

SUMMARY OF THE BOOK

EXAMPLES OF PRODUCTION AND USE STRATEGIES OF PALAEOLITHIC AND MESOLITHIC FLINT TOOLS

INTRODUCTION

This monograph is a summary of studies on the manufacturing technology and methods of use of flint artefacts (and links between these two elements) of the societies of hunters-gatherers that lived in the area of present-day Poland during the Pleistocene and early Holocene. In interpreting the prehistoric phenomena presented in this paper and connected with the manufacturing and utilitarian aspects, I refer mainly to the results of microscopic analyses, as well as the general data concerning particular Middle, Upper and Final Palaeolithic and Mesolithic groups. I collate the deliberations on the production and use of flint artefacts contained in this monograph with the data from the publications on the reduction technology and use-wear of the flint material from Poland. However, the key knowledge which constitutes the basis of this publication comes from my microscopic analyses of the Palaeolithic and Mesolithic artefacts, and comprehensive interpretation of their results.

As a result of the research carried out, the monograph presents conclusions concerning the *chaînes opératoires* in terms of the selection of flint raw materials, reduction techniques adopted and subsequent utilisation of flint tools. General comments on the differences between the communities listed, as well as conclusions related to the changes in the approach to the use of flint products in the Neolithic are included in the concluding chapter.

I. THEORETICAL PREMISES

The considerations presented in this paper are based on the concept of *chaînes opératoires*, use-wear analyses and experimental studies. The first stage of research focuses on the issue of the selection of flint raw material and the relationship between the choice of raw material and its intended purpose.

Patterns in the use of artefacts shaped from local raw material and the one transported from further afield have been investigated. In examining another element of the *chaîne opératoire*, related to the technology, the research questions concern the relationship between the reduction technique and the purpose of the product. The author's intention is to obtain information on whether the set of tools used to process the raw material had any impact on the later function of the product. Particular attention has been given to the morphology of the specimens. An attempt has been made to trace whether there is a correlation between the shaping of the specimen, in the form of retouching or application of special treatments, and its use or hafting. It has also been analysed whether there was a visible preference for natural or deliberately shaped edges in the treatment of specific raw materials. As regards the function of the tools themselves, in addition to the topics mentioned above, issues related to particular activities and the question whether there was an exclusive link between them and particular types of tools, with specific parameters and morphology, have been examined. Were there any elements of flint specimens assigned to particular activities that were distinctive of particular industries? A number of research considerations also deal with the function of particular tools and whether this function changed over time, as well as whether certain activities were undertaken by some communities and not by others. All the answers to the questions have been enclosed within a frame common for all individual industries, i.e. the *chaînes opératoires*. Despite the fact that they are based on data obtained from few sites, they allow drawing conclusions applicable to the communities inhabiting the Polish lands in specific periods of time.

The study presented here shows several *chaînes opératoires*, which are associated with the Middle Palaeolithic, Early Upper Palaeolithic industries, Aurignacian, Gravettian, Epigravettian, Magdalenian, Hamburgian, Arch-Backed Point, Swiderian and

Mesolithic groups. The scope of considerations and the characterisation of individual elements vary depending on the access to data concerning particular communities. Applying this reasoning and methods of analysis, the study summarises the *chaînes opératoires* of particular groups and compares them in terms of the flint knapping strategies adopted and the ways in which flint tools were used.

II. MIDDLE PALAEOOLITHIC GROUPS

The lithic industry of the Middle Palaeolithic groups inhabiting the southern areas of present-day Poland is associated mainly with the exploitation of local flint deposits. Several methods or techniques of reduction of flint raw material can be distinguished. One of the most common technologies utilised in the Middle Palaeolithic flint knapping is the one associated with flake production methods, which was combined with reduction described as simple debitage. The products of simple debitage, mainly flakes, were used to make various types of tools: side scrapers, notched and denticulate tools, points and hand axes, etc. In addition to simple debitage, flakes were produced using predetermined methods (simple blade forms also appear) that required preparation. The most notable is the Levallois method along with its individual variants. The blank produced in this way was the result of reduction planned over multiple stages. In the repertoire of formal tools, notable are the specimens whose shaping received more attention, i.e. unifacial and, above all, bifacial tools, classified as knives and hand axes. Such tools were made from massive blanks or obtained through core reduction method. The intensive, invasive retouching probably directly translated into the future use of the products. On the basis of the microscopic analyses of technological wear carried out for the Pietraszyn 49a site (Wiśniewski A. et al. 2019, Wiśniewski A. et al. 2020a), it can be concluded that both mineral and organic – bone or antler – tools were used in the course of knapping. The observed traces of techniques applied should be associated both with the production of blanks as well as final shaping, e.g. by retouching.

The issue of the utilisation of flint products associated with the Middle Palaeolithic communities inhabiting the present-day territory of Poland has been discussed in relation to the interpretation of items recovered from several sites. Selected microscopically analysed artefacts come from the sites of Obłazowa Cave (Vila and Mitja, Pijoan Lopez 2003); Zwolen (Juel Jensen 2005); Biśnik Cave (Cyrek K. et al. 2014); Wrocław, al. Hallera 1 (Wiśniewski A. et al. 2013); Pietraszyn 49a (Wiśniewski A. et al. 2019) and Stajnia Cave (Pyżewicz 2011b). In addition, studies

on the manners of use of the bifacial flint tools from the Ciemna Cave have recently been carried out (Pyżewicz, Kot pre-print). The use-wear studies conducted paint a picture of the use of flint tools by the Neanderthal communities that was characterised by the absence of clear links between the morphology of individual specimens and their purpose. It can be assumed that they were largely multifunctional tools, used primarily in the course of activities associated with cutting up of hunted game, rarely hunting or processing of hard raw material. Both ordinary flakes and, above all, retouched specimens, including side scrapers and knives, were used for such purposes. The data on the use of flint specimens from the early Middle Palaeolithic period, i.e. the results of the use-wear studies from the Biśnik Cave (artefacts from assemblages A7-A3) deviate from this picture. They show that the tools were predominantly used in the processing of hard raw material, mainly wood, less frequently bone; additionally, isolated specimens linked to hunting activities were recorded. Subsequent episodes, represented by examples chronologically related to the beginning of the Weichsel glaciation (MIS 5a-5d/MIS4) and the last stages of the end of the Middle Palaeolithic (MIS3), are associated with the dominance of tools intended for animal carcass processing. These remarks apply to the above-described products from the Biśnik Cave (assemblages B, C, D and E-F), Zwolen, Pietraszyn 49a, Wrocław, al. Hallera 1 and the Stajnia Cave, as well as the Ciemna Cave.

III. LEAFPOINTS INDUSTRIES

With regard to the groups with tanged points, it is extremely difficult to draw conclusions about the function of flint tools and establish the relationship between purpose and technology. This is mainly due to the infrequent use-wear analyses of the inventories of the groups in question, while the lithic technology has been examined in depth mainly in relation to the formation of leafpoints. The small number of use-wear data may be connected to the small number of sites linked to the leafpoints industries. Summarising the data on the technology, it is worth it to note some differences, dependent on individual units, in the preparation of blanks, including those intended for shaping into formal points. Taking into account the two main groups with leafpoints from the Polish territory – those of the Jerzmanowice and the Szeletian cultures – it can be assumed that the former group produced both blades and flakes (of elongated morphology), which were then used to make points. Typical Upper Palaeolithic elements related to the reduction of single- and double-platform cores, their preparation and removal of blanks are noticeable.

In regard to the final shaping of points, knappers concentrated on obtaining an appropriate symmetry, thinness, as well as a sharp tip, which was related to the utilitarian purpose of the specimens. The flint knapping methods used by the groups with leafpoints are to some extent illustrated by the results of the microscopic analyses carried out on a selected group of retouched forms from the site of Dzierżysław 1. On the basis of these studies, it can be concluded that both at the stage of core reduction and the final shaping of flint specimens, hammers or retouchers made of mineral raw material were used.

The subject of the use of flint tools by the groups with leafpoints living in Poland is very rarely discussed. So far, only the results of the use-wear analyses of the artefacts from the site of Dzierżysław 1 have been published (Fajer et al. 2005). Moreover, in recent years, technological and functional studies of selected bifacial tools associated with Early Upper Palaeolithic groups from Central Europe, including the material from the Nietoperzowa Cave, have been carried out (Kot, Richter 2012, Kot 2014, 2016). On the basis of a morphological analysis, a division of specimens typologically classified as leafpoints into points and knives has been suggested. The results of the above-mentioned use-wear studies from the Dzierżysław 1 site (Fajer et al. 2005) indicate that flint tools were used both for cutting animal carcasses as well as processing skins and wood. The researchers carrying out the work at the site believe that the Palaeolithic communities used the tools for both pre- as well as post-hunting activities. Also, selected flint material from the Dzierżysław 1 site has recently been re-subjected to microscopic analyses. On the basis of the results of the latest use-wear analyses, it can be concluded that basically all the flint forms have been strongly impacted by post-depositional factors. The surface changes are so intensive that it is now impossible to identify microwear associated with the original use and hafting, occurring mainly in the form of polishing. In order to supplement the scarce information on the use of flint tools by the groups with leafpoints groups inhabiting the Polish territory, selected forms from the Nietoperzowa Cave have also been analysed. This site is one of the most important points on the map of occurrence of groups with leafpoints.

The results of the macroscopic and microscopic analyses of several dozen points from the Nietoperzowa Cave clearly indicate that these forms were used during hunting. On the basis of the selective indications presented above, it can be concluded that the groups with leafpoints used flint tools for hunting and animal carcass processing activities. An extremely interesting issue is the relationship between the morphology, flint form knapping technique applied and the actual function of the artefacts. On the basis of the data obtained so far, it can be

suggested that the forms in the type of symmetrical, relatively thin leafpoints, retouched on one or both sides and with a clearly distinguished tip, served as elements of projectile weapons. The question of identifying knives used for cutting animal carcasses requires further research. This function might have been performed by asymmetrical bifacial specimens, but also, for example, ordinary flakes.

IV. AURIGNACIAN GROUPS

The stay of the Aurignacian communities, which probably constituted the first wave of colonisation of the *Homo sapiens* species, clearly differs at the technological level from the communities representing the so-called Micoquien and leafpoints industries. The first difference is the disappearance of the bifacial technology and the preferential method of producing flakes and probably also blades. Instead, two methods of production of blade blanks emerge. This duality in the approach to tool formation was also present in the Upper Palaeolithic industries of later chronology. The methods described are related to the two types of blanks preferred by the Aurignacian groups. The first method is related to the production of fine blanks intended for microlithic insets of the Dufour or Krems points type, made from small cores, which are often referred to in the literature as carinated end scrapers. The second method was oriented towards the removal of larger blade blanks, which were shaped into retouched blades, burins, perforators and end scrapers. Both types of reduction were carried out using the technique of direct percussion with a soft organic hammer. In order to verify particular research questions concerning the technology of the Aurignacian lithic industry, a microscopic analysis of the flint material from the Góra Puławska site was carried out. The forms of cores, blanks – blades and bladelets – technical forms, such as rejuvenation flakes, crested blades and preparation flakes, as well as formal tools were studied in detail. Obvious technological microwear was noted on the artefacts selected. The marks recorded on the platforms of small nucleiform pieces, also called carinated end scrapers, clearly indicate that tool sets consisting of antler billets were used during their reduction, including the removal of small bladelets. The assemblage from Góra Puławska also contains isolated macrolithic forms, on the surfaces of which technological microwear – traces of contact with a tool for flint knapping, made of antler – was registered. Taking into account the indications mentioned above, it can be quite confidently concluded that antler billets were used to execute both the *chaîne opératoire* connected with obtaining microlithic bladelets intended for insets, e.g. of the Krems and Dufour type, as well as the one

related to the removal of macrolithic blade blanks from which burins, end scrapers, retouched blades, etc. were made. In relation to the microscopic analyses carried out on selected nucleiform pieces recovered from the Kraków-Spadzista site (Nowak A., Wolski 2015), traces of contact between the flint surface and a mineral hammer were observed in several cases.

The utilitarian aspect of the Aurignacian flint artefacts from the territory of Poland has not yet been sufficiently presented in the literature. The few use-wear studies concern only selected artefacts from the Deszczowa Cave (Cyrek K. et al. 2000) and Kraków-Spadzista site (Stefański 2007, 2013, Nowak A., Wolski 2015). Several artefacts recovered from the Deszczowa Cave, from a layer associated with the Aurignacian groups, were analysed; the tools were used for works related to cutting animal carcasses, tanning and antler, bone and wood processing. The analyses of the material retrieved from the Kraków-Spadzista site were focused on two research problems, i.e. the ways in which burins (Stefański 2007, 2013) and nucleiform pieces (Nowak A., Wolski 2015) were used. In his use-wear studies, Damian Stefański concentrated on demonstrating the working parts of particular tools, as well as determining the nature of the actions carried out with their help. In his opinion, the dominant function of the Aurignacian burin was scraping. Traces related to such an activity are located within parts shaped by applying the burin blow technique. Additionally, formal burins may have sometimes served as knives, carving tools and, in isolated cases, as perforators. This research indicates that the products recovered from the site of Kraków, ul. Spadzista B+B1, i.e. formal burins, including characteristic carenoidal and busked forms, constituted a group of functional tools, adding another voice to the discussion on the actual purpose of nucleiform products. Further considerations related to the aforementioned issue were undertaken by Adam Nowak and Damian Wolski (2015), who used as reference material the formal end scrapers and burins associated with the Aurignacian groups that were recovered from the Kraków-Spadzista B1, B2, D and C1 site. Microwear interpreted by the researchers as possibly associated with the utilitarian aspect was observed on isolated examples of the nucleiform pieces selected; they were used for working skins, wood, antlers or mineral raw material. The authors point out that the nucleiform pieces may have alternately been used as cores for the production of bladelet blanks and as tools. The last assemblage of Aurignacian nucleiform specimens that has recently been analysed are the forms recovered from Góra Puławska. Their microscopic examination did not show these forms having been used in daily activities, which should have resulted in functional wear. In the light of these studies, nucleiform specimens

should be regarded as forms used to produce blanks – fine flint bladelets, some of which can be refitted with the cores described above. Among the bladelet forms from Góra Puławska, both those whose edges are considered to have been shaped with fine, often irregular, intentional retouch and those devoid of such shaping, none show any preserved traces of use-wear. Among the few macrolithic tools, microscopic traces of use-wear are present on two artefacts only.

On the basis of the studies of the artefacts from the three sites mentioned above, it can be demonstrated that the first representatives of the *Homo sapiens* in Poland used tools during post-hunting activities, i.e. cutting of animal carcasses and skin, bone and antler processing. At the same time, in isolated cases, the possibility of processing wood has also been taken into account. It should be noted that the above data do not show a clear correlation between the form of tools and their function, which is more evident in the studies of specimens associated with the later Palaeolithic and Mesolithic communities. The attempts made to formulate an answer to the question concerning the use of small nucleiform pieces, often classified as particular types of end scrapers or burins, did not bear clear results. On the basis of the studies of the artefacts from the site of Kraków-Spadzista, it can be assumed that the specimens of the above-mentioned morphology were used in the course of everyday activities, mainly related to the scraping of raw material. On the other hand, the results of the microscopic analyses of the nucleiform specimens from Góra Puławska identify them as artefacts used only for the production of bladelet blanks.

V. GRAVETTIAN AND EPIGRAVETTIAN GROUPS

The picture of the flint technology identified with the Gravettian and Epigravettian communities from the Polish territory is still characterised by certain deficiencies in comparison to other Palaeolithic industries. This state of affairs is due to a number of factors, which include a considerable diversity of individual assemblages, probably connected to large chronological and spatial gaps between them, and small distinctiveness of debitage. In general we can conclude that the production of blanks was based on the reduction of single-platform, less frequently double-platform cores, using the technique of direct percussion with a soft hammer. It is also significant that the Gravettian and Epigravettian specimens are characterised by an absence of additional characteristic treatments accompanying the preparation of the striking platform, which would facilitate distinguishing the technology

of the units in question from other groups. When considering the Gravettian knapping technology, it should be noted that, similarly to the debitage associated with the Aurignacian groups, a dichotomy in blade production is also observed here. In addition to the blade blanks described, small bladelets, characterised by small parameters, were manufactured. In regard to the Epigravettian technology, numerous similarities to the Gravettian technology can be demonstrated. Attention should also be drawn to the frequent preference for blade debitage with the dominant strategy of removing massive blanks from single-platform cores and the lack of intensive preparation. The technological studies carried out on the Gravettian material from the Polish lands have been supported by microscopic analyses. So far, studies of this type have only been performed on the artefacts from the site of Henryków 15 (Wiśniewski A. et al. 2015). On this basis, it can be concluded that the tools used for knapping flint raw material – at least in the case of the application of abrasion and trimming of the edges, as well as the preparation of striking platforms – were hammerstones.

Use-wear analyses, the aim of which was to trace the ways in which flint specimens were used in everyday life by the Gravettian and Epigravettian communities inhabiting the Polish territory, were carried out in several cases. They are studies of different research focus. In the case of the artefacts from the Kraków-Spadzista site, the functional considerations concerned selected groups of formal tool types, i.e. specimens created by the application of the burin blow technique (Stefański 2007), as well as shouldered and backed points (Kufel-Diakowska et al. 2016). On the other hand, from the inventories from Jaksice II (Kufel-Diakowska 2015b) and Targowisko 10 (Kufel-Diakowska, Wilczyński 2014), formal tools as well as a selection of unretouched debitage products, mainly blades, were subjected to detailed microscopic analyses. In the case of the Deszczowa Cave (Cyrek K. et al. 2000) and Henryków 15 (Wiśniewski A. et al. 2015) sites, use-wear studies were conducted on a few selected flint specimens. As for the functional interpretation of the specimens from the Epigravettian site of Sowin 7 (Wiśniewski A. et al. 2012), the only information heretofore published concerns the use of the artefacts in question for working hard, medium-hard and soft raw materials, i.e. most probably wood or bone and skin.

The results of the use-wear studies cited indicate that the specimens selected for utilitarian purposes were retouched forms – formal shouldered points, macrolithic backed pieces, burins, end scrapers, backed bladelets, rectangles, as well as retouched blades and isolated retouched flakes. They were mainly intended for hunting activities and subsequent work on processing the animal carcass. Referring in

more detail to the acquired data related to the ways in which formal tools were used, it can be concluded that there is a noticeable correlation between their form and purpose. On the basis of the analyses of the material from the two sites mentioned above, it can be surmised that practically only two types of flint products were used in works connected with hunting, namely backed forms (bladelets or points and rectangles) and shouldered points. The second type of activity associated with the use of flint tools by the Gravettian groups is related to the processing of animal carcasses. A morphologically varied tool set, consisting of retouched blades, burins, backed bladelets, was involved in cutting the carcass, while end scrapers and burins were used for scraping and cutting skin. A significant part of Gravettian flint tools was used for working bone and antler, which, on the one hand, could have been related to the manufacture of objects from this raw material, and, on the other hand, to the splitting of bones intended for another purpose, such as food preparation. This functional group is dominated by formal burins. The use-wear analyses carried out to date indicate that the Gravettian communities could have used flint tools during the processing of products of plant origin in isolated cases only.

The data concerning the use of flint products by the youngest Epigravettian groups inhabiting the Polish territory are scarce. An interpretation of the microscopic image of the artefacts from the Targowisko 10 site indicates that the main actions carried out with the use of end scrapers and blades were related to hide scraping. Isolated unretouched blade forms and a backed piece were used in works connected with animal carcass processing. In the case of few artefacts, mainly blades and burins, the researchers also managed to identify traces of activities related to the processing of raw materials of plant origin – cutting, scraping, splitting. On the other hand, the formal burins from the Kraków-Spadzista site were used for cutting and scraping, as well as piercing and carving unspecified raw materials.

VI. MAGDALENIAN GROUPS

Research to date indicates that the Magdalenian communities usually obtained flint for technological purposes from local or nearby deposits, although their assemblages also include artefacts made of raw materials whose outcrops were located further away. It should be noted, however, that the locally quarried flint was usually of good quality in terms of its processing properties. The picture of flint knapping technology in the territory of Poland is largely analogous to the data from the western part of the area inhabited by the Magdalenian communities. There

is a clear division between two ways of producing blanks, as reflected by the respective *chaînes opératoires*. The formation of macrolithic blade blanks involved a more sophisticated strategy, long-term planning, selection of better-quality raw material, greater practical and theoretical knowledge, which, in a relatively unified version, was passed on among the groups across the whole range of the territory they inhabited. In contrast, the production of small blade forms did not require a high level of competence on the part of the knapper, nor did it involve an advanced selection of raw material. Additionally, the technology was characterised by different local variations. This division is reflected in the functional studies of the tools – large tools constituted a “household” tool set, while small backed pieces were used for hunting practices. Studies of technological microwear show the dissimilarity of the marks formed on the two types of cores and blade blanks, differentiated by their parameters. Macrolithic blade forms were produced with tools made of organic raw materials, while smaller cores and blades detached from them exhibit features of the technique of direct percussion with a hammerstone.

Use-wear studies concerning flint artefacts recovered in Poland were carried out on the material from the sites of Maszycka Cave (Winiarska-Kabacińska 1993d); Wilczyce 10 (Winiarska-Kabacińska 2014b, among others); Klementowice-Kolonia 20; Ćmielów 95 *Mały Gawroniec* (Pyżewicz 2015a, Pyżewicz 2020b); Podgrodzie 16 (Pyżewicz 2015a); Wierzawice 31 (Bobak et al. 2017); Sowin 7 (Wiśniewski A. et al. 2020); Dzierżysław 35 (Ginter et al. 2002, 2005, among others).

On the basis of the above-mentioned microscopic studies, it is assumed that sets of flint tool were utilised during hunting-related activities, with small backed pieces as the main forms used for these purposes. Another group of functional tools recorded during the use-wear analyses was determined by the actions related to the processing of animal carcasses: dismemberment, cutting, separation of soft tissue from bones, hide scraping. A variety of tools were used in this type of work, including both scraping tools and functional knives. Unretouched blades and, sporadically, blades with an additional intentional shaping of the edges served to perform actions related to the initial stages of processing an animal carcass (skinning, cutting off various parts containing bones, antlers and meat, as well as cutting soft tissue only). Isolated formal tools, such as backed points, were sometimes used for analogous operations. Some perforators are also characterised by wear associated with processing, cutting animal carcasses, antlers/bones – such marks have been recorded along the unretouched edges as well as on retouched parts. Moreover, formal burins were

sometimes utilised for similar activities. Their longer edges were used to cut animal soft tissue and antlers or bones. Isolated burins were also used to cut skin. It is worth noting that marks observed on some backed bladelets indicate that these tools were used to cut animal soft tissue. In regard to hide scraping, formal end scrapers were mainly used to clean the skin from the remains of muscles, veins and fat, and presumably also get rid of hair. A large group of flint artefacts was used at various stages of works connected with the manufacture of everyday tools or their components from bone or antler, including the acquisition of raw material, preliminary shaping and decoration of the objects. This group of functional tools includes diverse forms of flint artefacts: formal burins, perforators, borers, unretouched blades and isolated end scrapers. Among the flint tools presented, formal burins attract particular attention. In comparison to other tool types, the number of their applications in the course of works connected with the formation of tools from organic raw materials is exceptionally considerable. Burins were used for cutting, scraping, grinding and carving bone or antler. On the other hand, flint artefacts used for working wood or herbaceous plants are rare. Isolated tools of this type have been recorded in the material from the Maszycka Cave (only a single blade was used for woodworking), Wilczyce (one blade fragment and perhaps two more artefacts – a burin for scraping and a borer for carving – were used for woodworking at this site) and Klementowice-Kolonia where, among the numerous specimens used, several specimens linked to the discussed functional group have been identified. These should include a formal perforator, which was used to cut plants, as well as several blades, burins and one end scraper, the surfaces of which are marked with wear probably resulting from contact with wood or herbaceous plants. The analysed and presented flint artefacts from the Polish lands were used for other purposes, namely the processing of mineral resources, in isolated cases only. These are mainly the specimens used in the process of lighting fire that have been identified in the inventories from Klementowice-Kolonia, Podgrodzie and Ćmielów, possibly also Wilczyce. So far, they are the oldest strike-a-lights from the territory of Poland. Moreover, traces of stone and ochre processing have been identified on few artefacts from Wilczyce: burins, smaller and larger backed forms, and blades. They were used for scraping, polishing, carving and boring.

VII. HAMBURGIAN GROUPS

The subject of flint knapping in the Hamburgian communities inhabiting the area of Poland has not yielded many studies, partly due to the small number and low

quality of sources. The studies mentioned indicate that the flint technology of Hamburgian knappers did not differ significantly from the reduction patterns observed in western Europe. Knapping was oriented primarily towards the production of blades, which were then shaped into various types of formal tools or used as is. The literature on the subject shows two types of interpretation of flint knapping techniques employed by the Hamburgian groups in the Polish lands. One is related to the application of direct percussion with a hammerstone only, while the other indicates that tools made of organic material, such as antler, were also used. The technological aspect in relation to microscopic examination was addressed by Bernadeta Kufel-Diakowska (2015a: 69–70). Her research confirmed that hammerstones constituted the main type of tools used for the reduction of flint raw material in the area of site Olbrachcice 8.

Based on the use-wear studies carried out on the formal tools and ordinary blades and flakes from the sites of Liny (Winiarska-Kabacińska 2016b) and Olbrachcice (Kufel-Diakowska 2015a), it can be concluded that the Hamburgian communities undertook activities related to hunting, processing animal hides and carcasses, and making objects from selected animal parts. Referring, in turn, to the functional studies of the material from the site of Mirkowice 33, the results of which have been mentioned in the literature (Sobkowiak-Tabaka 2011: 71, Winiarska-Kabacińska 2016b), it can be concluded that the main activities undertaken in the area of the encampment in question were connected with the processing of particular parts of animal carcasses – soft tissue and bone. When hunting game, the Hamburgian groups from the western part of the Polish territories mainly used shouldered points. On the other hand, activities related to the division of the animal carcass and cutting of the hide were mainly performed using blades as well as formal truncated pieces, flakes and, very rarely, other types of formal tools. A fairly homogeneous group of functional tools consists of formal end scrapers, which were used in the process of tanning. In order to scrape the hide, flint tools were hafted, and the work was carried out mainly with the retouched part – end scraper front. Sometimes, burins were also used to carry out these operations. It is worth noting that flint tools were also used for piercing hide, which was done with the help of formal perforators. One of the most important activities among the Hamburgian groups was the processing of bone or antler to manufacture objects of everyday use. It is possible to trace all the stages of the *chaîne opératoire* executed in their making and determine the types of tools that were utilised. Included in this group are the so-called *Zinkens*, distinctive forms of the Hamburgian groups. At the same time, in the course of the work described, manufacturers used

tools in the type of burins, borers, perforators and truncated pieces, as well as ordinary, often unretouched blades and flakes. On the other hand, evidence that the communities inhabiting the western Polish territory used flint tools for working wood and herbaceous plants is extremely rare. Hafts, weapon components and other wooden objects were fashioned with the use of blades, sometimes additionally retouched, burins, retouched flakes, isolated examples of other formal tools, such as the *Zinkens*, truncated pieces, saws or notched tools.

VIII. ARCH-BACKED POINT GROUPS

The Arch-Backed point communities tended to use particular varieties of siliceous rocks available locally. The lack of attachment to the quality of raw material also results from the way in which siliceous rock processing was approached, related to a strategy based on *ad hoc* knapping, which led to the removal of flake or blade blanks intended for formal tools – backed points in their various variants, truncated pieces, end scrapers and burins, among others. The listed artefact types should be regarded as tool sets characteristic of the groups in question. The main features of the flint technology employed are the amorphousness and massiveness of single-platform or reoriented cores and the products obtained from them, poorly developed preliminary core preparation – usually limited to removing one or a few flakes – and use of a faceting procedure. At the same time, it is noticeable that Arch-Backed point groups employ two blade producing methods within the framework of the technology used. The common features are the above-mentioned morphological elements (at least some of them), while there is a clearly noticeable difference in the preparation of the striking platform before the removal of blanks, which – depending on the chosen method of preparing the point of impact – differ in their morphology. Depending on the presence or absence of faceting, the resulting products may be characterised by either hard or soft features of direct percussion.

Use-wear analyses of flint artefacts recovered from Polish sites associated with the backed point groups were carried out on the flint inventories from the sites of Siedlnica 17 (Diakowska-Kufel 2015); Całowanie (Winiarska-Kabacińska 2014c); Lubrza 42 (Kabaciński et al. 2014); Lubrza 10 (Sobkowiak-Tabaka et al. 2018, Sobkowiak-Tabaka, Kufel-Diakowska 2019); Niedoradz 14 (Kwiatkowski, Masojć 2011), as well as on the isolated artefacts recovered from the areas near Lubrza and Bachorce (Pyżewicz et al. 2008). Small backed forms, the parameters of which change in individual inventories, were usually intended for

use in hunting weapons and mainly served as arrowheads. There are also products identified, mainly small backed forms, that should be assigned the function of lateral arrow insets. In isolated cases, retouched blades or blades devoid of any signs of intentional shaping were used as elements of projectile weapons, in addition to backed forms. Other activities, commonly undertaken by hunter-gatherer groups, were those related to the processing of carcasses of hunted animals, including their skinning and cutting. This functional group includes blades, flakes and formal tools. Formal end scrapers were mainly used for hide scraping. The Final Palaeolithic groups with backed points dwelling in the Polish territory can also be associated with activities related to the processing of bone and antler. Such activities were performed with the help of burins, end scrapers, perforators, as well as blades and flakes. Use-wear studies further indicate that isolated specimens were used for working wood and herbaceous plants. A few specimens were used for scraping or carving in hard inorganic material; some were perhaps used as strike-a-lights.

IX. SWIDERIAN GROUPS

The Final Palaeolithic knappers associated with the Swiderian groups were distinguished by their excellent knowledge of outcrops which yielded flint nodules of good and sometimes excellent quality, which is naturally intertwined with the technological aspect. The literature on the subject emphasises the attachment of the Swiderian communities to high-quality raw material, which is attested, among other things, by the greater number of “imported” rocks in their inventories, chocolate flint in particular. The method of shaping flint products employed by the Final Palaeolithic Swiderian communities is highly distinctive. Knapping was based on a precise reduction of double-platform cores, while single-platform cores were used less frequently. In all the variants presented, the technique of direct percussion with a soft hammer was utilised. An unusual precision in the treatment of flint nodules and focus on the production of blade blanks is evident in the Swiderian culture material. Supporting the technological analyses conducted to date, there are also microscopic analyses. They were carried out for the flint artefacts from site 3 at Suchodółka, confirming that only stone tools were used both in the initial as well as advanced stages of reduction related to the production of blade forms.

The sets of flint tools identified were related to several basic activities undertaken by the Swiderian groups. One of them were hunting activities. On the basis of the results of previous use-wear analyses, mainly typological tanged points should be considered

as products used for arrowheads. It is worth adding that not all of the use-wear analysis results indicate the use of tanged points as a component of projectile weapons. Based on the analyses of microwear preserved on the surfaces of some of the artefacts, it can be concluded that these distinctive Swiderian forms were also used as knives for cutting animal carcasses or as functional borers. Moreover, they were used for working wood, bone or antler, as well as to carry out unspecified activities. The function of end scrapers is mostly related to hide and skin processing; less frequently, such tools were used to work bone and soft tissue, i.e. to cut animal carcasses. Formal end scrapers used to scrape wood or work ochre are rare. On the other hand, formal burins are a rather heterogeneous functional group. It can be suggested that tools of this type were used for scraping, grinding, gouging or cutting organic raw material, such as bone, antler and soft tissue (meat or fresh skin). Isolated examples suggest the use of burins to perform other actions, including hide piercing, bone carving, scraping, antler carving, skin and wood processing. Other types of formal tools have very rarely been analysed in terms of their function, which is mainly due to their small number in individual inventories. It is also worth noting that it was possible to select from the assemblage of Swiderian flint tools a small group of strike-a-lights. On the other hand, blades, sometimes additionally retouched, were multifunctional tools if used. Isolated specimens were utilised to process wood and herbaceous plants, animal skins and carcasses, as well as antlers and bones.

X. MESOLITHIC GROUPS

The lithic industry of the early Holocene groups commonly made use of local raw material, whereas “imported” specimens were rare. At least in part this preference results from the methods chosen for producing blanks as well as flint tools themselves. The flint knapping techniques employed, while usually related to the removal of blade blanks intended primarily for the manufacture of flint microliths, vary temporally and regionally. Initially, the direct percussion technique is dominant, reflecting, at least to some extent, the methods favoured in the Final Palaeolithic. However, it becomes simplified, which is demonstrated, among others, by the minimised core preparation. This was most likely related to the immediate needs of makers and users, e.g. the lack of core sets or debitage products that would function as “stocks”. In contrast, the hallmarks of advanced planning of subsequent elements of the *chaîne opératoire* and of sophisticated flint knapping are not distinguished. On the other hand, a completely new technique of removing blanks, involving application

of pressure, appears during the Mesolithic period. In Poland, the technique in question is recorded in two variants. The older one, identified with the eastern areas and the Kunda group, is characterised by the removal of blades of considerable size from cores characterised by intensive work on the platform, manifested by frequent faceting. The reduction method employed by the Kunda group probably influenced the way in which the Janislawician group produced blades, as an analogous technology, connected with the application of the pressure technique, also appears in the areas occupied by the latter cultural unit. The second of the above-mentioned variants is linked to the Maglemosian or post-Maglemosian groups. In this case, the pressure technique was used to remove small blade blanks from cores that are not characterised by platform trimming or core preparation by a single removal. This kind of reduction should be linked to Scandinavian influences; at least, such a connection is indicated by the absolute dating of individual flint inventories recovered to date. In the Late Mesolithic, the indirect percussion technique, primarily connected with the removal of blades intended for wide trapezes, becomes more widespread and appears in the Komornician, post-Maglemosian, and Janislawician groups. Nonetheless, it should be emphasised that the direct percussion technique persists throughout the Mesolithic period. It was used in all the distinguished industries, for example, for shaping, trimming and repairing cores, as well as an independent method of producing blades and flakes. In addition, the use of splintering technique is occasionally recorded; however, in the Mesolithic, it does not usually play a significant role in the production of blanks.

Use-wear studies were conducted on the material recovered from often non-homogeneous settlement contexts associated with the Komornician, Maglemosian, post-Maglemosian, and Janislawician groups. The analyses were carried out for the sites of Dęby 29 (Willis 1990, 1992); Chwalim 1 (Winiarska-Kabacińska 1993c); Luta 1 (Winiarska-Kabacińska 2007a); Dąbrowa Biskupia 71 (Winiarska-Kabacińska 2007b, 2016c); Krzyż Wielkopolski 7 (Kabaciński et al. 2008, Winiarska-Kabacińska, Kabaciński 2016c), Sieczno 4; Toruń 247 and 249; Lubicz 12, 13 and 18 (Osipowicz 2010, 2014b, 2017, 2019a, Nowak D, Osipowicz 2012); Aleksandrów Łódzki 1 (Pyżewicz 2011a); Wojnowo 3; Turowiec 3; Jastrzębia Góra 4; Żuławka 13 (Pyżewicz 2012, 2013c, 2019a, Pyżewicz, Gruzdz 2014); Ludowice 6 (Osipowicz 2013, 2015, 2017, 2018; Osipowicz et al. 2018, 2019a); Nieborowa I (Winiarska-Kabacińska 2014e); Dąbki 9 (Winiarska-Kabacińska 2015a); Smolno Wielkie 2 (Winiarska-Kabacińska 2016b); Wierzchowo 6 (Chłoń, Płonka 2016); Grądy-Woniecko 1 (Pyżewicz 2017); Wilenko 13 and 16 (Sobkowiak-Tabaka et al. 2017); Rydno VI/60 (Boroń et al. 2018); Rydno IV/47 (flint

concentration X) (Boroń et al. 2019); Dubeczno 1 (Osipowicz 2019c); and Sadłowo 5 (Osipowicz, Bosiak 2019). The studies also cover a selection of tranchet axes from western Poland (Chłoń 2012), end scrapers from Otmuchów 28 (Wolski 2012), microliths and macrolithic truncated points from Trzciano 36 (Osipowicz, Weckwerth 2016). Also analysed was the material from the sites of Wieliszew III and VIb, associated with the Late Mesolithic Kokry industry (Boroń, Winiarska-Kabacińska 2016, 2018), as well as individual specimens from Dęby and Rydno IV/47 (flint concentrations II and IX), linked to the Desna groups (Winiarska-Kabacińska 2005), and the Kunda culture artefacts from Miłuki 4, only mentioned in the subject-matter literature (Siemaszko 2001). Unique are microscopic analyses of composite tools, such as those recovered from Tłokowo (Winiarska-Kabacińska 1993b, Schild et al. 2003, Osipowicz et al. 2020), or of grave inventories, such as those found at Janisławice (Pyżewicz 2013b).

Hunting-related activities were some of the tasks performed with the use of flint artefacts. Based on the data available, it is known that Mesolithic communities primarily hunted with bows and arrows, using mainly microliths and, in isolated cases, unretouched flint forms for these purposes. Small geometric forms were mounted on the tips of the shafts or reinforced the side grooves. Particularly noteworthy are trapeze forms, which become one of the elements of arrow armament in the Late Mesolithic. They were mounted on the tips of the shafts, with the longer unretouched edge directed upwards. Tools used for processing animal carcasses do not form such a formally and typologically compact group as those associated with hunting activities. Mesolithic groups used a variety of instruments for cutting animal skin or soft tissue along with bones. The tools most commonly used for these purposes were unretouched blades and, sometimes, flakes; however, in isolated cases, formal truncated pieces, end scrapers, scrapers, notched blades, burins and microliths were also utilised. End scrapers and, more rarely, scrapers were the standard types of formal tools used for hide scraping. At the same time, in isolated cases, specimens of different type were used for this purpose, including truncated and backed pieces, perforators, burins, blades and flakes, sometimes additionally retouched and, in most cases, probably set in wooden or bone handles. Mesolithic groups also engaged in intensive bone and antler processing with the help of flint tools. Thanks to use-wear studies, it is known that a variety of mostly more massive tools were used at different stages of forming antler and bone objects. The dominant category is that of scrapers – both in the sense of formal tools and the function they served. Other types of tools are also associated with bone and antler scraping, namely blades and flakes, sometimes retouched, as well as isolated burins, perforators,

truncated blades, end scrapers, picks, and tranchet axes. Tools for cutting or sawing bones and antlers are less frequently distinguished in flint inventories and include blades and flakes, sometimes retouched, isolated scrapers and tranchet axes. Occasionally, flint tools were used in the process of carving (formal burins, scrapers, perforators, as well as blades and flakes, also those additionally retouched), planing (scrapers, as well as blades and flakes, sometimes retouched) and making holes (specimens with distinguishable stings, such as perforators or borers, and blades, some retouched). The functional group presented here includes quite a number of recorded massive tools of the tranchet axe and pick type. The former were usually used for cutting raw material, while the latter served to make large-sized hollows or holes. In addition to the intensive processing of animal carcasses and the management of individual elements of animal origin, the Mesolithic period sees an increase in the processing of raw materials of plant origin. This is clearly visible in the inventories associated with communities functioning in the Atlantic, Late Mesolithic, period. Flint tools, most probably set in organic hafts, were used to work both wood and herbaceous plants. The group of flint products, on the surface of which microwear attributed to the raw material in question has been recorded, is quite typologically diverse. It simultaneously includes formal tools shaped from blades and flakes, unretouched debitage products, as well as massive core tools. Apart from organic raw materials of animal and plant origin, there is also sporadic evidence of the use of other types of materials. The functional studies carried out to date indicate that the early Holocene groups inhabiting the territory of Poland used flint to light fires. The tools that were most likely used to form holes in amber should be treated as unique.

XI. CONCLUSION

The data presented in this publication clearly show that differences, both concerning the strategies of supplying flint raw material as well as producing blanks and finished tools, existed between the individual industries. As it can be assumed, there probably were utilitarian and environmental reasons (e.g. access to raw material) behind them, as well as factors related to the group's mobility or social contacts, tradition, fashion, etc., which are usually difficult to document in archaeological sources.

In the case of the Middle Palaeolithic and early Upper Palaeolithic communities, knappers were generally willing to exploit the local resource base, less frequently resorting to specimens brought from further away. Flints of higher quality were used

mainly by the Magdalenian and Swiderian groups. It should be noted that it is difficult to establish on the basis of use-wear analyses whether any of the raw materials had a predetermined value in relation to some specific tool function. The only noticeable correlation can be seen among the Magdalenian components of projectile weapons, usually consisting of small backed insets. However, it is difficult to infer a superior functional quality of specimens made of chocolate flint over other types of this raw material. The Magdalenian makers and users were probably motivated by considerations other than the strictly utilitarian ones. It is worth noting that the communities in question favoured diversity in the raw material selection, perhaps in the context of allocating specific types of flint for tools, taking into consideration mainly technological properties, nodule parameters or aesthetic value. The Mesolithic communities, which did not have any major requirements with respect to the dimensions of flint nodules, return once again to exploiting their local supply base. The only exception is the Janislawician group, whose knappers utilised better-quality flint, which is probably related to the reduction techniques used.

On the other hand, when considering the aspects related to the reduction and tool production methods, there are very noticeable differences between the individual industries. Among the Middle Palaeolithic communities, the dominant technologies are those related to the Levallois method, production of bifacial forms and simple methods connected with the reduction of discoidal cores. The Middle Palaeolithic knappers commonly use hammerstones to work flint nodules, but – as we know from microscopic analyses, among others – they also utilise, with increasing frequency, hammers and retouchers made of antler or bone. In addition to an *ad hoc* tool formation, the Middle Palaeolithic technologies encompass more advanced and planned tool forms. Evident is the tendency towards reshaping and repairing working parts, a prime example of which is the removal of spalls to obtain a sharp working edge. The trend related to the production of flake and bifacial tools continues among the groups with leafpoints.

The approach to flint knapping methods changes radically among the Upper Palaeolithic groups. The number of flake tools is reduced, and the bifacial technology is recorded sporadically, mainly among individual units outside the territory of Poland. Lithic industry is dominated by two types of blade debitage, which should be directly linked to the purpose of the blanks obtained. Macrolithic and microlithic blade forms are produced. The use of antler and bone tools for working flint becomes more widespread, which is in line with the general trend to process the above-mentioned organic materials and utilise them to make objects of everyday use. From this point onwards, the specificity of blank preparation as well as final shaping of

specimens intended for elements of hunting weapons is also clearly marked. Other functional tool types also begin to be characterised by a specific form.

In summary, the Aurignacian groups were the first in the Polish territory to commonly use the methods of obtaining different variants of blades. Their macrolithic forms were shaped from previously prepared cores, and, which is worth emphasising, before they were removed the point for impact had also been precisely prepared. Organic hammers were certainly used to remove blades of this type, as confirmed by the microscopic analyses of the material from Góra Puławska. Detached specimens were used to form retouched blades, burins, perforators, end scrapers. On the other hand, when producing microlithic bladelets little attention was paid to preliminary core trimming and preparation of the point of impact. Organic hammers were mainly used to reduce small cores or nucleiform pieces; however, stone tools were also additionally utilised. The purpose of production of microlithic bladelets on the Polish lands is currently unknown. However, referring to analogous forms from Europe, it can be presumed that they were used in hunting weapons. Similar to the Aurignacian groups, the Gravettian communities are also distinguished by the specificity of flint processing. Also in this case, a dualism in the production is visible. In order to obtain flint tools for everyday use in the encampments, blade blanks were removed, which were then often additionally shaped by retouching or characteristic procedures, such as the burin blow technique. The technique of direct percussion with a soft hammer was used. It is also known that mineral hammers were utilised during the lithic reduction (trimming, preparatory treatments), as indicated by the results of the microscopic analyses of the material from the Henryków 15 site. It is worth emphasising that, in the case of one type of tools formed from blades, namely shouldered points, the material for their manufacture was selectively chosen, blanks that met predetermined standards were picked, and dedicated treatments were used to give the form its final shape. The second type of processing, analogous to the Aurignacian one, was related to the reduction of small form cores, including burin cores. They were used to produce bladelets, mainly intended for use as elements of hunting weapons. Comprehensive analyses of the Magdalenian material, which is currently among the best researched from the technological point of view (among the Upper Palaeolithic units), also show numerous similarities in the planning in respect to obtaining blanks for specific functional tools. On the other hand, the intensity of using bone or antler tools to process flint nodules changes. Magdalenian knappers commonly utilise hammers and retouchers made of organic raw materials, as confirmed by the observations of the morphology of cores and blanks, as well as the results of analyses of

technological microwear. They show an advanced and sophisticated technology of flint nodule reduction, which yielded large-sized blades, distinguished by the specific preparation of points for the removal of blanks (*en éperon*). As was the case with the earlier Upper Palaeolithic groups, the blanks are designed for the purpose of manufacturing of formal tools – burins, perforators, end scrapers, etc. On the basis of use-wear analyses, it is known that blades without additional retouching were also in use. It can be assumed that such a trend was also present among the earlier Upper Palaeolithic communities living in the Polish territory, but due to the dominance of functional studies on formal tools the data concerning non-retouched specimens is very limited.

It can be assumed that the picture of the Upper Palaeolithic lithic technology is similar in general patterns and involves dualism reflected in the reduction of macro- and microlithic cores. Of course, in the course of presenting successive technological nuances in the previous chapters, the features that are associated with the Aurignacian, Gravettian, Epigravettian and Magdalenian groups were highlighted, so that in many cases it was possible to distinguish the assemblages by chronology. It should be added that both types of blade forms (differentiated by size) could be obtained within a single extended reduction sequence, so the intermingling of the two technologies – macrolithic and microlithic – should be considered. For example, small bladelets were obtained from originally reduced, larger cores or were detached in the course of preparation, repair or correction of macrolithic forms. It is also interesting that the picture of the Upper Palaeolithic groups clearly shows a connection between the production of tools intended for everyday use and those utilised in hunting activities. The latter are to a large extent (apart from shouldered points) associated with the reduction of small cores, which did not require much in terms of nodule preparation and repairs, which coincides with a lower number of elements in the *chaîne opératoire*, related to trimming and preparation of the striking platform or flaking surface. This should be linked to a lack of requirements in respect to experience in flint knapping, as well as a greater ease and speed of making the necessary hunting equipment. The reduction of such cores also brings to mind the lower weight of flint nodules, as well as a simple tool set for knapping, which may be related to the mobility of the communities of that time. It is then possible that the elements described should be associated with the lithic industry presented by the Upper Palaeolithic hunters. With that approach to flint knapping, it was possible to prepare hunting weapons not only at a base settlement but also during far-ranging hunting trips.

The Final Palaeolithic technology, combined with the purpose of flint forms used, differs quite

significantly from that of the earlier communities. The dualism in flint nodule reduction, which was associated with the processing of cores of different parameters, disappears. Due to the number of sources and data available, this phenomenon is adequately illustrated on the example of the Swiderian groups. A strong commitment to the preparation of suitable blade blanks through intensive trimming of flint nodules as well as numerous treatments preparing the point of impact and correcting the morphology of the cores is evident. Moreover, there is a clear selectivity visible in choosing debitage products for the manufacture of formal tools designed for planned activities, such as end scrapers or burins. At the same time, as was the case with the preparation of blanks intended for shouldered points among the Gravettian groups or even the Levallois points, a preference can be observed. It is connected with the production of blades used to make tanged points, functionally associated with hunting activities. Both these approaches – related to selectivity and preference – resulted in a large amount of material remaining in the production areas, which was not used further down the *chaîne opératoire*.

A different technological approach is evident among the Mesolithic groups. The early Holocene communities were oriented towards exploitation of a large number of blanks produced, both of blade and flake type. Based on the studies of macrolithic specimens, such as end scrapers, burins, truncated points, perforators, tranchet axes and picks, it should be concluded that the selection of blanks for the manufacture of these formal tools was not at a particularly high level. Probably no significant attention was paid to this aspect. In many cases, it might seem that these are *ad hoc* tools. Contrastingly, a significant commitment to the preparation of blanks for making hunting weapon components is evident. Small bladelets were used to make microlithics, initially removed with the use of mineral hammers, and in the Late Mesolithic – by applying new solutions, i.e. the pressure technique and indirect percussion. It should be noted that these two last techniques are to a large extent applied to blanks intended for hunting weapons. This attachment to the quality of arrowheads and side insets is a point of commonality with the Palaeolithic groups. The noticeable implementation of technological innovations in flint knapping is strictly related to the changes and improvements in hunting equipment. It can be presumed that regularity, appropriate slenderness and width of the bladelets that were planned for use as arrow insets were extremely important. It should be remembered that, along with the aforementioned techniques, i.e. pressure flaking and indirect percussion, the number and complexity of tools used for the processing of raw flint material increases. We are also dealing with an increased number of elements of the *chaîne opératoire*, rules of

flint nodule reduction, as well as standardisation of produced bladelets. What is more, there is a strong interdependence between the technique of preparing bladelets and their subsequent shaping and perfecting their final form, the best example of which are trapezes, made exclusively from blanks removed by using the indirect percussion technique.

An extremely interesting issue is the one concerning the use of flint products by the oldest groups inhabiting the Polish territory. Unfortunately, due to the lack of data from use-wear studies, we cannot infer the real function of Lower Palaeolithic tools. It seems that the previous functional interpretations, based on the results of microscopic analyses, apply to the tools of the Neanderthal and *Homo sapiens* communities. It is known that the Middle Palaeolithic groups quite often used flint specimens as multifunctional tools. This observation is important in the context of a comparison with the tool use among the *Homo sapiens* communities. It can be concluded that the Neanderthal tool types did not usually involve strict specialisation. Products of varied morphology and parameters – flakes, formal denticulate and notched tools, side scrapers, knives and hand axes – were used in works related to cutting, processing of animal carcasses, both soft and hard tissue, sometimes also for woodworking. A variety of actions were performed – cutting, scraping, planing, sawing and carving. The activities undertaken were certainly connected not only with the preparation of food but also making objects of everyday use, clothes or elements of dwellings. It is worth noting that a greater standardisation is noticeable in certain tools, which should be attributed to their use in performing a specific activity. It may be assumed that in such cases the function of the item in question was planned in advance. This applies to products the manufacture of which was not only planned and executed according to specific rules and designs but also more time-consuming. These are mainly bifacial knives and hand axes used for cutting animal carcasses. Moreover, the seeds of hunting weapon specialisation can be observed, which is evident in the use of Levallois points. Unfortunately, it was not possible to identify strike-a-lights in the lithic material examined. Other archaeological sources testify that fire lighting was already known to the Neanderthal communities, so it would be worth focusing the attention in future functional studies on the possibility of identifying flint specimens that served such a function.

It should be assumed that the changes in the preparation and use of flint tools were also influenced by the morphological differences between the Neanderthal and *Homo sapiens* species, the hand structure in particular. The published results of the studies of the morphology of Neanderthal thumbs

indicate that they found it easier to handle more massive tools rather than small, complex specimens. This may be a clue as to why the Middle Palaeolithic groups preferred using tools in the form of massive flakes, side scrapers, knives and hand axes to carry out their daily activities.

The small amount of use-wear data related to the products of groups with leafpoints – of the Jerzmanowician culture, in the case of the work presented – certainly does not show the full range of activities undertaken by the communities in question during the transition period between the Middle and Upper Palaeolithic. We know that these groups used leafpoint type tools for hunting game and processing animal carcasses. The specimens and their manner of use are more similar to the approach represented by the Middle Palaeolithic rather than Upper Palaeolithic communities. Unfortunately, due to the lack of data from the areas of interest, further questions concerning the use of tools other than leafpoints cannot be answered at this stage of research.

The arrival of the new human species – *Homo sapiens* – brings about radical changes in the strategies of use of flint specimens. Tools of varying morphology, often designed for specific tasks, are shaped from mass-produced blades and bladelets. Noticeable is the significant specialisation of particular types of artefacts – end scrapers, burins, backed points, perforators, truncated pieces, retouched blades – as well as of specimens devoid of additional intentional retouch. Therefore, the reason why blade tools became widespread among the Upper Palaeolithic groups can be presumed. Referring to the experiences gathered in the course of making and using various objects made of flint as well as hafts made of wood, antler, bone, etc., the ease and speed of forming blade tools is noticeable. On the other hand, the raw material preparation, initial processing and final shaping of objects made of organic raw materials (handles, arrow shafts, spears) are more time- and labour-intensive and require more complex logistics. Blade forms could be quickly and efficiently replaced when the tool became less functional through damage to the working part, such as edge chipping or blunting. Various types of formal tools (end scrapers, burins, perforators) could, of course, be repeatedly retouched, shortening the specimen up until the point when the size of the tool made it unsuitable for further use. At the same time, the forms in the case of which an unretouched, naturally sharp edge of a blade or flake was used were best replaced once they wore out. Merely retouching the working part would not give as sharp an edge as when the blade or flake was freshly detached. This is particularly important in the case of tools designed for cutting different types of raw materials. Perhaps the absence of intensive use-wear on the flint specimens associated with the Palaeolithic and Mesolithic communities should be attributed

to such a care for a continuous effectiveness of the tools. As a result of the frequent tool replacement or retouching of the working parts, macro- and microscopically observed use-wear is indistinctive and poorly developed. The above observations provide arguments in the discussion on the popularity and spread of composite tools in the Upper Palaeolithic and subsequent periods. Hafts, which required considerable effort to make, might have been used over a long time. The flint piece itself, on the other hand, could be made quickly. Setting the tool in a handle made the work undertaken more ergonomic, and the planned effect of the activity could be achieved in a shorter amount of time.

Among the first *Homo sapiens* groups associated with the Aurignacian industry, a strong trend related to the above-described phenomenon of blade tool usage has been observed. In contrast, no clear relationship between the form type and its actual use has been noticed. It should be added that elements of the technological *chaîne opératoire* intermingle with the functional one, and this phenomenon is evident exclusively among the Aurignacian groups. Flint industries of the subsequent Palaeolithic and Mesolithic communities are characterised by the presence of a boundary between the manufacturing and utilitarian aspects. The first *Homo sapiens* groups utilise forms used for the production of small bladelets also as tools of everyday use – these are burin cores and end scraper cores. This is not a rule, as according to the data presented in the earlier part of this publication nucleiform specimens were repeatedly used exclusively to remove blanks (for example, the artefacts from Góra Puławska). An important observation concerns the use of bladelets, sometimes also intentionally retouched. This is the only distinct functional group. Small bladelets were used mainly as components of hunting weapons, as suggested by the data obtained outside of the Polish lands. Other formal tools, unretouched debitage products, were used for processing animal carcasses, skin, bone, antler. In isolated cases, they were used in wood-working. Among the material recovered from Polish sites, neither tools for working herbaceous plants nor strike-a-lights have been identified; we also do not have definite data concerning the processing of mineral raw material. That flint objects might have been used in such a manner is indicated by the data gathered from Aurignacian inventories outside the territory of Poland (cf. literature in Chapter IV). It is possible that the absence of the aforementioned macro- and microlithic functional tools, as well as the lack of observations regarding clear relationships between different typological categories result from the small number of use-wear analyses carried out on the Aurignacian material.

A larger pool of data is available in relation to the Gravettian communities. There is a visible

continuation of widespread everyday use of tools shaped from flint blades and bladelets, which often constituted elements of composite tools. Similarly to the Aurignacian groups, there are clear preferences in respect to tools used during hunting activities. Both small backed forms as well as shouldered points were used for this purpose, which may correlate with two types of hunting weapons. Retouched flint specimens (burins, retouched blades, backed points) are commonly used to cut animal carcasses. In turn, end scrapers and burins were utilised at the later stages of the work, e.g. for scraping and cutting the hide. Burins were equally frequently used to shape bones and antlers, probably in order to create objects for everyday use, such as hafts and blades. As for this type of tools, both the parts strengthened as a result of removing burin spalls, as well as the longer side edges were utilised. In the case of the material from Polish inventories, it has not heretofore been possible to separate a distinct group of functional tools designed for working wood and herbaceous plants. Only isolated cases of artefacts used for woodworking have been recorded. More examples of this kind of tools are known from other areas of Europe, where also an increase in the use of unretouched blades and flakes to perform actions related to the processing of animal carcasses as well as the above-mentioned wood and herbaceous plants has been observed. Regarding the territory of Poland, the use of unretouched blades and examples of working herbaceous plants have been recorded among the Epigravettian groups.

Thanks to the significant number of use-wear studies conducted, clear interdependencies resulting from the use of specific tool types among the Magdalenian communities are evident. A distinct separation between the *chaîne opératoire* related to hunting weapons and the one concerning other tools of daily use is also noticeable. Associated with hunting activities is the tradition, which first appeared in the Aurignacian and continued in the Gravettian, of using small insets. Analogously to the earlier groups, these were additionally retouched bladelets, shaped to fit the hafts, which were probably fixed in point grooves, a few on one or both sides. The trend of producing individual categories of macrolithic tools also continues.

The use of formal end scrapers is clearly connected to hide scraping – removing the remains of tendons, meat, membranes. Specimens with end scraper fronts served this purpose already among the Aurignacian and Gravettian groups, but it was not until the Magdalenian that this function became clearly marked. The activities described above resulted mainly from the need to make clothes, as well as elements of everyday equipment or dwellings. For the actions involved in the shaping of objects from antlers and bones, the Magdalenian communities, just like the earlier Upper Palaeolithic ones, commonly used burins. Thanks to the strengthening of the working

part by removing burin spalls, it was possible to use such tools to efficiently carve, grind and scrape hard raw material at a correct angle, without the risk of frequent chipping of the working edge (as it happens in the case of thin edges). Obviously, other types of tools were also used to work antler or bone, including perforators, borers, blades, which was conditioned by the need to perform other actions, such as making holes. It should be added that boring, or making holes in bone or antler, was already known among the earlier Upper Palaeolithic groups, albeit not the ones inhabiting the Polish lands, where some evidence can be found only in the Magdalenian group inventories. A more varied functional category, just as it was in the case of the previous Upper Palaeolithic groups, consists of tools used for cutting animal carcasses. This group includes retouched and plain blades, without additional shaping, as well as more formal types – end scrapers, burins, perforators. This diversity may partially result from the different actions performed in the course of butchering – cutting, sawing, scraping, splitting, smashing. Similarly to the earlier Upper Palaeolithic periods, use-wear related to the processing of wood and herbaceous plants has been recorded on flint specimens in isolated cases only, probably due to the climate of that time and the moment the human groups in question settled.

Referring to the use-wear data presented, it should be assumed that hunting played a major role in the life of the Upper Palaeolithic communities, and most of the daily activities were devoted to the processing of animal raw material. In contrast, the use of plant sources played a marginal role. In addition to the works related to hunting and gathering, the traces recorded on flint tools reflect activities dedicated to the processing of mineral resources, including ochre and rocks, as well as to lighting fires with the help of pyrite or marcasite.

During the Final Palaeolithic, the type of tools that were used for hunting changes. Backed points were primarily used during the warm Allerød period, while tanged points were dominant in the last Dryas (this does not apply only to the Swiderian culture, which is characterised in detail in this publication; tanged point forms as elements of hunting weapons were also used by the Bromme or Ahrensburgian). More attention was paid to the shaping of the afore-mentioned artefacts than other tool forms. They were made from carefully selected, slender blades. Flint projectiles were elements of specialised hunting weapons and, on the basis of use-wear studies, it can be concluded that they were mounted individually at the tips of the shafts, while backed points were sometimes also set in side grooves.

In many cases, the ways in which flint tools were used by the Arched-Backed point groups differed from the approach of the groups with tanged points (in this case, the Swiderian ones). One clear difference

concerns the intensity of tool use. In the case of the former group, characteristic is the durability and long-term use of flint specimens, reflected in the ample, distinctive use-wear as well as traces left after repairs. No significant wastefulness of flint material has been recorded; instead, care and planned use of a significant number of products has been observed. This type of approach may result from a less mobile lifestyle or limited access to raw material deposits. On the other hand, as highlighted in the earlier part of this study, the Swiderian communities commonly made no use of a significant number of produced blanks, which, due to their morphology or parameters, could have been successfully used to perform everyday activities. This is probably related to their mode of existence – Swiderian communities were more mobile, and thus more knowledgeable about raw material deposits, even those located far away, which included knowledge of flint outcrops. They also typically took care to obtain flint raw material and tools of good quality.

During the Final Palaeolithic, flint tools were still used primarily in the processing of animal carcasses and individual animal parts. Among the groups with Arched-Backed points, tools used to cut animal carcasses are characterised by a varied morphology and, importantly, the presence of one longer sharp edge – these are formal backed points, truncated pieces, retouched blades and flakes. Wear attributed to the processing of hides using flint end scrapers has frequently been recorded. There is also a noticeable trend towards the use of formal burins, end scrapers and other types of specimens, including blades and flakes, to manufacture bone and antler objects. The Swiderian groups are generally characterised by a clear specialisation in terms of hide processing, usually cleaned, as was the case with earlier communities, with formal end scrapers. Truncated pieces, burins, blades and, rarely, other types of tools were used to cut animal carcasses. As regards the processing of antlers and bones, still dominant is the burin group, used for grinding, scraping and carving. This functional group also includes perforators, scrapers and blades. Moreover, it is worth noting that tools of different morphology and parameters used during the processing of wood and herbaceous plants also appear, which is a natural consequence of the presence of an enriched plant cover in the environs of the communities of the Allerød period. It is also worth noting that isolated tools of the functional group in question have been recorded among the Swiderian groups. As evidenced in the inventories of the earlier Upper Palaeolithic communities, flint artefacts were occasionally used for working mineral raw material in the Final Palaeolithic as well, which was probably related to lighting fires, although it is possible that they were also used for processing ochre or making some objects out of stone.

With the onset of the Holocene, there is a change in the ways in which flint tools are used. It should be emphasised that despite the significant change in the morphology and parameters of the specimens used as components of hunting weapons, such tools still receive considerable attention. Once more, a certain split can be noted in the lithic industry, with the formation of arrowheads and side insets constituting the dominant element, whereas tools used for other purposes may have been *ad hoc* in nature. In regard to hunting weapons, the Mesolithic communities followed rigid designs. Flint elements had a pre-planned form – these were triangles, backed or truncated points, retouched insets, either placed singly at the tip or several together, then also on the side, in a groove. Backed points and trapezes were intended for arrowheads rather than side insets. Over time, more slender and thin forms of geometric insets began to be preferred, with the exception of trapezes, whose desirable morphology called for a considerable width of the specimens and regular cutting edge at the same time. It can be concluded that the tools constituting part of hunting equipment were meticulously prepared, and it was for the formation of tools of this type that new knapping solutions were sought after. Other activities involved a different kind of planning in regard to the use of flint tools. A wide variety of flint tools was utilised in cutting carcasses of hunted animals – from ordinary blades and flakes, through formal macrolithic tools, such as truncated pieces, end scrapers or scrapers, to isolated cases of microlithic geometric tools. Formal end scrapers and scrapers were generally used for hide scraping. The latter are recorded among various functional types and are a common tool type used in the Mesolithic – an *ad hoc* and multifunctional form that provides a good example of the approach to flint tool use of the communities of that time. Likewise, when making objects of everyday use from hard organic raw materials, such as bone or antler, not much attention was paid to the morphology of the forms (these were both scrapers and unretouched debitage products, as well as formal burins, perforators, truncated pieces, end scrapers). Certain interdependencies between the workmanship and use can be seen only among the group of picks, used to make hollows and holes, and tranchet axes, utilised to split raw material. In contrast to the Palaeolithic communities, the early Holocene groups often used flint tools for wood and plant processing. Their number increases with the successive stages of the Mesolithic. All known forms of flint tools – both formal macrolithic tools and unretouched specimens – were used to process plant material. The marked increase in the interest in processing plants and wood is primarily due to the opportunities that arose with the changes in the natural environment. They also led to a greater importance of fishing. Unfortunately, this is not reflected

in the results of use-wear analyses, which may be due to the problems in distinguishing this functional group type. It is also possible that most of the actions related to fishing and fish processing were performed with tools made of other raw materials, e.g. bone or wood. The range of activities undertaken with the help of flint tools probably was even wider, as indicated, among other things, by isolated tools the purpose of which was identified as working amber or lighting fires.

From the conclusions presented above, it follows that radical changes occur between the Middle and Upper Palaeolithic. Differences in the flint knapping strategies are clearly visible between the Neanderthals, who usually treated tools as multifunctional forms that could be reshaped many times, and the *Homo sapiens*, who selected individual forms from mass-produced blanks and used them for specific purposes. It is evident that certain forms of tools did not change their predominant function throughout the entire period of their occurrence, as is the case with formal end scrapers, used primarily for hide scraping, or burins, used mainly for working – primarily scrap-

ing and carving – hard organic materials, such as bone and antler. Also noteworthy is the importance of and special attention paid to the formation of elements of hunting weapons, which defined and in a way distinguished particular industries. Recorded among the Palaeolithic and Mesolithic communities are also tools which could have belonged to various functional groups, such as blades, sometimes additionally retouched.

Summarising the data on the use of flint tools by the Palaeolithic and Mesolithic groups, it can be concluded that the information provided shows changing preferences in the use of specific materials, reflects the emergence of new technologies, subsequent inventions, and solutions associated with everyday existence. It is also possible to obtain information on organic and inorganic raw materials that have not been preserved at the archaeological sites presented. Environmental changes in the world of plants and animals, as well as dietary preferences are also indirectly revealed.