	Retouched blades	–	23	1	–	–	–	24	
	Blades with arched ends	–	2	–	–	–	–	2	
	Transverse truncations	–	3	1	–	–	–	4	
	Flake endscraper	11	2	–	–	–	–	13	
	Borers	–	1	1	–	–	–	2	
	Perforators	1	–	–	–	–	–	1	
	Denticulated tools	6	–	2	–	–	–	8	
	Retouched flakes, sidescrapers	14	8	4	1	–	–	27	
	Axes	8	1	–	–	–	–	9	
	Chisels	1	–	–	–	–	–	1	
	Hammer stones	7	1	–	–	–	–	8	
	Others and indefinite	–	1	–	–	–	–	1	
	Altogether = percentage	48	42	9	1	–	–	100	
	Total specimen number	547	221	105	6	1	21	901	
	Percentage	60.7	24.5	11.7	0.67	0.11	2.33	100.00	
	P index	10.4	4.26	10.6				8.01	

The basic raw material was banded Krzemionki flint (Table 17), from which axes, chisels and flake tools were made. There was quite a proportion of Świeciechów flint used for producing blade tools. It was complemented with chocolate flint.

ARTIFACTS AND ASSEMBLAGES OF ARTIFACTS

PRODUCTION WASTE AND BLANKS. *Core forms.* From the Mierzanowice settlement we know strongly used blade cores of Świeciechów flint (Fig. 13: 28).

Table 17. The percentage proportion of raw flint in the GAC

Flint	Sites in northwestern Poland total		Mierzanowice	
	small tools without axes	total	tools	total
Banded-Krzemionki	40	**66**	**48**	**60.70**
Chocolate	**47**	9	9	11.70
Świeciechów	8	2	42	24.50
Erratic Baltic	5	13	–	0.10
Rugian	–	1	–	–
Others and indefinite	–	9	1	3.00
Total	100	100	100	100.00

Bold type denotes percentages of the dominating raw materials.

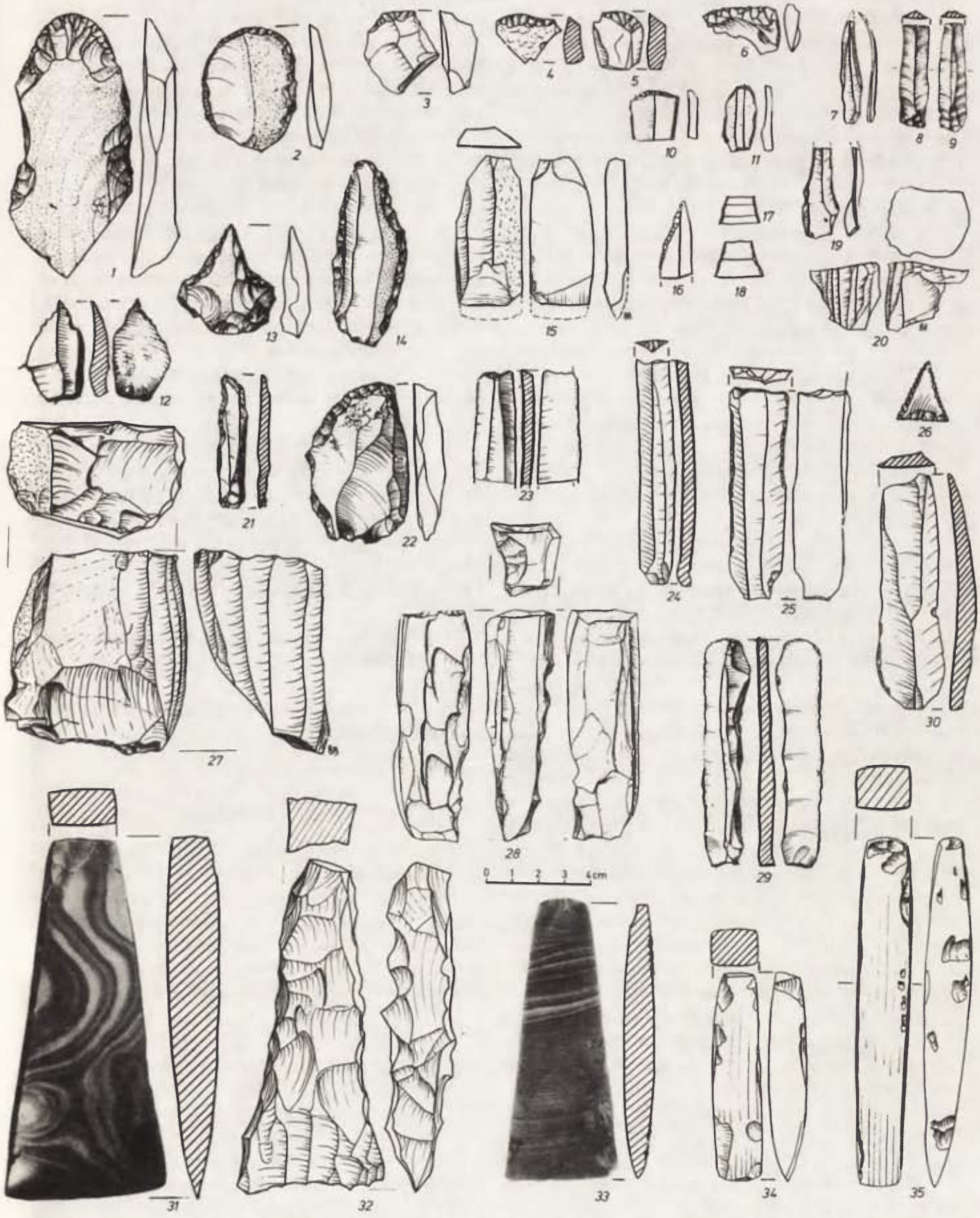

Fig. 13. Artifacts of the Gierczanka industry and other GAC finds from banded-Krzemionki (*1*, *2*, *12*, *13*, *27*, *31–35*), Baltic (*3–7*, *11*, *15*, *19*, 20, 26), chocolate (*8–10*, *21*, *30*), Świeciechów (*14*, *22–25*, *28*, *29*), and indefinite (*16–18*) flints

1, *2*, *12* *14*, *21–24*, *28*, *29* – Mierzanowice, Tarnobrzeg District; *3–5*, *15*, *20* – Przybranowo, *6*, *7*, *10*, *11*, *19* – Tuczno, Bydgoszcz District; *8*, *9*, – Bieniewo, Skierniewice District; *16* – Klementowice, *17*, *18* – Stok, Lublin District; *25*, *26*, *30* – Zaborze, Ciechanów District; *27*, *32*, *35* – Krzemionki, Kielce District; *31* – Pruskołęka, Ostrołęka District; *33* – Niniski, Siedlce District; *34* – Beszowa, Tarnobrzeg District

Similar parameters are characteristic of blade cores of banded flint from the mine at Krzemionki (Fig. 13:27). Subcarinated cores with narrow flaking surfaces, up to 90 cm high, 25–65 mm wide and up to 105 mm thick-long, subconical cores up to 80 mm and others, including a stump-like one, were used. The blade cores were worked into flake ones and hammer stones. Amorphous flake cores after orientation changes dominate.

From the Mierzanowice settlement, there come a few semi-finished axes and chisels, which are the basic core forms from the site of the mine at Krzemionki (Fig. 13:32). From the studies on the group of roughouts and semi-finished axes from this mine, we can state that among them there dominate specimens 101–110 mm long, with the maximum width in the edge part of 51–60 mm, the minimum width in the back part of 31–40 mm and the same thickness (Balcer 1983, 219). They are slightly larger than in the most often met ready-made axes (see below), which is justified by losses in the further working of semi-finished specimens.

Blades and Flakes. The whole blades and blade tools from the Mierzanowice settlement are 40–116 mm long, 7.2 mm on average. The whole blades and their fragments are 10–26 mm wide, most often 15–20 mm, 17.2 mm on average, while they are 4.4 mm wide on average. In the Gierczanka Industry a typical blade would have the dimensions $70 \times 15 \times 4.4$ mm. The flakes mainly came from the working of semi-finished axes, although flake cores were also exploited. The main blanks were medium-size and large cortex flakes.

Tools. The groups of 100 tools at Mierzanowice include 52 flake specimens, 30 blade pieces and 18 core forms (Table 16). Most of the blade tools are blades with usually one side partly with micro- and denticulated retouch (Fig. 13:21). The most characteristic forms are truncated blades with transverse streight truncations (Fig. 13:23–25). There are also similar blades with retouched arched ends without the character of an endscraper (Fig. 13:29).

The flake tools are much more massive than the blade ones. We divide endscrapers into: A – fairly elongated and bulky with symmetrical arched and sharp-arched scraping surfaces with side notches (Fig. 13:1); B – bulky and short (Fig. 13:22) suboval or subcircular ones, the latter with almost circular retouch (Fig. 13:2). Double specimens also occur.

Blade perforators and groovers have delicate points with alternating retouch (Fig. 13:12), while the points on the flake specimens are more massive (Fig. 13:13). The flake tools also include retouched flakes, denticulated tools and sidescrapers (Fig. 13:14).

The core tools are axes, chisels and hammer stones. Only fragments of axes, 3–5 cm wide and 2.5–3 cm thick and probably about 10 cm long, come from the Mierzanowice settlement. The damaged axes were not repaired. They were used as hammer stones and flake cores. A chisel and a semi-finished chisel come from the Mierzanowice settlement.

The latter specimens connect the Mierzanowice settlement with the banded flint mine at Krzemionki, on the one hand, and with the great territory where this raw material spread, on the other hand, over a radius of about 600 km, exactly in the form of axes and chisels. They usually are part of the equipment of the numerous GAC graves. They are four-sided, dihedral, with flat backs, very regular, carefully made and completely polished (Fig. 13:31, 33). We can recognize as chisels specimens with 4:1 length-width ratios, with edges not exceeding 30 mm in width (Fig. 13:34, 35).

The axes are from 5 to more than 20 cm long. Analysis of 80 axes from the territory ranging from Pomerania to Volhynia shows their average dimensions: 109 mm long, with edges 48 mm wide, backs 29 mm wide and the maximum thickness of 21 mm. Most often, the sides of the axes converge at angles of 11–13° (41%), 8–10° (36%), 16–19° (18%) and 3° (5%).

There are very few GAC axes from Świeciechów, and also chocolate, flint.

From the GAC graves in the lowlands, we know microlithic artifacts – trapezes (Fig. 13:17, 18) and a truncation (Fig. 13:16).

INFORMATION ON THE GAC FLINT ARTIFACTS IN THE LOWLANDS

There is no doubt that the GAC in the Lowlands was within the influence range of the Gierczanka industry. This is evidenced not only by axes and chisels of banded flint the semi-finished forms of which were shaped in the native region of the industry. What is characteristic of the Gierczanka industry is mentioned above truncations of Świeciechów flint (Fig. 13:25) and retouched blades of chocolate flint (Fig. 13:30), coming from the Mazovian graves at Zaborze, Ciechanów District (Mazurowski 1977), whereas blades of this raw material were found at Bieniewo, Skierniewice District (Uzarowiczowa, Kowalczyk 1973).

Data on the local flint processing in the GAC in the Lowlands are provided by materials from two settlements in Kujawy, at Tuczno and Przybranowo, Bydgoszcz District. Small ordinary (Fig. 13:20) and counter shock bipolar flake and blade cores were used there. Small flakes were the main blanks. The blades and blade tools are 4–6 cm long and 13–

20 mm wide (Fig. 13: 7–9, 19). There occur endscrapers from more massive chocolate flint blades, 14–18 mm wide. The common tools were flakes and blades, partly retouched (Fig. 13: 19) and with use traces, flake and blade endscrapers (Fig. 13: 3–6, 10, 11) and sidescrapers (Fig. 13: 6). Sporadically, there occurred burins, trapezes, triangular (Fig. 13: 26) and tanged arrowheads, perforators and groovers and a micro-axe-chisel from a blade (Fig. 13: 15).

In the GAC flint processing, there is a fundamental discrepancy between the character of blade and flake tools and the core axes and chisels. The former are small, mediolithic and also microlithic. They show no properties of the Eneolithic technological breakthrough before the GAC emerged. The axes and chisels are, on the other hand, at least moderately macrolithic. They were more carefully worked than the TRB axes, although, as a rule, they are smaller. We can assume that they were used as weapons rather than working tools. They may have had extra-economic cult and social meanings. The range and intensity of the propagation of banded flint axes over a radius close to 600 km was a phenomenon with a scale not to be met for the other cultures, the most characteristic of the GAC flint processing (Balcer, Kowalski 1978).

8. THE SOUTH (LESSER POLAND) INDUSTRY IN THE CORDED WARE AND ZŁOTA CULTURES

The industry was distinguished on the basis of materials from cemeteries of the Cracow-Sandomierz and, to a lesser extent, Lubaczów groups, identified as part of the younger CWC, and those from the cemetery at Złota (Machnik 1966; A. Kempisty 1978; Uzarowiczowa 1970; Krzak 1976; Tunia 1979). The flint finds from the CWC and Zlota culture show only slight differences in raw material and typology, therefore we consider them as parts of one industry.

RAW MATERIALS

In the CWC, in the Cracow-Sandomierz group in the Sandomierz Upland, small tools were produced from chocolate flint, whereas in western Lesser Poland Jurassic flint was used to a larger degree. Świeciechów flint was the raw material for most CWC axes and also the main raw material in the Złota culture, where chocolate flint artifacts also occurred (Table 18). In the Lubaczów group of the CWC, there occur artifacts of Volhynian flint, which was also used in the Złota culture. There are also few artifacts of Baltic flint. What is significant is the complete, or nearly so, lack of banded flint specimens, as deposits of it are in the direct vicinity of the cultures with which the industry in question was related.

Table 18. The percentage proportions of flint materials in the southern CWC and Zlota culture

Flint	Mierzanowice	Zerniki Górne Kielce District	Koniusza Cracow District	Zlota
Chocolate	**81.0**	**61.0**	**80.0**	15.0
Świeciechów	18.0	20.3	4.3	**64**
Banded-Krzemionki	1.0	0.8	–	–
Jurassic	–	13.6	12.9	X
Volhynian	–	0.8	–	15
Baltic	–	3.4	2.8	X
Total	100.0	100.0	100.0	–

X – occurring in indefinite percentage.

ARTIFACTS AND ASSEMBLAGES OF ARTIFACTS

Production Waste and Blanks. The few data indicate the use of ordinary and counter shock bipolar flake cores and single- and double-platform blade cores after orientation change. Their surfaces indicate the advanced preparation of blade cores, probably semiconical and subconical, rather elongated, and about 10 cm high. Small and very small ordinary and scaled flakes come from the graves. The blades from graves under mounds in the Cracow-Sandomierz group are 33–110 mm long, with the average dimensions 54 × 18 × 5 mm. Blades of Volhynian flint, known from the Lubaczów group of the CWC are up to more than 12 cm long. The Złota culture blades were 10–12 cm long, about 2.5 cm wide and 6–10 mm thick.

Tools. There are 11 varieties of tools (Table 19).

a. *Arrowheads.* They are the most numerous tools of the industry Fig. 14: 9–13, 18–28). Formed from fragments of blades and flakes with bifacial retouch at the edge, they are triangular-like (Fig. 14: 9–11) and heart-shaped with notches in the bases (Figs. 14: 12, 13, 17–28), separating the symmetrical and asymmetrical "wings". Recently, W. Borkowski (1987) defined strictly the differences in raw material and style between the CWC arrowheads and those of the Złota culture. He showed that CWC arrowheads were usually made of chocolate flint, had most often asymmetrical outlines, triangular notches in the bases and sharp or slightly rounded wings (Fig. 14: 18–28). In contrast, the Złota culture arrowheads have more often straight or slightly in-bent bases and straight or slightly curved sides (Fig. 14: 9–11). There is quite a number of inter-

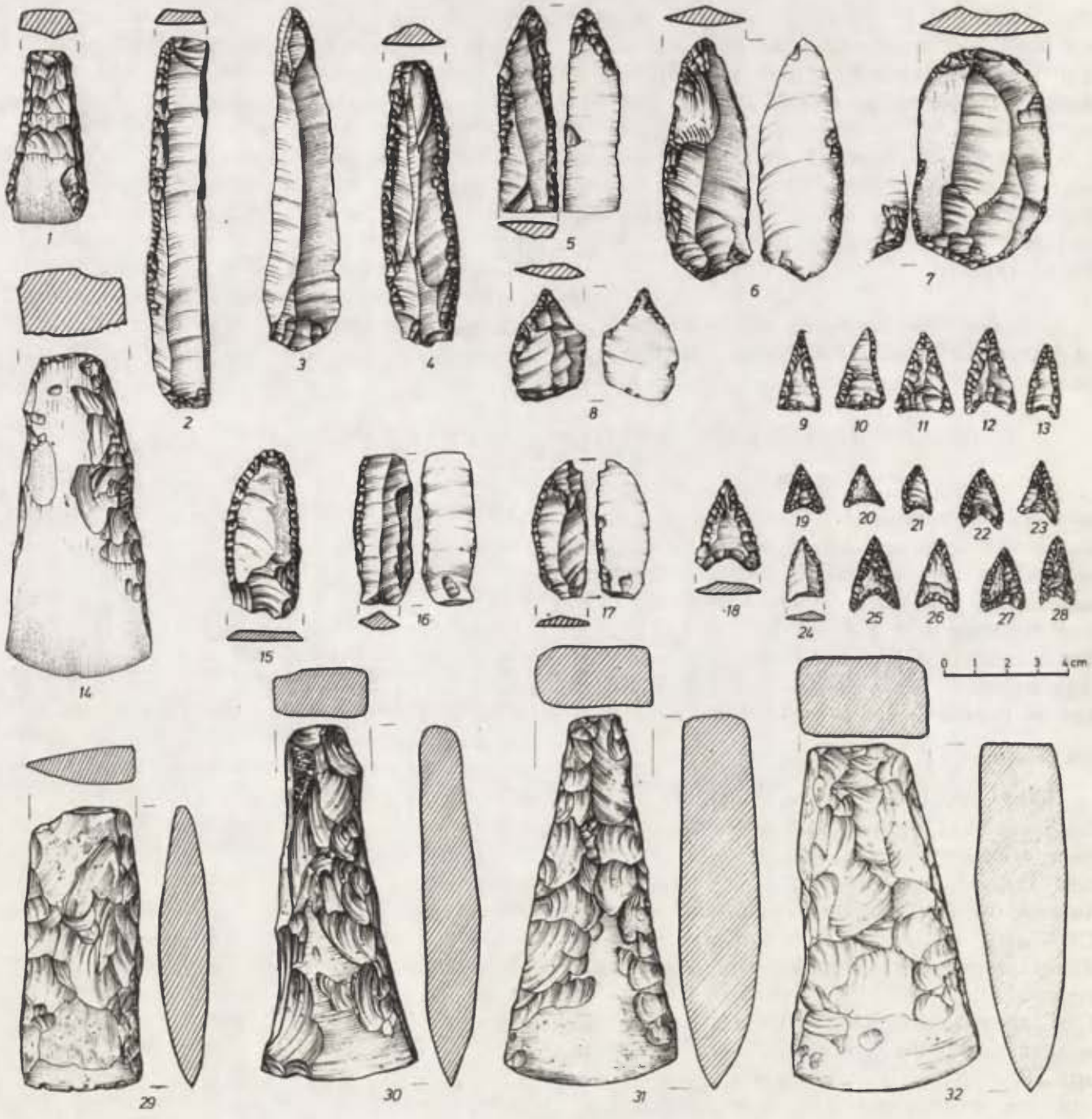

Fig. 14. South (Lesser Poland) industry. Artifacts of the Złota culture (*1–14*) and CWC (*15–32*) from Volhynian (*1, 3*), Świeciechów (*2, 7–14, 29–32*), Jurassic (*4*) and chocolate (*5, 6, 15–28*) flints

1–14 – Złota, *15–32* – Mierzanowice, Tarnobrzeg District

mediate forms. They are from 8 to more than 30 mm long. Most of them are 15–20 mm long and 10–20 mm wide. Usually, they short and bulky, only some of them are fairly elongated.

b. *Axes*. The basic forms are four-walled, dihedral with flat backs (Fig. 14: 14, 30–32). Some of them narrow uniformly from the edges to the backs (Fig. 14: 14). There are characteristic axes with distinctly widened edges and relatively narrow backs (Fig. 14: 30, 31). We can identify the other axes as defective or altered forms of those described above. They are triangular (Fig. 14: 29) and celts, strongly deformed and irregular. In their unaltered form, the axes are 83–155 mm long, with edge width of 38–70 mm, back width of 17–34 mm and 14–26 mm thick. Most often, there are relatively small axes,10–11 cm long, with average edge width of 49 mm, back width of 23 mm and 23 mm thick. The three distinct axes from Złota are 15–15.5 cm long, with edge width of about 7 cm, back width of 27–34 mm and 20–28 mm thick. From the Złota culture we know flake axes (Fig. 14: 1) and celts (Krzak 1976, Fig. 31b).

c. *Continuously and partly retouched blades* (Fig. 14: 2–4, 6, 16). There are distinct blades with retouch on one and both sides 95–120 mm long (Fig. 14: 2, 4), particularly pointed ones with converging sides. Moreover, there are specimens mostly partly, sometimes only slightly, retouched (Fig. 14: 3).

d. *Other tools* are endscrapers on flakes (Fig. 14: 7) and blades, bulky and short, less frequently fairly elongated, including those on blades with retouch sides, longitudinally (Fig. 14: 15, 17) and transversely arched sidescrapers, perforators and groovers (Fig. 14: 5, 8), burins, retouched flakes, notched tools and retouched flakes. The macrolithic tool from Złota is a combination of a sidescraper and a denticulated piece. From Złota we also know hammer stones.

Table 19. The percentage structure of tool groups in the south industries of the CWC and Złota culture

Tools	Mierzanowice	Żerniki Górne	Other CWC sites in Lesser Poland altogether	Złota	On average
Arrowheads	63.33	37.0	41.4	76.7	54.6
Retouched blades	10.23	15.0	21.6	10.7	14.4
Endscrapers	1.14	10.0	5.8	3.4	4.8
Sidescrapers	2.27	8.0	X	0.8	2.8
Retouched flakes	4.55	–	1.4	–	1.5
Burins	1.44	–	–	0.4	0.7
Notched pieces	–	2.0	–	–	0.5
Perforators	–	–	–	1.9	0.5
Hammer stones	1.14	–	–	–	0.3
Denticulated tool + sidescraper	–	–	–	0.4	0.1
Total	100.00	100.0	100.0	100.0	100.0
Specimen number	88	60	208	261	617

In the tool assemblages from the graves, the most numerous are forms which were the edges of weapons, while there are a few working tools (Table 19). There are no harvest tools. The products of the industry are not stylistically uniform. The axes and blade pieces mainly represent the moderate, less frequently maximal, macrolithic. The other tools are mediolithic, while the arrowheads are, for functional reasons, microlithic. Therefore, we can define the dominating style as the moderate macrolithic and mediolithic. Characteristically, there are relatively many forms with retouch on both sides and on the surface, including, apart from arrowheads, also sidescrapers and retouched blades. Among the axes, the most characteristic ones are those with widened edges.

9. THE NORTH INDUSTRY IN THE CORDED WARE CULTURE

The distinguishing of this industry has to the greatest degree a hypothetical nature, since its source bases have so far been least known. They are the CWC materials in the Lowlands, coming mainly from the multi-cultural dune sites in Greater Poland (Waga 1931), Kujawy, West Pomerania and Lower Silesia. It is difficult to distinguish them from the artifacts of the post-corded early Bronze cultures.

The basic raw material was erratic Baltic flint. Within the range of this industry, there occur imports of Rugian flint. Blanks were obtained from ordinary and counter shock bipolar cores and from small blade cores. There was a particularly large proportion of the counter shock bipolar technique.

Artifacts of the industry are probably the numerous heart-shaped, triangular and tanged arrowheads (Fig. 15: 2–4, 9, 10), projectile points 5–8 cm long (Fig. 15: 1), retouched blades, endscrapers on blades and flakes (Fig. 15: 6), ordinary, unifacial sidescrapers (Fig. 15: 11, 12) and bifacial ones with surface retouch (Fig. 15: 5), perforators and groovers (Fig. 15: 8), small retouched blades, also with bilateral, bifacial invasive retouch and axes (Fig. 15: 14) and celts (Fig. 15: 13), and also possibly truncations (Fig. 15: 7). From West

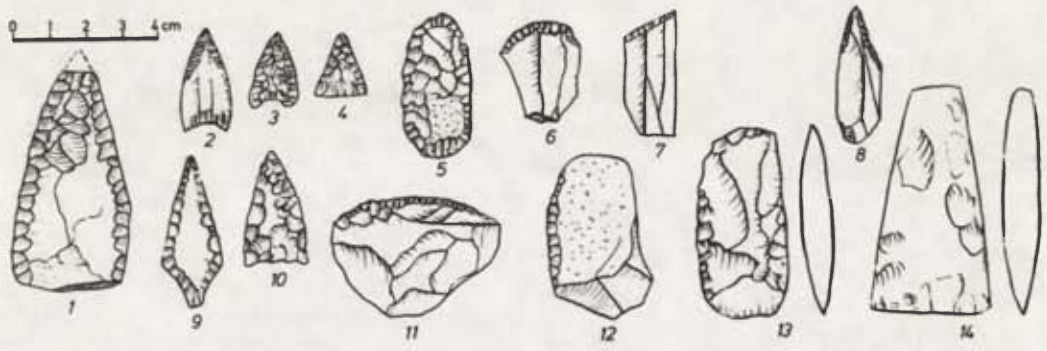

Fig. 15. North industry. Artifacts of Baltic Cretaceous flint attributed to the CWC
1, 4, 5, 8, 11–14 – Poznań-Luboń; *2, 3, 6* – Glinno, *7, 9, 10* – Rudki, Poznań District

Pomerania, Greater Poland and Kujawy, there come large, lanceolate projectiles, so-called "Płonia type projectile points" of Rugian flint. They are elongated up to 16 cm long, carefully worked on both surfaces. K. Siuchniński (1969; 1972) related at least some of them with the CWC, while W. Wojciechowski (1976) believed that they came from the Early Bronze Age. From Pomerania we know large axes with thick backs, of Rugian flint, too, which can be CWC artifacts.

There are no data for determining the structure of the groups of artifacts of the north industry of the CWC. Its separate nature results from the raw material specificity, namely the limited usefulness of local erratic flint and the simultaneous lack of southern imports. In stylistic terms, the mediolithic with macrolithic elements dominated. What is characteristic is the macrolithic elements dominated. What is characteristic is the rather large proportion of flake and blade forms with bifacial and bilateral invasive retouch. Celts are more frequent. These properties/elements determine the beginnings of the technological breakthrough in flint processing at the turn of the decline of the Neolithic and the Early Bronze Age. However, there was still quite a number of blade tools, which connects the north industry of the CWC with the Neolithic more strongly than with the early Bronze Age.

10. THE POMERANIAN INDUSTRY IN THE ŁUPAWA GROUP OF THE TRB AND THE RZUCEWO CULTURE

This industry combines the previously distinguished industries of separate ceramic cultures, which show large coincidence of diverse properties (Balcer 1983, 278 ff.). To our mind, the industry crystallized in Central Pomerania in the late Neolithic, but it represents the early phase of the Neolithicization of epimesolithic communities which persisted there in the peculiar conditions of the seashore environment (Balcer 1986a).

The name of the industry not only comes from that of the region, but is also connected with the basic raw material, namely the Pomeranian variety of Baltic flint (Domańska 1974), occurring in the form of fine pebbles, so-called "swallow loaves". Studies on the industry in the Łupawa group of the TRB (Jankowska 1980) are mainly based on 11,000 specimens provided from the excavations carried out by D. Jankowska at Poganice, Słupsk District, and elaborated by L. Domańska (1974; 1980; 1983). For the Rzucewo culture they come from the settlements Osłonino, Rzucewo and Lichnowo, Gdańsk District, giving about 9000 specimens, elaborated by D. Król (1978; 1983). These researchers differ slightly in classifying the artifacts, making a generalization difficult.

RAW MATERIALS

The basic raw material was Pomeranian flint (90–97%). It was complemented by variety A of Baltic flint, of slightly higher quality, occurring in larger chunks. Single specimens are traces of imports of Volhynian and banded flints.

ARTIFACTS AND ASSAMBLAGES OF ARTIFACTS

Production Waste and Blanks. Counter shock, bipolar pieces are the basic core forms. Bipolar, bifacial pieces, most often about 25 mm long, dominate (Fig. 16: 2, 3, 5–7). Initially worked counter shock bipolar pieces are larger (40–50 mm) than the residual ones.

Ordinary, single-platform (Fig. 16: 1, 4) or multiplatform flake cores after orientation changes are 1.5–2% of the core forms. We know no blade cores, but their use is indicated by few blade tools (Fig. 16: 21–24).

Small and very small chips, 25–30 mm long, about 20 mm wide and about 4 mm thick, dominate. There are also ordinary flakes and those from the walls of polished axes. The few blades and blade tools indicate the use of blades 40–80 mm long, 13–29 mm wide and 3–10 mm thick. They are present in a slight amount, 0.3–0.6% of blanks.

Tools. 85–90% of tools were produced from surface-scaled flakes and counter shock, bipolar cores themselves (Table 20). Most often, they are only partly retouched. It is difficult to identify and classify these tools. The researchers differ in this respect (Domańska 1974; Król 1978; 1983).

Table 20. The percentage proportions of tools in the essemblages of the Pomeranian industry. The succession according to the place in the hierarchy determined from the mean percentage proportion

Tools	Poganice	Rzucewo Site 1	Osłonino Site 2	On average
Retouched flakes	10.8	40.74	51.35	34.30
Endscrapers	65.2	20.40	18.37	23.79
Sidescrapers		24.63	15.67	24.30
Notched pieces	13.7	1.39	3.34	6.14
Burins	0.5	2.78	4.87	2.72
Retouched blades	1.8	3.71	0.54	2.01
Arrowheads	1.0	1.86	2.72	1.86
Smoothers	–	1.39	–	0.46
Axes and axe-like tools	X	0.47	–	0.16
Indefinite and others	7.0	2.63	3.14	4.26
Total	100.0	100.00	100.00	100.00

X – occurring in indefinite, small percentage.

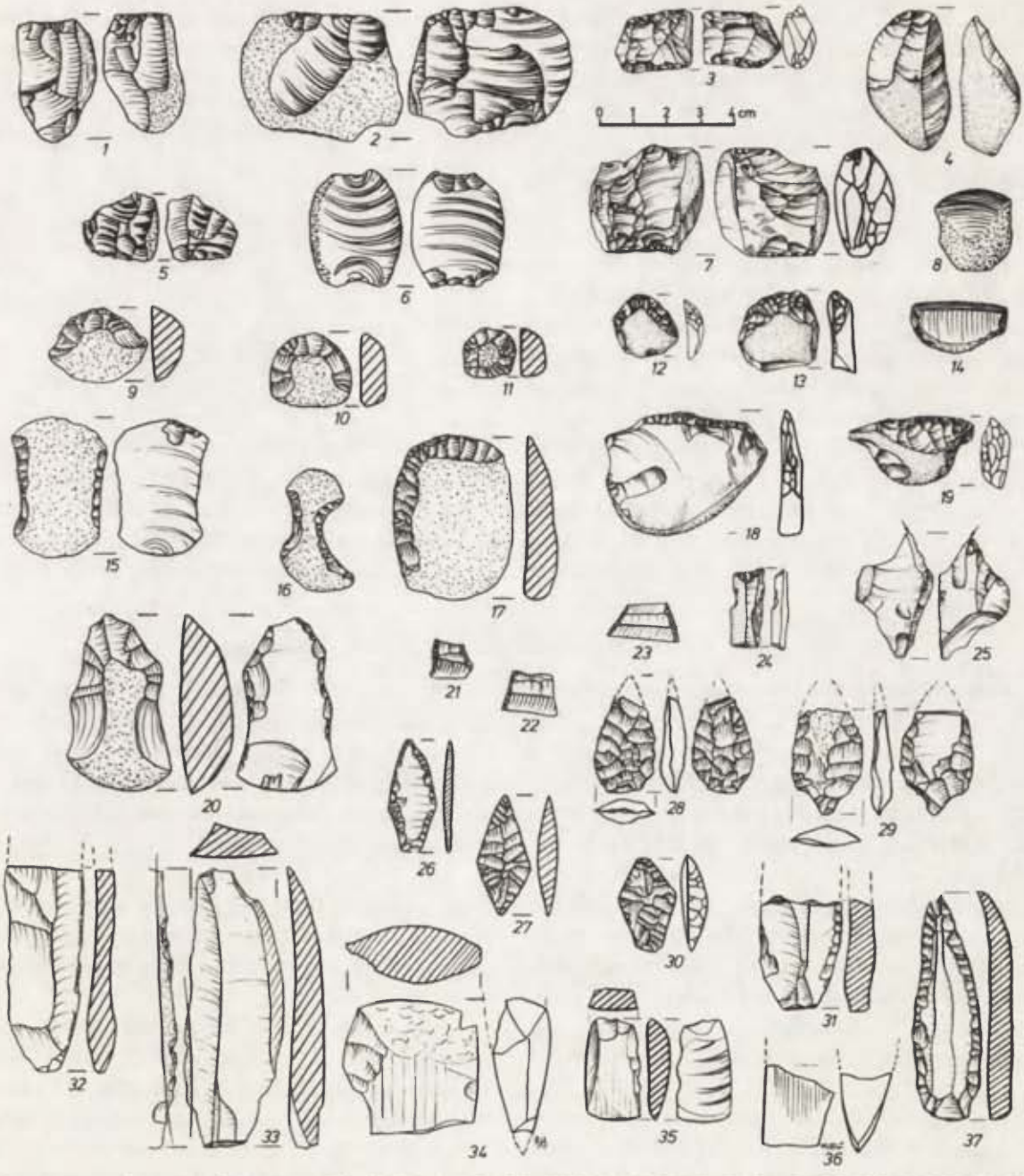

Fig. 16. Pomeranian industry. Artifacts from Pomeranian (*1 – 20, 35*), variety A of Baltic (*31–34, 36, 37*) and indefinite (others) flints
1, 2, 5, 6, 9–11, 15–17, 21, 22, 26, 27, 32–34 – Poganice, Słupsk District; *3, 4, 7, 12, 13, 18, 19, 24, 25, 28–30* – Osłonino, *8, 14, 23, 31, 35–37* – Rzucewo, Gdansk District; *20* – Łupawa, Słupsk District

There dominate endscrapers with straight, arched and almost circular scraping surfaces (Fig. 16: 9–13), symmetrical and diagonal pieces, many with retouched sides. They are mostly short and, less frequently, bulky. The scraping surfaces of some endscrapers are polished like axes (Fig. 16: 8, 14).

D. Król (1978) distinguished, in contrast to sidescrapers, asymmetrically and irregularly retouched sidescrapers. We can define some of the flake tools as endscrapers (Fig. 16: 17–19). The others are retouched flakes. L. Domańska (1974) distinguished quite a number of notched pieces (Fig. 16: 15, 16). Continuously and partly retouched blades (Fig. 16: 31–33) include specimens with retouch along almost the entire perimeter and converging sides (Fig. 16: 37).

Arrowheads and projectile points with surface retouch are triangular, heart-shaped, leaf-shaped with hardly distinct ends (Fig. 16: 26–30) and tanged. There are trapezes from fragments of blades (Fig. 16: 21–23), including a high one from a chip.

We only know flakes from axes or their fragments (Fig. 16: 33). They were probably axes with oval cross-sections from semi-finished celts. We know a micro-axe from a chip (Fig. 16: 35) and a small adze-

like tool (Fig. 16: 20). Moreover, they are perforators and groovers, burins (Fig. 16: 25), blades with notches, smoothers from flakes and a microlithic truncation (Fig. 16: 24).

Chips and counter shock bipolar pieces, and the tools made from them, dominate in the tool assemblages. There is only a slight proportion of other tools. The *P* index is relatively high, namely 6–12 (Table 21). The industry represents the mediolithic with a large proportion of the microlithic. It reflects the very peculiar raw material specificity related to the use of the counter shock bipolar technique on a scale not to be met in any other industry in the Odra and Vistula basins. An original property was the polishing of some previously retouched flake tools, used probably for preparing the delicate skins of marine mammals.

The small number of blade tools and the lack of whole axes produced from better raw material indicates that they were treated differently than artifacts from the universally available Pomeranian flint. Use traces on axes, and arrowheads and projectile points indicate, at the same time, knowledge of contemporary forms and techniques of flint processing.

Table 21. The general percentage structure of artifact groups of the Pomeranian industry

Artifacts varieties	Poganice		Rzucewo Site		Osłonino Site 2	
	number	%	number	%	number	%
Core forms	X	86.2	174	5.94	103	8.35
Flakes and chunks	X		2529	86.31	945	76.64
Blades	X		10	0.34	2	0.16
Tools	X	13.8	217	7.40	183	14.84
Total	1540	100.0	2930	99.99	1233	99.99
P index	6.24		12.50		5.74	

X – occurring in indefinite number.

11. THE ŁOMŻA INDUSTRY IN THE NIEMEN CULTURE

This industry has so far been the only one related to the circle of the paraneolithic cultures of the forest zone. The outskirts of this circle, ranging further northwards and eastwards into the USSR territory and the Scandinavian countries, reach the Vistula basin (E. Kempisty 1973). In the northeast Polish lands, there are mainly finds of the Niemen culture and traces of the Narwa culture. In this paper, we use flint materials co-occurring with the Niemen culture ceramics. They come from sand and swamp sites, which have been investigated only slightly, most often mixed with older – Mesolithic and Paleolithic – finds, and also with younger ones, from the metal epoch.

The leading site is the settlement at Sośnia, Łomża District, where more than 13,000 flint specimens, elaborated by E. Kempisty and H. Więckowska (1983), come. They are complemented with materials from Woźna Wieś, Łomża District (E. Kempisty, Sulgostowska 1976), too, hence the name of the industry, and from Augustów-Wójtowskie Włóki, Suwałki District (Sulgostowska 1978). We distinguish the Łomża industry, to a large degree, hypothetically, because there are no pure ceramic-flint assemblages.

ARTIFACTS AND ASSEMBLAGES OF ARTIFACTS

Raw Material, Production Waste, Blanks. Only northeast erratic Baltic flint was used. It occurred in nodules up to 10 cm. Table 22 contains varieties of artifacts. Only some of them require an additional commentary.

Most cores did not go through the pre-core phase. The cores are from flakes, blades, and from blades and flakes; they are single-platform and multi-platform after orientation changes. The blade cores are subconical (Fig. 17: 23), stump-like and also those with narrow flaking surfaces (Fig. 17: 24), closely resembling the subcarinated ones. The flake ones are smaller and more residual.

The blades are 15–60 mm long, but the blade tools indicate that the blanks were 4–8 cm long. Among the flakes, there are mostly microlithic chips 5–8 mm long, but there is a large number of flakes up to 8 cm long.

Tools. There is a particularly great variety of tools found at the leading site at Sośnia (E. Kempisty, Więckowska 1983, 64–69). Even this fact can already suggest that what we have here is a set of inhomogeneous elements of more than one industry. There is no doubt that forms with Neolithic features, particularly large, mediolithic ones, can be related to the Niemen culture. They include retouched and microretouched flakes up to 66 mm long, blades with retouch (Fig. 17: 2) up to 88 mm long, endscrapers on flakes (Fig. 17: 15) and on blades (Fig. 17: 1) up to 85 mm long, sidescrapers (Fig. 17: 16), including flake ones with flat retouch and one with parallel, slightly oblique retouch (Fig. 17: 17), up to 75 mm long. There are triangular arrowheads (Fig. 17: 14, 18, 19, 21, 22), a fragment of a heart-shaped tanged one (Fig. 17: 20) up to 17–32 mm long and lanceolate arrowheads up to 51–70 mm. The Sośnia type arrowheads in the form of very narrowed trapezes, triangular (Fig. 17: 13) or intermediate trapezoidal-triangular (Fig. 17: 12) are particularly interesting. The latter were probably formed from trape-

Table 22. Flint materials from Site 1 at Sośnia, Łomża District

	Artifact varieties	Number	Percent
Production waste and blanks	Pre-cores	3	0.02
	Blade cores	80	0.64
	Flake cores	77	0.61
	Blade and flake cores	28	0.22
	Indefinite core fragments	38	0.30
	Counter shock bipolar pieces	15	0.12
	Blades and blade fragments	2962	23.59
	Flake material	9351	74.49
	Altogether	12,554	100.00
Tools*	1. Retouched and micro-retouched flakes	151	19.21
	2. Retouched, micro-retouched blades and those with use traces (polished)	136	17.30
	3. Endscrapers	130	16.54
	4. Sidescrapers	116	14.76
	5. Large and small arrowheads, and leaf points	63	8.01
	6. Microlithic forms	59	7.50
	7. Truncations	41	5.22
	8. Burins	27	3.44
	9. Perforators	27	3.44
	10. Denticulated tools	17	2.16
	11. Notched pieces	7	0.89
	12. Hammer stones	6	0.76
	13, 14. Adzes	3	0.38
	Picks	3	0.38
	Altogether	786	100.00
	Indefinite pieces and fragments	239	
	Tools and their fragments	1025	
	Flint material – total	13579	
	P index	12.12	

* Succession according to place in the numerical hierarchy

zoidal fragments of blades by using retouch at the sides and on the surface. They combine the properties of trapezoid arched backed pieces and Neolithic triangular arrowheads, and are microlithic, 10–15 mm long. Moreover, there are burins (Fig. 17: 27), perforators and groovers (Fig. 17: 3), denticulated tools, notched pieces, picks (Fig. 17: 26) and hammer stones. Truncations are greatly differentiated, from microlithic, 12 mm long, to large ones, up to 80 mm long, with oblique backs (Fig. 17: 6–8), and of the Michałów type with transverse or slightly oblique backs (Fig. 17: 4, 5), but retouched on the ventral surfaces.

The forms with numerous Mesolithic counterparts include: trapezes (Fig. 17: 9–11), Wieliszew arch backed pieces, formed by the burin operation, leaving also blades with notches and burin-like ones, triangules and microlithic backed pieces, and adzes (Fig. 17: 25). Moreover, two leaf points occurred.

At the sites, there dominates the production waste (Table 23). For the Sośnia materials, the *P* index is high, namely 12.12. In the tool group, most specimens

Table 23. The general structure of the flint material assemblage from Site 1, Sośnia

Artifacts varieties	Number	Percent
Core forms	241	1.77
Blades	2962	21.81
Flake material	9351	68.86
Tools	1025	7.55
Total	13,579	99.99
P index	12.12	

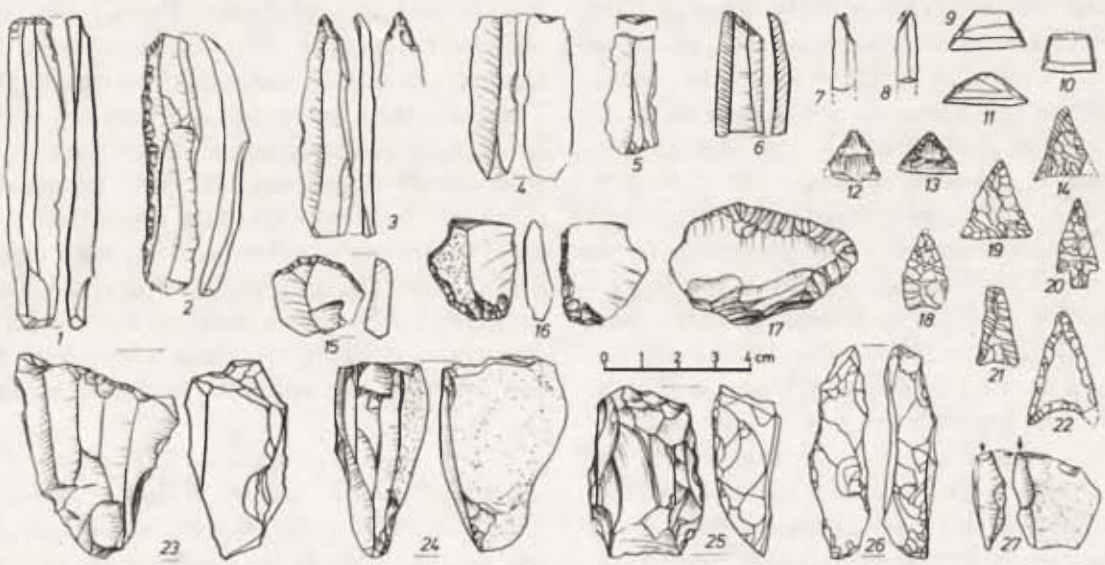

Fig. 17. Artifacts of northeastern Baltic Cretaceous flint from Sośnia, Łomża District

are flakes and blades retouched to a varying degree, namely 36.5% Sidescrapers are slightly fewer – 31.3%. Along with the former, they dominate as 67.8%. Arms arrowheads, including trapezes, are 15.5% of the tools. There is a slight proportion of (adzes) and picks – 0.8%. There are no flint axes.

There is quite a number of very small specimens, up to 30 mm long, a few are as much as 70–80 mm long and there are no macrolithic pieces.

Many artifacts show typically Neolithic properties, including those of the decline of the Neolithic. They are quite large cores with facets of massive raw material, mediolithic tools from blades and flakes with flat retouch, including parallel one, in particular arrowheads and projectile points with retouch on both sides. Microlithic artifacts co-occurred with them, including Mesolithic arch backed pieces, among them those produced by using the typical Mesolithic burin technique. The proportion of these artifacts is about 8%. They can be: 1 – Mesolithic relics in the Neolithic inventory; 2 – an addition of Mesolithic finds in a mixed inventory. The researchers on the Sośnia materials hold different opinions on this subject: H. Więckowska connects them with the Niemen culture, while the late E. Kempisty identified them as remnants from an older settlement phase from the Mesolithic period (E. Kempisty, Więckowska 1983, 85–87).

What dominated in the wooded zone was an assimilating economy, which at the same time applied some technological achievements of the Neolithic – hence the term "ceramic Mesolithic" (Kowalczyk 1969, 14, 17). This is justified by the presence of Mesolithic relics, which still also occurrred in a number of early agricultural cultures both in the Lowland and in the South. We cannot exclude the possibility, even quite a probable one, that additions of Mesolithic artifacts existed. The problem is that we cannot distinguish strictly between Mesolithic relics connected with the ceramic Niemen culture and the older finds from the ceramics-less Mesolithic. This prevents a precise determination of the real set of artifact varieties connected with the Łomża industry and a detailed study on the structure of their groups. A fact of tremendous interest is, on the other hand, the existence of intermediate forms between trapezes and the Neolithic arrowheads in the form of Sośnia arrowheads. These artifacts at least the production of which did not require the use of the Mesolithic burin technique, namely trapezes, small truncations, adzes, picks and other microlithic tools, may have been Mesolithic relics, already, on the other hand, related to a para-Neolithic ceramic culture.

III. RESULTS OF COMPARATIVE STUDIES AND CONCLUSIONS

1. SUMMING UP OF COMPARATIVE STUDIES

We can identify the flint industry as links in the development of flint processing in particular cultural-chronological units. Using the comparative method, we can determine the mutual relations, influences and the kinds and courses of change in the industries. The varied possibilities of characterizing the industries bring about the different degree to which the comparative studies on them are carried out. Because of the limited volume of this paper, we can only give the general results of this research (Balcer 1983, 256–279).

The Cracow and Sąspów industries represent two periods in the development of flint processing in the linear cultures. The changes to be seen in the Sąspów industry relative to the Cracow industry were reflected by: 1 – the greater role of Volhynian flint; 2 – the moderate macrolithicization of blades and blade tools, 3 – the application on a greater scale of parallel oblique retouch; 4 – burins taking the dominating place in the numerical hierarchy of tool groups. In addition, there was a complete coincidence of trends in raw materials and typology and technique. The production followed a single trend, as it was limited to preparing tools from blades and flakes. In the younger phase of development of the north, Brześć Kujawski variety of the Cracow industry, the differences from the Sąspów industry were greater, because the role of Lesser Poland raw materials decreased. This may indicate the increased isolation from southern influences, causing a development lag. Therefore, the Cracow industry persisted in the Lowlands, while in the upland areas the Sąspów industry was already developing. The new technical trends, related to the beginnings of the Eneolithic technological breakthrough in this industry, were clearly connected with the inflows of Volhynian flint. This indicates the inspiring role of the extraction and processing centres in the region whese deposits of this raw material were within the ranges of the LgPC and the TC.

The Cracow Industry and the Biernaszewka Industry from the older periods of flint processing in the linear cultures and the TC were undoubtedly separate (Balcer 1983, 259). In the southeast peripheries of the Cracow industry, however, there was Dniester flint,

which was basic for the Biernaszewka and Łuka Wróblewiecka industries. The Cracow and Biernaszewka industries represent the same phase of the typical mediolithic, related to the same early Neolithic degree of flint processing development. Cores, blanks and tools had similar metric properties. Endscrapers or sidescrapers dominated in these industries. In the Biernaszewka industry there were more differentiated microlithic pieces. Harvest tools were different: mainly raw blades in the Biernaszewka industry and truncations in the Cracow industry. They did not become common until the Łuka Wróblewiecka industry.

At the decline of the LgPC, the Sąspów industry came closer to the TC industries. In the region of contact between the late Polgar and TC groups, it is impossible to distinguish between a number of flint artifacts from these units, particularly those of Volhynian flint, such as retouched blades with parallel oblique retouch. In contrast to the Sąspów industry, in the Łuka Wróblewiecka industry and the Volhynian industry in the TC, there occurred arrowheads and projectile points, there were more blunt borers and there were fewer burins than in the Sąspów industry. The Sąspów and Volhynian industries had common manifestations of a technological breakthrough, on the other hand, no flint axes were produced in the Sąspów industry, and they did not emerge until the Lesser Poland industry in the TRB.

The Sarnowo industry combines many (80%) features common with the industries of the linear cultures: the Cracow industry in the Brześć Kujawski variety and the Sąspów industry (Balcer 1983, 261). What is very significant is the presence of a number of properties common with those of the Sąspów industry, characteristic of the beginnings of the technological breakthrough. In the Sarnowo industry there are fewer truncations, but more Mesolithic relics. The very characteristic arched truncations in the Sarnowo industry have their counterparts in the Sąspów industry and in the southeast group of the TRB among the artifacts from the settlement at Gródek Nadbużny, Zamość District. They are an common element for the Sarnowo, Sąspów and Lesser Poland industries.

The distinct differences between the Sarnowo and Lesser Poland industries, within the same TRB, are, on the other hand, the measure of changes brought about by the Eneolithic technological breakthrough. The most significant differences include: 1 – the decreased significance of chocolate flint brought about by Świeciechów and banded flints; 2 – a change of the dominating blade core from a subcarinated with a narrow flaking surface to a subconical one; 3 – the introduction of the production and dissemination of flint axes; 4 – the considerable macrolithicization of tools – the vanishing of truncations and the emergence of macrolithic retouched blades, used as sickle insets with uniform edges; 5 – the vanishing of microlithic pieces; 6 – the increased number of blunt borers.

In the conditions of ample raw materials in the South, what is striking is the large proportion of the counter shock bipolar technique in the Lesser Poland industry. We can regard it as a manifestation of a continuation of the northern upland traditions in the TRB, since both in the South, in the Sąspów and in TC industries counter shock bipolar pieces hardly ever occurred.

The Lesser Poland and Pietrowice industries have very many common properties (63–75%; Balcer 1977, 31–39; 1983, 265 ff.). They indicate analogous tendencies following the technological breakthrough. In the Pietrowice industry, their implementation was restricted by the lesser possibilities provided by Silesian-Moravian Baltic flint compared with Lesser Poland raw materials. Quite a number of counter shock bipolar forms relates the Pietrowice industry with both the Cracow industry in the Brześć Kuj. variety and the TRB industries. We can recognize truncations in the Pietrowice industry as relics of the Cracow industry in the late Brześć variety, particularly in the Jordanów group. These units show similar metric properties for blades. Picks, sticks and adze-like tools may, on the other hand, have been Mesolithic relics from the northwest area of the Lowlands in the basin of the middle and lower Odra. In turn, we can recognize the emergence of celts and oval axes as manifestations of new trends and Western influences. These forms more often occurred in the later Lesser Poland industry in the TRB and in the RPC.

The Lesser Poland industry in the TRB and the Volhynian industry in the TC show highly convergent general typological-technical and stylistic trends followed after the technological breakthrough (Balcer 1981; 1983, 267–271). The basic properties common to these industries are: 1 – manifestations of the maximum macrolithicization of blades and blade tools; 2 – the dissemination of axes; 3 – the same variety of basic tool kinds with retouched blades distinctly dominating; 4 – the dissemination of blunt borers; 5 – a very rational use of tools by way of repair and reshaping.

There are differences between the industries, and the most essential of those are: 1 – the dissemination of other kinds of retouch; 2 – the domination of other kinds of retouch – variety B in the Lesser Poland industry and variety A in the Volhynian industry; 3 – no counter shock bipolar pieces and artifacts from Lesser Poland raw materials in the Volhynian industry. The differences indicate the diffe-

rent origins and developments of the two industries, while the many coinciding properties reflect an increase in mutual contacts. This applies in particular to the contact area between the ranges of the TRB and the TC in the West Volhynian Upland. On the basis of detailed stylistic properties, we can assume that many select blades, variety A axes and tools of Volhynian flint from the TRB sites were products of the Volhynian Industry imported to the territory within the TC. It was the main carrier of the southeast influences working on the TRB and played an inspiring role, just as it had on the LgPl earlier.

A comparison between the CWC and the GAC and the linear cultures and the TRB is made greatly difficult by the differences in the character of the grave and settlement finds dominating in these cultures (Balcer 1983, 275–277). We can state that the Lesser Poland industries in the TRB and the south CWC and Złota culture have about 50% properties (elements) in common, while the greatest differences were: 1 – the use of chocolate flint in the south industry of the CWC; 2 – lack of banded flint in it; 3 – smaller dimensions of most tools; 4 – no traces of repair or reworking in tools; 5 – the domination of arrowheads and projectile points; 6 – no blunt borers. The significant common properties include: 1 – the versatile use of Świeciechów flint; 2 – the occurrence of variety A axes, pointed retouched blades also including those with parallel oblique retouch and arrowheads. The forms given in point 2 connect the south industry of the CWC and Złota culture also with the Volhynian industry in the TC.

Analogous projectile points, celts and a number of small tools, including characteristic pointed retouched blades occurred both in the north industry in the CWC and in the Pietrowice industry in the TRB, and in the Pomeranian industry in the Łupawa group of the TRB and in the Rzucewo culture within the CWC. This can indicate the direct relations and the sui generis "replacement" of the TRB industries by those of the CWC: of the Lesser Poland TRB one by the south CWC one, and of the Pietrowice industry in the north zone by the north industry in the CWC, with which the Pomeranian industry in the Łupawa group of the TRB was partly connected.

The Gierczanka industry in the GAC and the Lesser Poland industry in the TRB are only related by the use of banded flint in the production of improved axes. Except for this, the industries show completely contrasting stylistic and typological trends. In the range of the production of small, particularly blade tools, the Gierczanka industry represents the phase before the technological breakthrough, showing moreover, the presence of microlithic pieces.

The Gierczanka industry is also completely different from the south industry in the CWC and Złota culture (Balcer 1983, 277). They are differentiated by the lack of banded flint in the latter and by the typological and stylistic differences in small tools. Flint materials do not confirm the relations between the GAC and the Złota culture to be seen in the ceramics.

Some artifacts of the Gierczanka industry have analogoues in the Mesolithic Janisławice culture and also in the older phase of the Cracow industry. Gierczanka industry shows, however particular originality and individuality. The lack of manifestations of the Eneolithic technological breakthrough in the range of the production of "small" tools indicates the "selective conservatism" and the character of axes with "selective borrowings" relative to forms which were weapons or cult-related objects.

The Pomeranian and Łomża industries are also different (Balcer 1983, 278 ff.). The Pomeranian industry only shows traces of knowledge of south raw materials of which there is a complete lack in the Łomża industry. What the two industries have in common is the presence and the high status of arrowheads and projectile points with surface retouch. These pieces and pointed retouched blades have also analogies in the industries of the CWC.

2. MANIFESTATIONS AND CONDITIONS, AND THE COURSE OF CHANGE IN THE NEOLITHIC INDUSTRIES

In general stylistic terms, the mediolithic and macrolithic were the basic phases in the Neolithic. In the different industries, microlithic elements occurred till the end of the Neolithic. In the basic current of the flint processing development in the Neolithic there was an increase in the proportion of macrolithic artifacts – in a transition from the mediolithic to the maximum macrolithic, and then to the moderate macrolithic. Detailed stylistic changes lay in richer retouch on small tools, more complex forms, increased care in making and polishing core forms.

The macrolithicization was accompanied by a change in the blade technique – in a transition from using small cores with narrow flaking surfaces exploited by the striking technique to large cores with wide flaking surfaces exploited by a special pressure technique. The increase in the size of blanks permitted their richer retouch. A breakthrough change was the intro-

duction of the production of axes which were increasingly carefully formed and finished. There was a diversification in arrowheads and projectile points, bifacially worked, first at the edges and then on the surface.

A manifestation of the differences was a change in the structure of tool groups. It resulted from the main function of flint processing as an auxiliary field of the fundamental branches of economy, related to the production of tools to be used not only in manufactures goods but also in the production and gaining of food (sickles, axes, hunting weapons). The economic conditions were of primary significance because of changes in the demand for an appropriate number of correct quality tools. The most important economic changes – Neolithicization, a transition from land cultivation and domestic breeding to migratory breeding – were related to technological changes in flint processing.

There were very strong raw material conditionings – the demand for raw material for the production of a larger number of larger tools was the main reason for the development in the flint exploitation. The nonuniform distribution of flint deposits within the ranges of particular cultures brought about the different conditions of the flint processing development. They were best close to the flint deposits. It was only a social organization of long-distance distribution that could break barriers to the production capacities. In the Neolithic, in the Vistula and Odra basins, the distances were up to 600 km from the deposits.

We can observe the phenomenon of using in some industries particular raw materials which are absent in the other industries. The reasons for it may have been different: 1 – technological, resulting from the varied processing usefulness of raw materials; 2 – political, caused by the occupation of the deposit territory by specific communities in the form of the ownership kind, e.g. the lack of Świeciechów flint in the industries of the linear cultures may have resulted from the fact that Epimesolithic communities took over its deposits; 3 – the stopping of imports of Swieciechów and banded-Krzemionki flints to western Lesser Poland in the late phase of development of the Lesser Poland industry may have resulted from the fact that GAC communities had taken them over; 4 – the cause of the lack of banded flint in the south industry of the CWC and Zlota culture may have been the same.

The flint processing was strongly connected with its own traditions and the use of foreign influences. Direct and indirect contacts, particularly those related to the flint distribution, brought about the dissemination of inventions. Analogous forms, produced by using the same techniques, occurred in the different industries over extensive territories, irrespective of the cultural divisions, over long periods. They became as it were the common achievements. An example is the parallel oblique retouch and pointed retouched blades in the industries connected with the TC, LgPl, TRB, CWC and Średnij Stok, in Zaporozhye, cultures; the axes with widened edges in the TC, TRB, GAC and the CWC; the arrowheads and projectile points in the industries of the CWC and Złota culture, the Pietrowice, the Pomeranian and the Łomża Industries.

In the flint processing development in the Neolithic, periods of slight evolution and stabilization were followed by rapid changes. They consisted in dropping the older stylistics, the vanishing of old properties/elements and the emergence of new ones, while the old ones became relics with secondary or tertiary significance. Such changes were related to technological breakthroughs. Three such breakthroughs were related to the Neolithic flint processing, namely 1 – one connected with Neolithicization; 2 – in a transition from the early Neolithic to the Eneolithic; 3 – in a transition from the Neolithic to the early Bronze Age.

Because of the qualitative jumps related to the breakthroughs, it is difficult to study the continuity of the flint processing development. The strongest breakthrough was connected with Neolithicization.

As a result of comparative studies, we can state that a number of industries were connected by many properties/elements. Due to this, we can reconstruct the basic current in the flint processing development in the basins of the Vistula and the Odra. Its manifestation was the cycle of industries in the early agricultural cultures. Below we give a graphic model of this cycle (Fig. 18).

The cycle had two development lines. One was connected with the linear cultures and the TRB, the other with the TC. They were related by the southeast influences on the Sąspów and the Lesser Poland industries and terminated by the industries of the circle of the CWC.

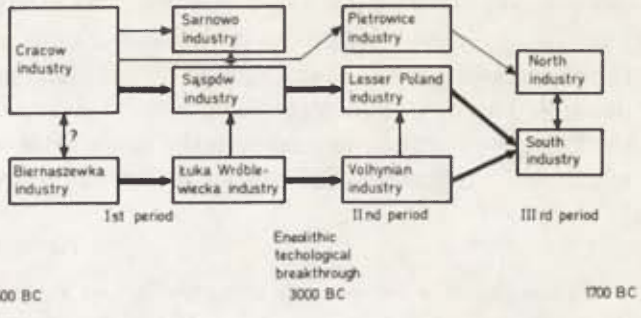

Fig. 18. A graphic model of the cycle of industries in the early agricultural cultures

The development of the TC industries was a model example of the Neolithic flint processing development within one culture. The other line represents a similar kind and rate of change in the linear cultures and the TRB.

We can distinguish three periods in the development of the cycle: I – early Neolithic, from the beginning of the Neolithic to the Eneolithic breakthrough (4500–3000 BC); II – middle Neolithic, from this breakthrough to the decline of the TC and TRB (3000–2300 BC); III – late Neolithic in the CWC and Złota culture (2300–1700 BC).

We do not include in this cycle the industries of units Neolithicized later or only partly: the Gierczanka, the Pomeranian and the Łomża industries, as in them only some elements common with the cycle of the early agricultural culture industries occurred.

The industries discussed here represent three phases in the Neolithic flint processing development:

I. The early Neolithic is characterized by the mediolithic with elements of the microlithic. This phase is represented by the industries in the Ist period of the development of the cycle of industries in the early agricultural cultures and, despite the late chronology, also by the Pomeranian and Łomża industries.

II. The middle Neolithic, with a large proportion of the macrolithic, the production in two directions after the Eneolithic breakthrough, covering the industries of the IInd period of the cycle of the industries of the early agricultural cultures.

III. The decline of the Neolithic, the moderate macrolithic, with the large proportion of bifacial forms with surface retouch on both sides, equivalent to the IIIrd period in the cycle of the industries of the early agricultural cultures.

It is difficult to classify the Gierczanka industry which, in terms of the production of small tools, represents the Ist phase, and in terms of the production of axes and chisels, the IIIrd phase of the Neolithic flint processing development.

3. THE ARCHAEOLOGICAL CULTURE AND THE FLINT INDUSTRY IN THE NEOLITHIC

The industrial systematization does not coincide with the cultural systematization of the Neolithic in the area under the present study. The same industries occurred in the different ceramic cultures, e.g., the Lesser Poland industry in the TRB and the RPC; the Pomeranian industry in the Łupawa group of the TRB and the Rzucewo culture. The Cracow industry combined the different cultures and groups in the cycle of the linear cultures.

The different industries occurred in the same culture, e.g., the Sarnowo, the Lesser Poland, the Pietrowice, and the Pomeranian industries in the TRB. The reasons for this coincidence may have been: 1 – the genetic relations of the cultures; 2 – close contacts and influences; 3 – the development in an analogous natural environment based on the same raw materials, related to the same degree of the economic development. We can explain the differences by the absence of these factors.

The industries persisted longer than the phases of the cultures, or even the whole cultures. The industries are much fewer than the distinguished units of the general (ceramic) cultural-chronological systematization. This would indicate the greater stability of the flint processing compared with the other fields of a culture, particularly the production of ceramics, which provided the basis for systematizing the Neolithic. The technological breakthroughs indicate, on the other hand, the possibility of very rapid changes in the flint processing, which separate the industries of the same cultures, e.g. the Sarnowo and Lesser Poland industries in the TRB.

The development in the analogous natural conditions, with analogous economy, brought about, as a result of contacts and influences, the uniformization of the industries of the different ceramic cultures, particularly in the contact regions and where their ranges overlapped – e.g. the LgPl, TC, TRB and RPC in Moravia, Upper Silesia and the West Volhynian Upland. On the other hand, the ecological and economic differences and the relative isolation caused contrastive differences between the industries, e.g. the Pomeranian industry compared with the other industries in the TRB. Despite this, we identify at least single elements occurring in the so-called "chronological horizons" in the completely different, but at least partly contemporary industries. This can indicate the penetration of the basic technical ideas and inventions, irrespective of the cultural divisions and ecological differences. Therefore, we can speak of certain integration in the flint processing development in the territory under study.

4. GENERAL REMARKS

Since the flint processing industry is just one of the elements of the archaeological culture, in the studies on the general prehistorical problems of the Neolithic we should use the flint materials in the full context of available sources. On the other hand, it is almost only on the basis of flint artifacts that we can

study the relations between the Neolithic ceramic cultures and the older ceramics-less Mesolithic and Epimesolithic cultures.

Between the Mesolithic and Neolithic flint processings there came the sharpest technological breakthrough related to Neolithicization. This process covered not only the LPC but also the Epimesolithic communities in the Lowlands until the chronological end of the Neolithic period. This author believes that most manifestations of Mesolithic traditions occurred in the form of relics in the Cracow, Sarnowo, Pietrowice, Gierczanka, Pomeranian and the Łomża industries (Balcer 1983, 291–293; 1986b). They were only eliminated by the Eneolithic technological breakthrough – they were no longer to be seen in the Lesser Poland, the Volhynian and the South industries of the CWC and Złota culture already crystallized as a result of internal Neolithic changes. The role of flint materials in the study of these changes is diversified.

The flint materials confirm the strict relations between the linear cultures in the development cycle. The relations between the TRB industries and those in the linear cultures and the TC confirm the deciding effect of south and southeast influences in the Neolithicization of the Epimesolithic communities which "generated" the TRB.

It is seen in the flint materials of the CWC that the traditions of the TRB and TC were continued. The industries of this culture occurred in a territorial system resembling that to be found for the TRB.

The flint material indicates the particular separateness and originality of the GAC. It does not confirm the relations between the Złota culture and the GAC.

The different nature of the Pomeranian and Łomża industries results from their development in the seashore and wooded zone which was relatively strongly isolated from the south influences, having no good conditions for the development of the production economy, with late and limited Neolithicization.

Studies on the industries show sharp differences between the upland South with the primary flint deposits and the Lowlands. These zones were connected by meridional contacts. In the Neolithic, in the basins of the Vistula and the Odra, within the range of the flint industries, we can distinguish three main zones: 1 – eastern, "Vistulan", in the basin of the Vistula, where particular relations, to be seen in the raw material ranges, connected Lesser Poland and Kujawy, Chełmno Land and eastern Greater Poland; 2 – western, "Odra" zone, where particularly the Cracow and Pietrowice industries indicate connections of Lower Silesia with West Pomerania and western Greater Poland; 3 – northeastern, with Central Pomerania, Eastern Pomerania, the lake districts and Podlasie, and northeastern Mazovia, which was most isolated from the influences from the other zones. This division is suggested the ranges of the industries and their links. The south and southeast influences were strongest, while the parallel ones connecting the eastern and western zones were much weaker.

If we were to carry out a general systematization of the Neolithic in the basins of the Vistula and the Odra only from flint materials, as a result of comparative studies on the industries, we should have to connect the different elements of the systematization of ceramic cultures. They would form 7 units:

1. The Linear Pottery culture and the early Lengyel-Polgar Complex.
2. The late LgPl and the early Funnel Beaker culture.
3. The late Tripolye culture, the early TRB (without the Łupawa group) and the Radial Decorated Pottery culture.
4. The Globular Amphora culture.
5. The Corded Ware and Złota cultures.
6. The Łupawa group of the TRB and the Rzucewo culture.
7. The Niemen culture and other cultures of the wooded zone.

The Bell Beaker culture may not have been distinguished, since its flint material combines the properties of the South industry of the CWC and of the Mierzanowice industry of the early Bronze Age of Mierzanowice culture.

In the territory discussed in this paper, there were convenient conditions for the development of flint industries because of the rich raw material deposits in Lesser Poland and the western Ukraine. The presented results of the studies on flint processing are concerned with its development in the typological-technical aspect, in the varied natural conditions on the uplands and the Lowlands within the rich mosaic of ceramic cultures. Therefore, they can be interesting from the general theoretic point of view. A separate aspect of the studies is the rich economic and social problems related to the flint processing in the Neolithic (Balcer 1980), which has not been considered widely in this paper and requires a separate discussion.

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Abbreviations

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AUL FA – Acta Universitatis Lodziensis, Folia Archaeologica, Łódź
AUW – Acta Universitatis Wratislaviensis, Wrocław
Kultura – *Kultura pucharów lejkowatych w Polsce, Studia i materiały*, ed. T. Wiślański, Poznań 1981
PA – Przegląd Archeologiczny, Poznań, Wrocław
PMMAŁ – Prace i Materiały Muzeum Archeologicznego i Etnograficznego w Łodzi. Seria Archeologiczna, Łódź
SA – Sprawozdania Archeologiczne, Wrocław – Warszawa – Kraków
SilA – Silesia Antiqua, Wrocław
WA – Wiadomości Archeologiczne, Warszawa

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