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RYDNO
A FINAL PALEOLITHIC OCHRE MINING COMPLEX

Rydno is a unique, Final Paleolithic hematite mine located on the north-eastern footslopes of the Holy Cross Mountains (Góry Świętokrzyskie) in the Kamienna Valley. Intensive excavations of the mine as well as at numerous surrounding sites yield data relevant to various problems concerning social structures, economy, ownership status, etc. of the small societies of the Final Paleolithic.

INTRODUCTION

Perhaps, Rydno is the most vaguely known complex of Stone Age sites in Europe, yet its importance for the understanding of the functioning and existence of prehistoric societies is enormous. In contrast to the importance of this unique phenomenon, and in spite of immense field research programs, very little has been published which will give an idea about the problems and materials involved. There is only one article of a few pages published by Stefan Krukowski (1961), informing about the existence of the complex, and a few mentions in more general works (e.g., Schild 1975, 325; J. K. Kozłowski, S. K. Kozłowski 1975, 61; 1977, 207). Also, the existing technical reports on excavations of some of the sites belonging to this complex state this fact usually without further elaboration or interpretation of the place of the published particular occurrence within the complex (J. K. Kozłowski 1963; Ginter 1965; Schild 1965; 1967; Schild, Marczak, Królik 1975).

What, then, is Rydno a name that does not even exist on any topographic maps of Poland? Why has it deserved an extensive financing of numerous field seasons and the engagement of many prehistorians?

In short, Rydno is a prehistoric ochre mine surrounded by at least several dozens of Terminal Paleolithic, Mesolithic, Neolithic and Bronze Age sites located on the grounds of three villages: Nowy Młyn, Łyżwy and Grzybowa Góra, all Commune of Mirzec, Voievodedom of Kielce. The name is artificial, given by S. Krukowski and formed on the base of a core *rudy*, *rydz* — red, the color of the earth at the place of mine and at some sites near the mine.

The mine and the surrounding sites occur within an area estimated at ca. 3 km^2. The number of occupational units belonging to this complex is unknown. Several of them were excavated or collected from deflational surface. Yet, the present authors are not able to give the number of these which were recovered by two major collectors and excavators, L. Sawicki and S. Krukowski. The number of these recorded during excavations organized by the authors, or in which they took some part, as well as the published or mentioned by the others, seem to be around 50 units, mostly of Terminal Paleolithic age. Since the materials recovered during most of the field campaigns in Rydno are not accessible, or have been destroyed during the war, the conservative estimation of the total number of recovered prehistoric loci in the area should oscillate around one hundred. If so, the complex of Rydno is probably the most dense cluster of Paleolithic occurrences ever discovered. This fact alone should generate a particular attention and arise special interest in this unique phenomenon.

SHORT HISTORY OF RESEARCHES AS RECONSTRUCTED FROM PUBLICATIONS AND INTERVIEWS

It seems that Ludwik Sawicki was the first prehistorian who discovered Stone Age sites eroding from the sandy terrace of the Kamienna River near the villages of Nowy Młyn and Grzybowa Góra. The sites were entirely composed of lithic material and occurred in deflational basins on the surface of barren sands and gravels. In the years of 1923 to 1925, the surface sites were collected by L. Sawicki and his wife Irena (cf. Sawicki 1958, 60).

A few stratigraphic trenches were also made during these field seasons. Judging from footnotes and some other mentions, there were three major sites at Nowy Młyn (I–III) and one at Grzybowa Góra Ia to Ic (Sawicki 1958, 60). It is certain that each of these sites, or major areas, contained several "nests", a term used in those days to design flint concentrations. In the writings of Sawicki, one can find indications that some of the major areas must have contained up to at least 10 concentrations, e.g., Nowy Młyn Ia, Nest 10 (Sawicki 1935, 22, Pl. XX 22).

Yes indeed, the party of L. Sawicki must have found the areas rich in concentrations of lithic artifacts. Today, Mrs Miernik who lodged the Sawickis in her house at Nowy Młyn, remembers that during one of these three years of collecting, perhaps in 1924, the wooden boxes containing the collections filled a horse driven wagon during transportation to the nearest train station in Skarżysko-Kamienna.

The location of sites designed by Sawicki as Nowy Młyn I–III and Grzybowa Góra Ia-Ic are not totally identified. However, some of the living inhabitants of the village remember that the Sawickis concentrated their activity in two areas: the first, at Nowy Młyn along the northeastern side of the hill, at the edge of the "Babica" bog; an the second, at Grzybowa Góra, on the deflated surface of sandy terrace at the place named "Nad Piaską" (on Piaska source). Both of these areas are today completely deflated, barren or covered by small pine bushes without traces of prehistoric occupations.

In spite of the rich collections assembled by the party of Sawicki, only 46 drawings of tools have been published (Sawicki 1935, Pls XX, XXI), as well as a few cross-sections of two small stratigraphic pits (Sawicki 1958, 60 f.). There are still a few small cardboard boxes of the debitage from Nowy Młyn remaining in the collections of the Stone Age Department of the Institute of the History of Material Culture, perhaps containing a few hundred pieces. This collection is all what remains of these huge materials destroyed by German bombs during the siege of Warsaw in September, 1939. It cannot be excluded, however, that some additional information as to the exact locations of work, number of concentrations and their content may be preserved in private archives of Sawicki, still unregistered and not totally available.

After the field campaigns of L. Sawicki, the area seemed to have been unvisited until 1937. During this year, S. Krukowski dug out at least four lithic concentrations at Grzybowa Góra of which only Concentration IV/1937 is shortly described in his synthesis of Polish Paleolithic (Krukowski 1939, 93 f.). According to the information given by S. Krukowski to one of the present authors (R. Schild), Concentration (*Kshemenitsa*) IV occurred on partially deflated surface of the Kamienna terrace (cf. Fig. 2 for supposed location). The materials from this concentration are preserved in the collections of the State Archaeological Museum in Warsaw. There is no information concerning the remaining assemblages excavated during the 1937 field season.

Seemingly during the thirties, a local policeman and amateur of prehistory found one of the numerous flint caches associated with the Rydno complex. The cache, known as Grzybowa Góra, Cache II of Okrutny has been published by Krukowski (1939, 108, Pls 25–33). It contained over 20 Masovian pre-cores together with a few other pieces.

The pre-World War II field activity in Rydno was stopped by the outbreak of war. However, seemingly already in 1943 and 1944 S. Krukowski moved to the area and spent some time collecting and prospecting the sites. Until then, the real association of all these sites was unknown. All of them were treated as regular, Terminal Paleolithic occurrences on river terraces or dunes, not different from the others of similar age.

After the war, Krukowski began a series of field campaigns which lasted until 1960. Although the results of most of these field seasons are entirely unknown, the latest ones have some records available because of the participation of the young prehistorians and/or students. Thus, between 1955 and 1960 there were five field seasons: in 1955, 1956, 1957, 1959 and 1960. During each of these campaigns there were at least four cuts opened; however the longest season, in 1959, resulted in the excavations of 11 cuts (Rydno I/59 to XI/59) of which some measured more than 200 m^2.

It is certain that during this time, and most probably already in the forties, Krukowski discovered the association of the lithic concentrations with the mine. In spite of the fact that the mine was never excavated by this researcher, Krukowski determined its location and learned that the ochre occurred in the form of hematite pebbles and gravels in a lower Triassic conglomerate.

After the season of 1960, a long, and unfortunate, pause in field activities stopped the interest in the prehistoric complex of Rydno. An accidental visit to the site, in 1975, of the excursion of the participants of a flint mining symposium in Cracow, revealed that the complex was being destroyed by industrial exploitation of sand in two large quarries and several small ones. It was quite clear that only a fast and strong action could save some portions of the complex and salvage some of its sites.

During the following year, an expedition of the Department of Stone Age of the Institute of the History of Material Culture, led by the senior author, began systematic field seasons which are still being continued. Thus, until now there were four large field campaigns, in 1976, 1977, 1978 and 1979. In 1977, another expedition from the Institute of Archaeology of Warsaw University led by Stefan K. Kozłowski joined in this important salvage enterprise. Since 1979, two consecutive field campaigns, in 1980 and 1981, were organized at Rydno.

THE GEOMORPHOLOGY AND GEOLOGY

The Rydno complex lies in the Northern Foothills of the Holy Cross Mountains (Góry Świętokrzyskie), on the upper Kamienna River which flows along northern slopes of the Suchedniów Plateau (for regional terminology see Gilewska 1972, 300). Today, the river is cut into Triassic and Liassic sandstones as well as fluvioglacial sands and gravels (Fig. 1), forming both banks of the valley.

The geomorphology of this, upper section of the Kamienna River is highly influenced by the Radomka Glacistadial (G III max.) of the Central Polish Glaciation, a stadial preceding Warta advance in its classical understanding (Różycki 1972, after Werth). The area was invaded by the Radomka glacier tongue (Lamparski 1970; Różycki 1972, 179) entering the Kamienna Valley near the city of Skarżysko-Kamienna. During this time the river served as the marginal stream valley carrying waters toward the east, both from the Końskie tongue and the western section of the Radomka tongue (Różycki 1972, 178). Another marginal valley joined the Kamienna River from the north-west at the villages of Posadaj, Łyżwy nad Nowy Młyn (Fig. 1 and 2). In the result, the Kamienna Valley was filled with fluvioglacial alluviae whose remains form several benches along its high banks (Samsonowicz 1934; Różycki 1972, 178) and cover the bottom of the north-western stream valley.

More detailed look at the morphology of the area shows the Triassic sandstones of the northern slope of Suchedniów Plateau forming southern bank of the valley (Fig. 3). These sandstones are covered by usually thin remains of sands and gravels associated with Cracow Glaciation (G II of Różycki). An isolated, Triassic hill cut off by the river and biforking marginal valley, stands up in the centre (Fig. 2) of the area. The villages of Łyżwy and Nowy Młyn are located on its southern, toward the river, slope. From the west, the hill is cut off by the valley of Oleśnica River which flows into the Kamienna through the south-western branch of the fork of the marginal valley. On the north and north-west, is the northern branch of the fork, joining the valley at the eastern tip of the Łyżwy—Nowy Młyn hill, near the water mill

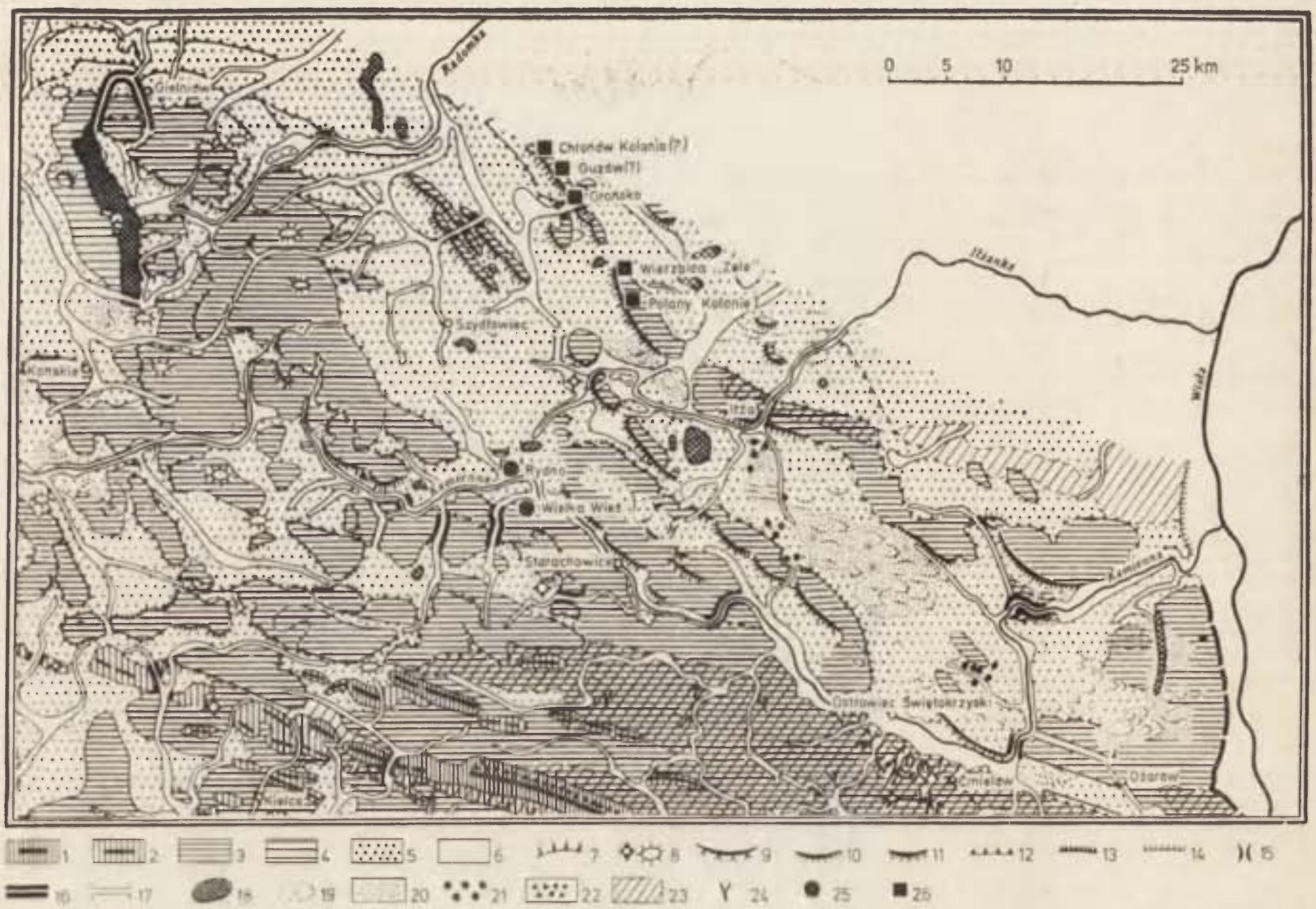


Fig. 1. General morphological sketch of the north-eastern footslopes of the Holy Cross Mountains. After Gilewska (1972)

1 — high, hard rock ridges; *2* — low, hard rock ridges; *3* — plateaus, ridges and watersheds; *4* — tablelands; *5* — uplands and higher river terraces; *6* — valley bottoms; *7* — tectonic steps; *8* — relict mountains and hills; *9* — gypsum cuestas; *10* — limestone cuestas; *11* — sandstone cuestas; *12* — denudational steps; *13* — denudational scarps; *14* — erosional scarps; *15* — saddles; *16* — gorges; *17* — ice stream valleys; *18* — glacial and fluvioglacial relict hills and ridges; *19* — dunes; *20* — dune fields; *21* — karstic sink holes; *22* — rocky fields; *23* — loess; *24* — loess ravines; *25* — Final Paleolithic hematite mines; *26* — Final Paleolithic flint mines (quarries)

Fig. 2. Sketch map showing some sites and location of mine. Roads and buildings omitted

1 — Rydno IX/59; *2* — I–III/76, I–III/77, V/77, III/78; *3* — I/78; *4* — Rydno—Mine III/78; *5* — Rydno V/57; *6* — VII/59; *7* — IV/59; *8* — XI/59; *9* — II/56; *10* — VIII/57; *11* — II/57; *12* — I/57; *13*— III/57; *14* — IV/57; *15* — XII/59; *16* — II/59; *17* — X/59 and IV/60; *18* — VI/59; *19* — VIII/59; *20* — XIII/59; *21* — I/80; M — Magdalenian; B — Bromme—Segebro; ▲, assemblages of Arch Backed Piece complex; ■, Masovian assemblages; X — Mesolithic; N — Neolithic; black patch, hematite quarry; T — Triassic hills; JL — Jurassic (Liassic) hills; hachured sections, areas worked by Sawicki and Krukowski (approximate)

of Piaska (cf. Fig. 2). The bottom of the northern branch is waterlogged and filled with a thin bed of peat-bog.

The top of the Nowy Młyn—Łyżwy hill shows the outcropping sandstones and clays while its slopes are covered by the thickening slope sediments containing redeposited fluvioglacial sands and gravels, as well as wind-facetted boulders and pebbles of local sandstones.

The two branches of the ice marginal stream valley are filled with fluvioglacial sands, gravels and boulders. The morphology of their floors has been largely modified by the small Oleśnica River forming its own terraces, as well as by the streams flowing through the northern branch.

The left bank of the Kamienna Valley is formed by Liassic sandstones and silts in most areas covered by various fluvioglacial deposits, today heavily eroded and altered. A few sand and gravel benches, seen at various elevations, are the remnants of fluvioglacial terraces partially masked by slope sediments of later age. These form most of the southern slopes of the Skarżysko--Kościelne hill.

The floor of the Kamienna Valley is occupied by sandy terraces of which the III Terrace (II above floodplain) is the most extensive one. It covers most of the floor and, toward the slopes of the valley, grades smoothly into gravely and sandy slope deposits. The floodplain is relatively large, cutting either into the III Terrace or the hills (cf. Fig. 2).

Almost all of the prehistoric sites surrounding the hematite mine are localized on the III Terrace of the Kamienna. Therefore, its geological characteristics and chronology are of importance. The surface of the terrace rises four to six metres above the floodplain and is closed by the contour lines of 222 m to 226 m above sea level. On the river side, the terrace is always well marked by more or less pronounced cliff-like sand walls. Toward the slopes of the valley, the level of the terrace rises gradually, grading into the lower portion of the slope sediments. Here, the boundary of the terrace is vague and never sharp, both from the litho-stratigraphic and morphological point of view.

Several trenches, natural cuts as well as quarry walls yielded sufficient material for the understanding of the litho-stratigraphy and dynamics of the terrace. Generally, the terrace is made up of two major sedimentary series of unequal thickness.

The Lower Series is formed by bedded sands with rare pebbles, gravels and occasional lenses of pea-gravel. The bedding is subhorizontal to cross-bedded, depending on the location of the section. Thus, the sections close to the slopes of the valley show more or less horizontal lamination of sands with a slight dip toward the center of the valley. Here too, the sands contain lenses of redeposited Liassic silts. Closer toward the center of the valley, the silt lenses disappear and the cross-bedding is seen quite often. The sands of the Lower Series grade up into sands and gravels of the Upper Series some 1.5 m to 1 m below the surface of the terrace. The total thickness of the Lower Series is unknown, base unexposed, although it is believed that it must be greater than 4 m.

Numerous cryoturbations mark the upper section of the Lower Series, especially at places where clayey and silty sediments occur in the sands. The structures are of various types and include cryptobatholithic structures, heaves, ice wedges as well as other forms.

Fig. 3. The Kamienna Valley seen from Grzybowa Góra, looking south-west. The mine indicated by black arrow

The Upper Series is thin, never thicker than 1.5 m. It is made up of a bed of gravel or rubble in a sand matrix resting conformably over the sands of Lower Series. The gravel-rubble bed is variable in thickness and its texture depends on the location. Thus, near the slopes of the valley the bed is almost entirely composed of angular to sub-angular rubble, obviously cryogenic in origin and redeposited down the slopes. Also, the sizes of the rubbles are large with some boulders reaching 30 cm to 40 cm in diameter.

Closer to the center of the valley the size of the rubble diminishes and the amount of rounded to sub-rounded pebbles increases, as well as the share of the sand matrix. Near the center, and far from the slopes, the gravel-rubble bed is made up of sub-rounded to rounded gravels and small pebbles. Both, the gravel and rubble are almost entirely composed of local sandstones with a small admixture of the erratic rocks.

The rubble-gravel bed grades up into medium and coarse-grained sands with gravel and occasional pebbles. The sands are loose and the bedding almost entirely destroyed by subsequent vegetation. The uppermost section of the Upper Series is included in a fully developed podzolic soil. Numerous cryoturbations involving pebble or gravel heaves are seen developed in the Upper Series.

All of the sites associated with the III Terrace of the Kamienna occur within the podzolic soil. The artifacts are vertically displaced within a horizon measuring 30 cm to 60 cm, with a clear majority included in the topmost part of the main illuvial horizon (B_2). No organic materials are preserved, except for occasional burnt scraps of bones.

The litho-stratigraphy of the III Kamienna Terrace indicates a specific, periglacial dynamics of its formation. It is obvious that the intense slope movement of the materials was the primary source of the deposit. Heavily overloaded river with reduced capacity and competence only partially participated in the distribution of the material, particularly at the foot of the slopes. The role of the alluvial transport increased toward the center of the valley where some sections with typical current bedding are observed.

The Upper Series with its rubble horizon, and the deposition over ice-filled periglacial structures, marks the peak of the competence of slope movement. It is obvious that the rubble are of cryogenic origin and were moved down the slopes by solifluction.

The dating of the III Terrace of the Kamienna River is based on its general situation in the sequence of events in the area, and most of all, on its relationship with the loess deposits in the region. Down the river from Rydno, near Wąchock, Brody Iłżeckie, Skarbka Dolna, etc., the III Terrace of the Kamienna is adjacent to the low plateau covered with a thick mantle of loess. Nowhere in this area the loess overlapes the terrace. Thus, the downcutting of the terrace must have been subsequent to the deposition of the youngest loess which is very well developed in this area. The sedimentation of the terrace, on the other hand, could have been either contemporaneous with the sedimentation of the youngest loess or subsequent to it, a problem deserving detailed stratigraphic studies in the areas where these two units occur together.

Taking into account the morphology and sedimentary dynamics of the III Terrace, it seems that this unit is chronologically identical with the so-called "terrace of high sanding-up" of W. Pożaryski in the Vistula Valley, near the mouth of Kamienna (cf. hypsometric data in Pożaryska 1948, 49, and Pożaryski 1952). According to Pożaryski, the sandy deposits of "high sanding-up" are developed on a redeposited upper Younger Loess and sometimes covered by a thin, slope loess, the so-called "superimposed loess" of Pożaryski (1952, 41).

Summarizing the circumstantial evidence available, it is quite possible that the III Terrace of the Kamienna was formed during the sedimentation of the upper Younger Loess (IIb) and was abandoned by the river after the termination of the deposition of the eolian loess. If so, the major horizon of cryoturbations and the formation of the rubble horizon at the contact of footslopes and the terrace might have been synchroneous with the level of intense cryotourbations formed in the upper Younger Loess. The latter is well seen just above the Komorniki Soil development, and is dated to an early maximum of the Baltic (Vistulian) Glaciation.

Again, the exact chronology of the end of loess sedimentation in Central Europe and Poland is not entirely clear. A few radiocarbon dates from Ságvar, in Hungary, and Dolní Věstonice, in Czechoslovakia, as well as the litho-stratigraphic sequence in Lower Saxony and Hesse, in Federal Germany, and in Belgium (cf. review of literature in Schild 1973) indicate the end of eolian loess deposition before Bölling, most probably in the Oldest Dryas (I). In Poland it is certain that the upper Younger Loess (IIb) was already deposited before Alleröd (cf. Mojski 1969; Jersak 1969a and 1969b; Maruszczak 1972). Recently, Jersak (1973, 110), basing on the relationship of the youngest loess with the eolian dunes which are relatively well dated, ends the deposition of loess in central and southern Poland before Bölling, in the Oldest Dryas. Such chronology would place the beginning of the downcutting of the III Terrace in the Bölling, a chronology agreeing with the presence of dunes on the surface of the III Terrace of the Kamienna.

THE MINE

On the north-eastern slope of the Łyżwy—Nowy Młyn hill (Figs 4 and 5) is an area of conspicuous red soil, seen on the ploughed fields and in small cuts as well as on ants' mounds in the small woods. The center of this red soil patch is the most intense in color and shows numerous quartz and hematite gravels on the surface. Broken pieces of red sandstones, fragments of grinding stones often semi-circular and shaped, together with darkly stained, chipped flint artifacts are seen in this area. Another, similar place occurs in the Kamienna Valley, near Wielka Wieś, some 5 km to the south-east of the mine of Rydno.

Seemingly already in the forties, Krukowski was linking the dark red area on the hill with prehistoric mining activities. This hypothesis was based on the occurrence of the ground hematite, hematite gravel and red quartz gravel in the prehistoric sites, so numerous in the area. In spite of this hypothesis, only in 1977 the first systematic excavation of the mine have begun. Since then, the trenching permitted the opening of more than 100 m² of the mining field and helped evaluate the extent of the mine as well as the general geologic situation of the ore (Fig. 6). Also, the geophysical sounding which began in 1979 gave first information as to the location of some of the exploitation pits.

A line of stratigraphic trenches together with shallow boring with hand augor yielded necessary data for stratigraphic placement of the ore (Fig. 5 and 6). The deep core drilling at Łyżwy, on the other hand, gives basic stratigraphic information concerning chronological and sedimentary identification of the hard rock sequence containing hematite gravel. A geophysical, stratigraphic sounding of the sediments is still not finished.

Under a thin layer of contemporaneous, ploughed humic horizon is an inconspicuous B horizon developed in red sands, containing numerous ventifacts, pebbles, gravel and boulders of local sandstone as well as erratic pebbles and boulders. The bed thickens downslope and becomes more sandy. Also here, the preserved lamination shows the bedding conformable to the slope. The bed contains a few lenses of clay, as well as yellow and reddish sand horizons derived from desintegrated sandstones. It is obvious that the sediment originated as a typical slope deposition, showing some evidence of gravitational sorting. The slope sands grade downslope into the sands, gravel and bulders of the III Terrace of the Kamienna or similar slope alluvial sediments.

The top of the hill at Nowy Młyn is covered by recent, arable soil developed in sands with local rubble, ventifacts and erratic gravel, pebbles and boulders, a degradational remnant of glacial deposits. Below, is a dark red, thin clay covering Variegated Sandstones of which the hill is made up. The sandstones are forming a weathered, rubble horizon near the top grading downward into bedded, cemented sandstones, interbedded with thin horizons of fine-grained sandstones, passing into mudstones. The bedding is not even, often disturbed, with the general dip toward the south. The sand grains, gravel and pebble are made up of quartz, sandstone, cherts, claystone chips as well as metamorphic and ignous chips. The cement is argillaceous or micaceous sericitic (Senkowiczowa 1973, 66). A relatively thick (over 1 m) lense or bed of a dark

Fig. 4. Northern slope of the Nowy Młyn—Łyżwy hill. Persons and the tent at the edge of the woods indicate eastern section of the mine, looking south-west

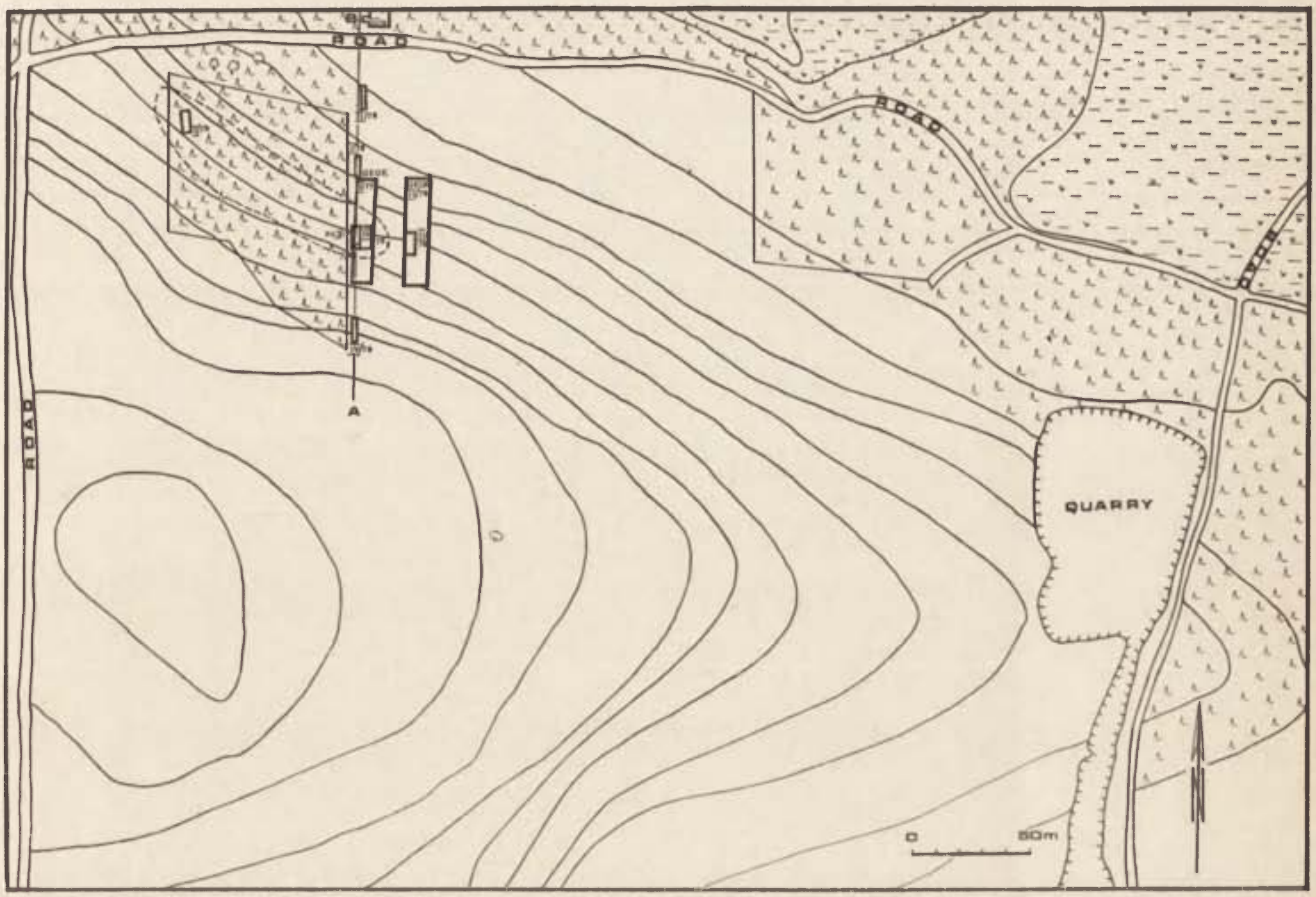


Fig. 5. Topographic sketch of the hematite mine and location of cuts and trenches. Dotted line indicates approximate limits of mining field; large rectangles show areas of geophysical sounding; general cross-section on Fig. 6 (A—B) overpasses, toward north, point B; contour intervals of 1 m

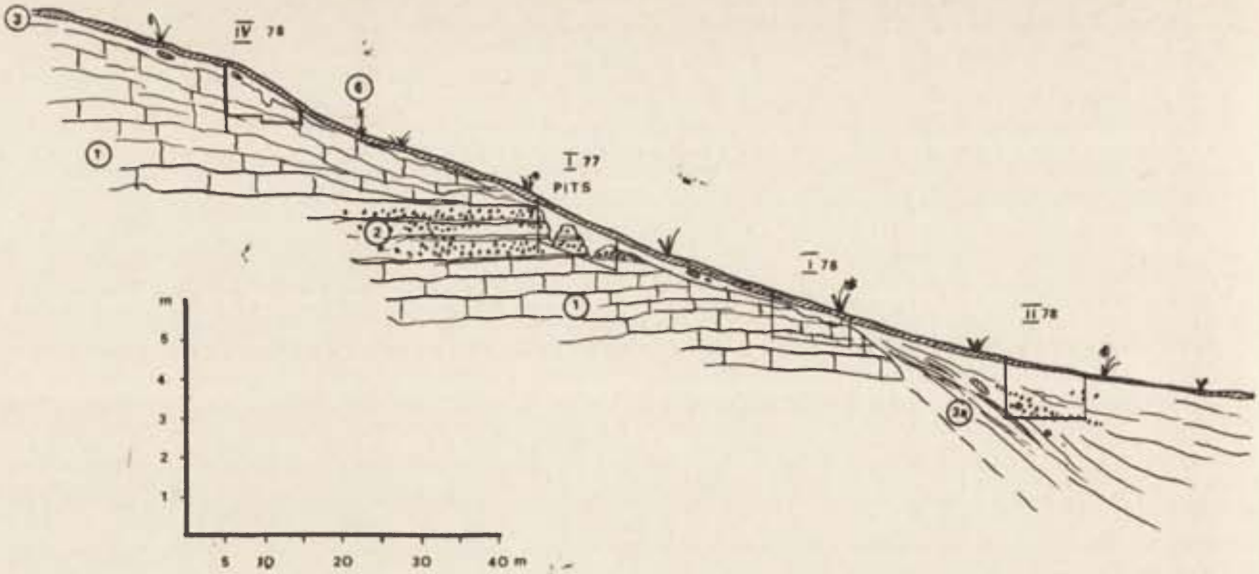


Fig. 6. General cross-section of the

1 — Variegated Sandstone, upper Roethian; *2* — conglomerate bed with hematite gravel and prehistoric pits; *3* — slope sediments; *3a* — slope sands, redeposited
5 — peat; *6* —

red conglomerate occurs within the sandstones. It is made up of quartz, hematite, chert, sandstone and ignous gravel with occasional pebbles in a dark red clayey matrix. This truncated bed of conglomerate is outcropping on the north-eastern slope of the hill, near the contour line of 235 m asl., in an area measuring some 100 m by 30 to 40 m (cf. Fig. 5). The conglomerate dips generally toward the south, conformable with the overlying and underlying Variegated Sandstones.

The Variegated Sandstones of the hill of Nowy Młyn and Łyżwy are known as Beds from Łyżwy and are understood as a local development of the upper Variegated Sandstones (Roethian) of lower Triassic, upper Roethian age (Senkowiczowa 1973, 66).

Two cuts at the south-eastern edge of the outcropping conglomerate, Cut I/1977 nad Cut III/1979, as well as one cut in the woods at its north-western edge, Cut I/1979 (cf. Fig. 5), disclosed several exploitational pits. Two of these were found in Cut I/1977, at least one in Cut I/1979, and several in a huge, complex dug-out area partially exposed in Cut III/1979.

All of the pits are sunk from the layer of slope sands, pass through the consolidated conglomerate and stop at the very top of the bedded Variegated Sandstone. In Cut I/1977, Pit 1 is oval in horizontal outlines measuring ca. 380 cm at the top (Figs 7–9). The walls are smooth, gently slopping toward the center. The deepest part descends 120 cm below the surface. The fill is composed of

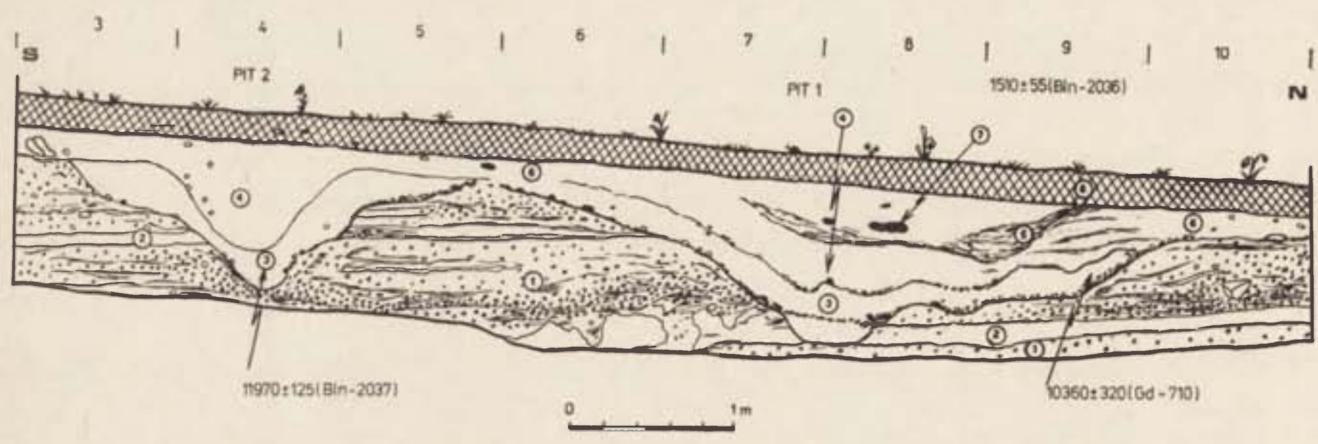


Fig. 7. Rydno—Mine, Cut I/77, west face along half squares C/3–10, dates in conventional radiocarbon years B. P.

— weathered conglomerate, weak red (7.5 R 4/2); *2* — fine-grained sandstone, reddish gray (5 R 5/1); *3* — first phase of pit filling, weak red (7.5 R 4/2); *4* — second phase of pit filling, grading into 6, weak red (10 R 4/3); *5* — windfall pit with charcoal; *6* — B horizon of soil developed in slope sediments, contact between *6* and *4* obliterated by root activity, weak red (10 R 4/4); *7* — place of charcoal sample Bln-2036; *8* — arable humic horizon, reddish brown (2.5 YR 4/4)

mine along the A–B line (Fig. 5)

sandstones, gravel and boulders, grading into 4; *4* – horizontally laminated alluvial and slope sands, crosses indicate position of artifacts at Rydno–Mine III/78; arable humic horizon

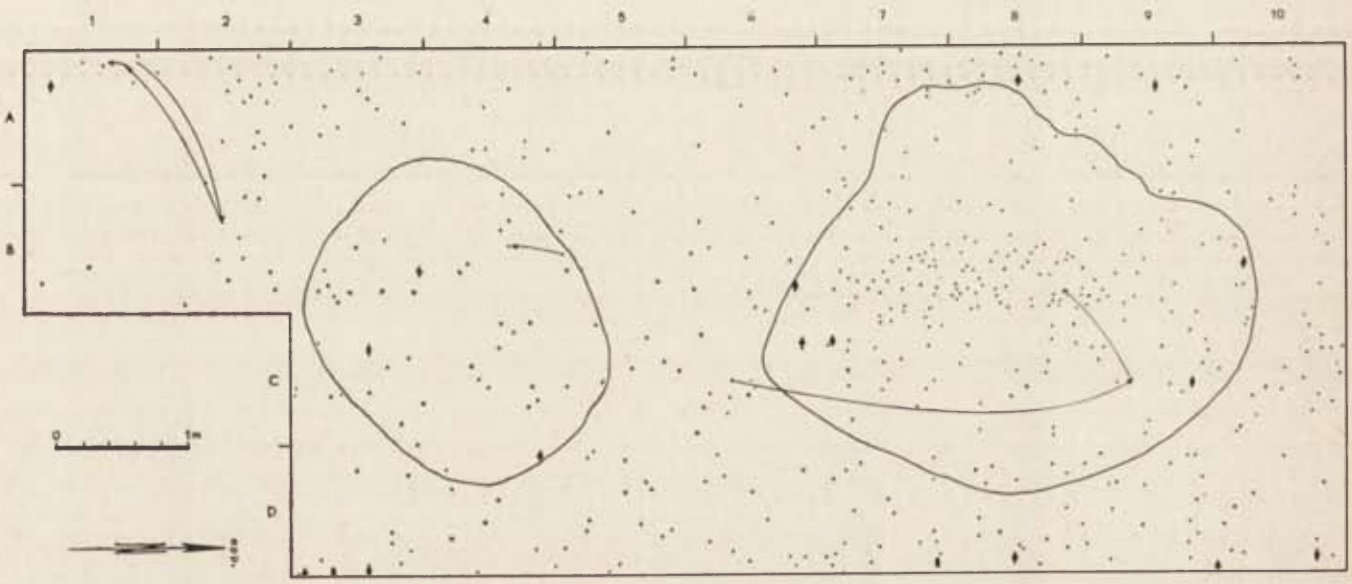


Fig. 8. Rydno-Mine, Cut I/77, outlines of pits and horizontal distribution of artifacts

Key as on Fig. 13

the dark, red, desintegrated conglomerate and clay, an obvious back dirt of the first phase of natural filling, and the red, sandy desintegrated conglomerate of the second phase of filling. A sample of charcoal heavily saturated with hematite from the base of the pit gave a date of 10,360$\pm$320 years B. P. (Gd-710). In the upper section, a lense of charcoal separates the uppermost portion of the fill from a more recent pit containing numerous pieces of charcoal. A sample of charcoal from a concentration at the lower portion of the subsequent pit gave a radiocarbon date of 1,510$\pm$55 years B. P. (Bln-2036)[1], indicating that the later pit most possibly originated as a hollow made by a windfallen tree (cf. Fig. 6).

Archaeological content of the exploitational pit and the artifacts in its immediate vicinity are unmistakably belonging to the classic Masovian, a fact well corroborat-

[1] The authors are most grateful to Dr. Quitta from the Institute of Old History and Archaeology of the DDR Academy of Sciences for arranging for two radiocarbon datings at the Radiometric Laboratory of the Institute.

Fig. 9. Rydno-Mine, Cut I/77, basal parts of the pits, Pit 2 on foreground, looking north-east

ed by the radiocarbon date. The assemblage is composed of several willow-leaf Masovian points, blade cores with opposed striking platforms showing traces of preparations, numerous elongated blades and a few other tools (cf. Plate I and Table V).

Pit 2, in Cut I/1977, is considerably smaller, almost round, measuring ca. 240 cm in its upper section. The walls are more steep, and the bottom is at 110 cm from the surface. The sediments of the fill are identical to those from Pit 2. A sample of isolated charcoal pieces from near the bottom of the pit gave a radiocarbon date of 11.970± 125 years B. P. (Bln-2037), indicating that the pit was exploited either during late Bölling or early Older Dryas.

The artifacts recovered from Pit 2 are not diagnostic and are rare. Except for the uppermost section of the pit, which was certainly subjected to contaminations caused by bioturbations, the fill contained a few blades and an

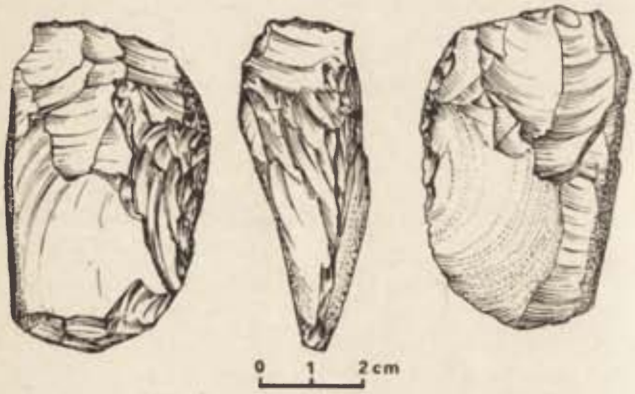


Fig. 10. Rydno—Mine, Cut I/77, single platform core from Pit 2

initially exploited, single platform blade core with prepared back (Fig. 10). The difficulties in establishing firm taxonomic association of the pit with an archaeological entity are, on the other hand, increased by the fact that there is no single assemblage in Poland dated to Older Dryas. Perhaps, the most likely candidate would be the Hamburgian, also seemingly occurring on the III Terace of the Kamienna in the Rydno complex, or some unknown Magdalenian groups. The first of these hypotheses seems to be more reliable.

In Cut I/1979, the excavations disclosed a fragment of a shallow basin cutting through the thin and poor layer of conglomerate, obviously representing the very bottom of the bed. The basin stops at the top of the Variegated Sandstone. The artifacts recovered from the basin are mostly composed of flakes. A single backed piece and the general technological characteristics indicate a strong association of this poor assemblage with the Arch Backed Piece complex, firmly dated in Poland to the second half of Alleröd and early Younger Dryas (Schild 1979).

In Cut III/1979, a fragment of a huge, multi-unit exploitation quarry was discovered, together with a small, isolated shallow pit (Fig. 11). A sample of charcoal from the latter gave a date of 9,840±370 years B. P. (Gd-719) indicating its Younger Dryas/Preboreal age. The large quarry extends beyond the edges of the cut. The exploitation clearly follows the bed of the conglomerate and descends toward the south reaching the depth of over 2 m at the southern wall of the cut. A geophysical sounding indicated that the deepest part of the quarry is perhaps located 1 m farther to the south. Patches of the left-

-over, basal portions of the conglomerate bed are seen at the bottom of the quarry. Numerous swales occur at the bottom of the quarry indicating individual exploitational units which are not recognizable higher up in the section. Four charcoal samples collected only from tight concentrations within the quarry gave the following ages: 10,710±250 years B. P. (Gd-714); 10,910±220 years B. P. (Gd-713); 11,940±300 years B. P. (Gd-724)[2] and 12,290±210 years B. P. (Gd-725). The date place the exploitation of the quarry at least in the Bölling sensu stricto (Gd-725 and Gd-724), late Alleröd (Gd-719) and an early Younger Dryas (Gd-714).

The artifacts recovered from the multi unit quarry in Cut III/1979 are certainly mixed, representing elements of at least the Arch Backed Piece complex and the Masovian (Pl. II). It is clear that the quarry in Cut III/1979 is formed by numerous intersecting pits of various Final Paleolithic ages and was used during some 2,000 years by various taxonomic entities.

Although the excavations of the mine at Nowy Młyn are not finished, some general observations could already be made. First of all, it seems that the exploitation units were located over most of the outcropping conglomerate bed. Because of the stratigraphic setting of the bed, the north-western portion of the field was less productive, containing only the poorer, basal portion of the conglomerate. It is quite possible, therefore, that most of the mining activity concentrated in the central and south-eastern portion of the field.

Preliminary computation of the yield obtained from 1 m³ indicate a figure of 1894g of gravel, pebble and grain of the hematite occurring in the conglomerate in the south-eastern section of the bed. The figures in the north-western section of the mine seem to be smaller. Both areas must have been worth excavating in spite of a rather poor yield. Thus, Pit 1 could not yield more than 7086.32 g of the hematite and Pit 2 gave some 5456.85 g of the ochre. The relatively low figures of yield suggest that perhaps the red clayey matrix of the conglomerate was a sought-for commodity, too.

THE SITES

Almost all known sites surrounding the mine occur on the III Terrace or on gentle slopes of sandy deposits. The density of occurrences increase toward the river or the bogs of the northern branch of the marginal stream valley, a typical pattern of the spacing influenced by the sources of permanent water. Another type of distribution seems, on the other hand, to have a cultural character. Thus, the recent field campaigns brought to light

[2] All Gd dates were measured by Dr. M. Pazdur at the C14 Laboratory of the Institute of Physics, Silesian Politechnical School, Gliwice.

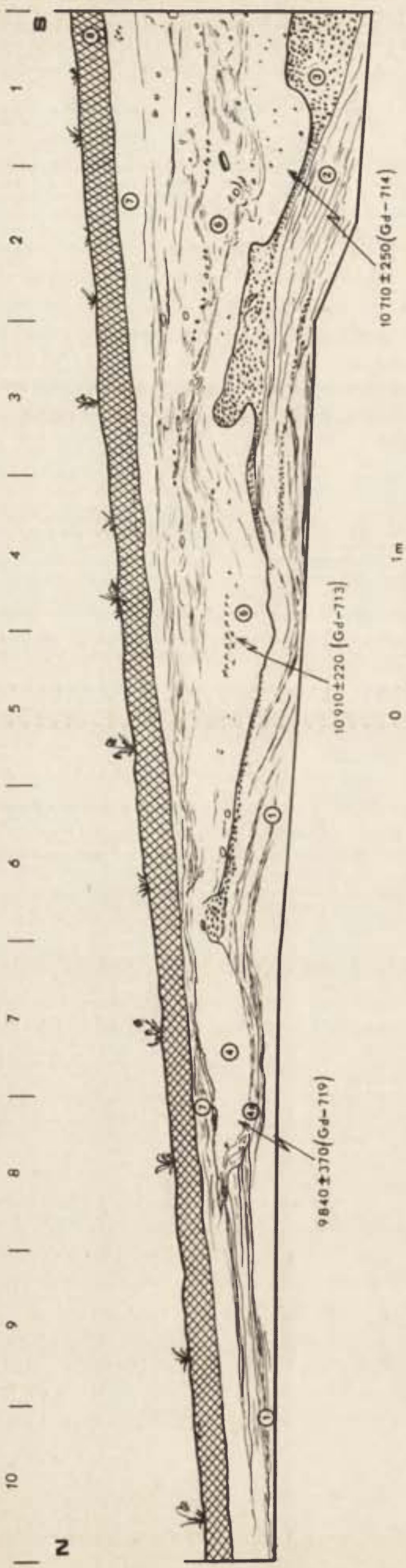


Fig. 11. Rydno—Mine, Cut III/79, east face along squares I/1–10, dates in conventional radiocarbon years B. P.

1 — Variegated Sandstone; *2* — clayey Variegated Sandstone; *3* — conglomerate with hematite gravel and pebbles; *4a* — first phase of pit filling; *4* — second phase of pit filling; *5* — first phase of pit filling in multi-unit quarry; *6* — second phase of pit filling in multi-unit quarry, contact between individual pits concealed; *7* — B horizon of soil; *8* — arable humic horizon numerous, large occupational units of the Arch Backed Piece technocomplex clustered on the III Terrace between the Kamienna and the northern branch of the marginal stream valley (Babica). The Masovian units, in contrast to the previous ones, occur mostly to the north and east of the marginal stream valley (see Fig. 2); although, there too are a few *kshemenitsas* classified within the Arch Backed Piece complex.

It appears that the oldest settlements surrounding the mine could be associated with the Hamburgian. Unfortunately, all of the materials seemingly pertaining to this unit were collected by the Sawickis from the deflational surface, and published only in some fragments. Thus, the unidentified deflational surface of Nowy Młyn Ia gave at least one Hamburgian shouldered point, the only one illustrated by Sawicki (1935, Pl. XX 10). At Nowy Młyn III, Deflational Surface, there was at least one shouldered point and two *zinken*, the only illustrated, characteristic Hamburgian elements (Sawicki 1935, Pl. XX 11,19,21). Although the Hamburgian is dated in Poland (Burdukiewicz, 1980) only at one site (Olbrachcice 8, Voievodedom of Leszno), it is obvious that it could be associated with Bölling *sensu lato*, also the most likely age of the downcutting of the III Terrace. Perhaps, Pit 2 from Cut I/1977 and the Gd-725 date from the large quarry at the mine is also associated with this taxonomic unit.

A single Final Magdalenian site is known from Cut II/1959 (Schild 1965) which yielded a damaged by sand quarring *kshemenitsa*. The unit contained traces of ochre processing in the form of slight coloration of some areas resulting from the admixture of powdered hematite. The small assemblage from Cut 11/1959 contains, among backed elements, a few arch backed pieces suggesting its late age, perhaps an early Alleröd or slightly before.

The Bromme-Segebro related assemblage has been reported from the adjoining excavations of Cut X/1959 and IV/1960 (excavated by B. Ginter and M. Kobusiewicz; Schild 1975, 262), where it seemingly occurred as a single *kshemenitsa*. Also, some of the characteristic pedunculated points of Bromme appearance were published by Sawicki as occurring at Nowy Młyn Ia, Deflational Surface (Sawicki 1935, Pl. XX 5), and Nowy Młyn Ib, Deflational Surface (Sawicki 1935, Pl. XX 6). The assemblage from Cut X/1959 and IV/1960 is the only Bromme-Segebro related, homogeneous assemblage known from Rydno. Although not dated, its age should be confined to Alleröd.

One of the best represented technocomplexes at Rydno is that of Arch Backed Piece (cf. Pls III–XV). It is securely dated elsewehere to the second half of Alleröd and an early Younger Dryas (cf. Schild 1979). Major settlement units of this technocomplex are the following: Rydno IV/1937 (Grzybowa Góra IV/1937); I/1957, Northern *Kshemenitsa* (exc. of Z. Krzak, H. Mackiewicz and Z. Kuczyński); IV/1957, South-eastern *Kshemenitsa* (Schild 1967); IX/1957 (exc. of S. Wierzbicka; Schild 1975); I–III/1976 (Pls III–IX); I–III/1977 (Pls X–XII); and V/1977; I/1978 (Pl. XIII); III/1978; Rydno-Mine III/1978 (Pls XIV–XV); all excavated by the present authors. Some elements of this technocomplex are also known from the mine itself, at least at Rydno-Mine, Cut I/1979 and III/1979. It is presumed that several assemblages of this taxonomic unit must have occurred in the excavations led by S. Krukowski before 1956.

Next in time, and possibly most numerous, are the occurrences of the Masovian cycle. The dating of the classic section of this large taxonomic unit is quite secure and confined to Younger Dryas and a very early Preboreal (Schild 1979). There are two major categories of the Masovian occurrences. The first, are regular, "living" settlement units, and the second, combine strong elements of intensive flint processing with some elements of regular, "living" entities. The most important of the former ones are the following cuts: Rydno (Grzybowa Góra) II/1956 (J. K. Kozłowski 1963); Rydno IV/1957, Main *Kshemenitsa* (Schild 1967); Rydno IV and VII/1977 (excavations of S. K. Kozłowski). Among the workshop sites, more information exist about the following assemblages: Rydno I/1957, II/1957 and III/1957 (exc. of H. Mackiewicz); II/1959, Western Trench (exc. of M. Kobusiewicz); IV/1959 (exc. of S. Wierzbicka); VII/1959 (exc. of M. Kobusiewicz); and XI/1959 (Schild 1975).

Strong elements of this cycle are also presented on the mining field (Pit 1, Cut I/1977) and in many other trenches and cuts where they occur as isolated or sporadic pieces, e.g., Rydno-Mine (vicinity) III/1978. It is certain that many entities of the Masovian cycle must have been excavated by Krukowski before 1955.

The Mesolithic at the Rydno complex is much less numerous than the Final Paleolithic; although it is chronologically filling a longer time section (ca. 3,000 years; from ca. 7,600 B. C. to 4,600 B.C.) than the Final Paleolithic (ca. 2,500 years, from ca. 10,400 B.C. to 7,900 B.C.). Also, the occurrences classified within the Mesolithic are in most cases much smaller and poorer, except for two sites, Rydno VI/1959 and XIII/1959, which are comparable in size and number of lithics with the average Final Paleolithic *kshemenitsas*.

The occurrences of the Narvian cycle (Komornica culture of S. K. Kozłowski) are recorded in the following cuts: Rydno IV/1957, North-eastern Section and South--western Section (Schild 1967); Rydno VIII/1959 (Ginter 1965). The time period of the Narvian cycle is well determined by palynological and radiocarbon dating elsewhere in Poland as confined to Preboreal and Boreal (S. K. Kozłowski 1972; Więckowska 1975; Schild 1975 — the dates from Całowanie).

On a later level, during Vistulian cycle (Janisławice culture of S. K. Kozłowski), perhaps entirely confined to the Atlantic period (see dating in Schild, Marczak, Królik 1975), the occurrences are slightly more numerous and certainly considerably richer in occupational debris. The most important sites on which some information is available are the following: Rydno II/1956, Eastern Section (J. K. Kozłowski 1963); Rydno VI/1959 (Ginter 1965); and Rydno XIII/1959 (Schild, Marczak, Królik 1975).

The post-Mesolithic periods at Rydno are always recorded as limited traces of occupation. In almost all cases they are reduced to one or a few artifacts or pot sherds. The richest, and yet the earliest traces are those of the southern Funnel Beakers known from Rydno VI/1957 (exc. of H. Mackiewicz) where they occurred together with large milling stones showing traces of hematite grinding. A flake from an axe with rectangular cross-section is recorded in the cut near the mine (Rydno--Mine, Cut III/1978), a most likely trace of a halt of Funnel Beakers. An isolated bilateral side-scraper made of banded, Krzemionki flint, showing clear stylistic affinities to the early Bronze Age Mierzanowice culture, is also known from Rydno-Mine Cut III/1978. Other traces of Bronze Age entities are known from Rydno IX/1957 located just near the edge of the III Terrace. Some other occurrences seem to be associated with the Trzciniec culture (S. K. Kozłowski, personal communication).

During recent excavations, a beautiful stone fireplace was discovered in the south-western section of Cut I/1978. Two samples of charcoal collected from this hearth gave the following radiocarbon dates: 6,380±65 years B. P. (GrN-8900) and 6,180±60 years B.P. (GrN-8893)[3]. The dates suggest the association of the hearth with the Linear Pottery culture or a Final Mesolithic. The only two small flakes which were spatially associated with the hearth are non-diagnostic.

RECENT EXCAVATIONS AND ELEMENTS OF DIFFERENTIATION OF SETTLEMENT PATTERNING

Although clearly generated by the needs of salvage, more recent excavations have concentrated on defined, smaller sections of the terrace aiming at a more complete exposure of occupational units and their relationship. Also, the beginning of recent campaigns postdated the period of an early approach to the complex of Rydno characterized by a concentration on the problems of the taxonomy of sites surrounding the mine and on the understanding of the relationship between the mine and the sites. Furthermore, a fast progress in the dating of major taxonomic units of the Final Paleolithic and Mesolithic in Poland obtained at Witów (Chmielewska 1978) and Całowanie (Schild 1975; 1979), eased the characteristic chronological and taxonomic tension so often felt in the works on the archaeology of Stone Age.

Already during the mid-seventies, it was evident that Rydno was a unique complex of occurrences surrounding the hematite mine. The concentration and number of the involved sites was much bigger than any other known clustering of settlements caused by unusually favorable environmental conditions such as, e.g., the agglomeration of Final Paleolithic sites on Final Pleistocene terraces of the confluence of the Vistula and Bugo-Narev, near Warsaw (see Schild 1979). On the other hand, a very special character of the complex, seemingly related to the exchange of goods, was suggested by the presence of numerous workshops which based their production on chocolate flint processing, brought in from the mines located some 15 km to 20 km to the north, as well as by common presence of exotic raw materials and numerous caches of pre-cores.

Indeed, variable spatial characteristics of the settlement units, differing densities and saturation in tools, all suggested quite inconstant character of the so far recognized occupations. Yet, major areas of the potential occurrence of sites were already gone: the result of industrial sand exploitation (four large quarries totalling approximately more than 50,000 m^2); individual, farmer sand quarring (ca 40,000 m^2 to 50,000 m^2); deep deflation and massive surface collection by previous researchers, mostly the Sawickis (ca 20,000 m^2); and, finally, the deplation by preceding excavations which were concentrating on the recovery of individual loci.

All of the information gathered during previous researches suggested that, perhaps, much better keys to the understanding of the complex, the role and relationship between individual sites, etc., are hidden in the spatial differentiation of occurrences, their variability in the abundance of tools, and other debris, as well as in the evidence of flint and hematite processing. Furthermore, nothing was known about the techniques of exploitation, proprieties of lithic inventories found at the mine or at sites located close to the mine itself, etc.

The major salvage and research effort has been concentrated in the area adjacent to the largest, working quarry in the section of the III Terrace located between the Kamienna and the northern branch of the marginal stream valley (Fig. 12). Here, the quarrying preceding the accidental visit in 1975, had cut through two basin houses the remnants of which could be seen in the northern wall of the quarry. The salvage of these partially (I/1976) or almost totally (III/1976) destroyed objects seemed the most urgent.

Beside these two cuts the area was extremely carefully surveyed and all of the deflated basins, as well as the ants'

[3] The authors express their special thanks to Dr. W. G. Mook from the C14 Laboratory of the State University at Groningen for measuring the samples from Rydno I/78.

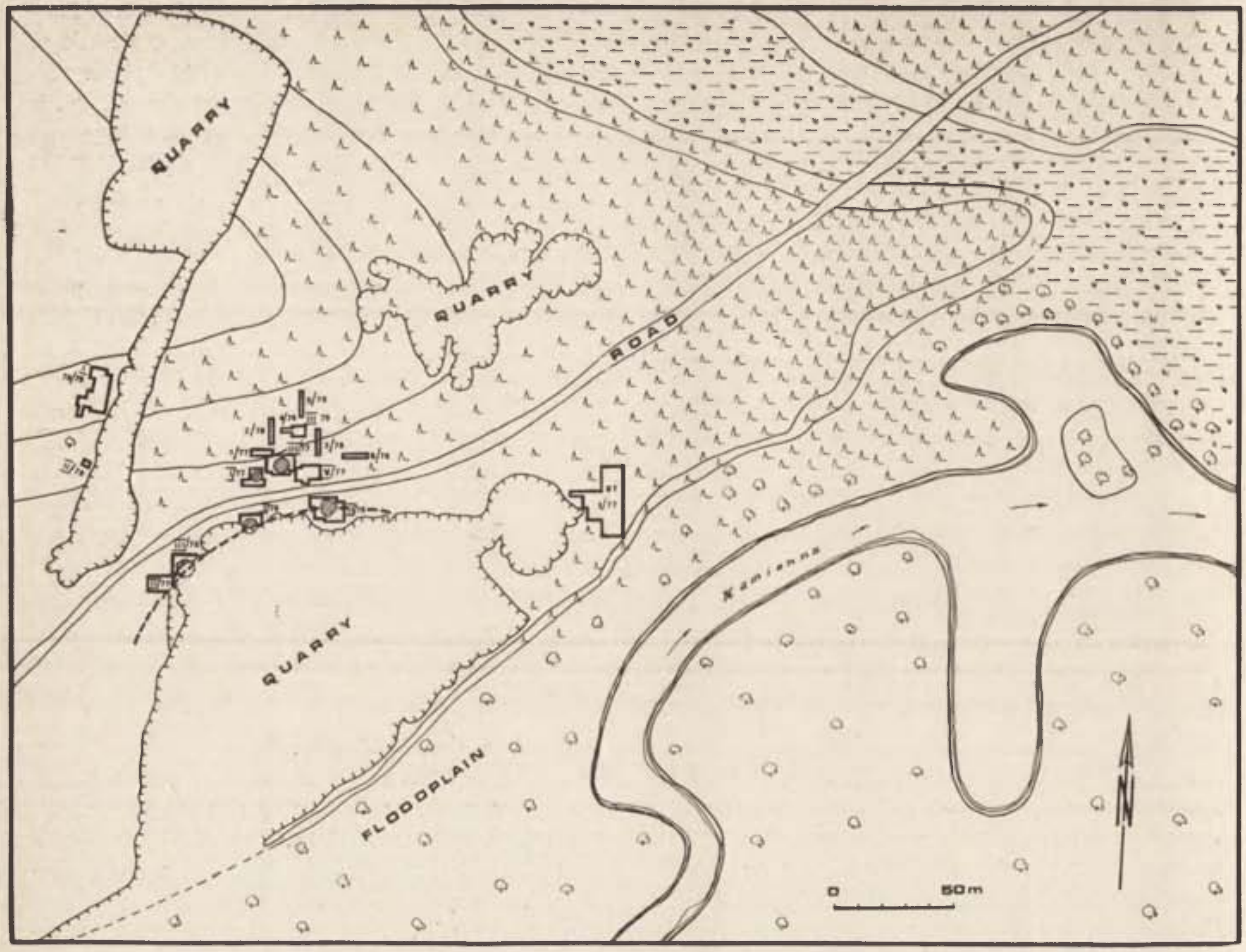


Fig. 12. Topographic sketch of the area worked in 1976–1979 at Nowy Młyn

BT, area of boring test; dotted line indicates the arch on which basin houses of Rydno I-III/76 are located; houses shown by hachured ovals; contour intervals of ca. 1 m

hills prospected foot by foot. The latter are often a good evidence of the prehistoric pits, basin houses etc., at Rydno always filled with sand containing admixture of powdered hematite. In addition, several test trenches and a grid boring were made. The trenching and surface prospection enabled the discovery and further excavation of several occupational units. In total, during the seasons of 1976 through 1979, 856 m² were excavated near the quarry and 430 m² were drilled (cf. Fig. 12). It is believed that this work revealed most of the large units occurring in the vicinity of the quarry. It is obvious, however, that several entities must have been destroyed during sand exploitation. Some may still be buried in the section just east of the worked concentration of settlements and trenches. Large areas of the terrace, in particular the north-eastern portion of the terrace between the Kamienna and the stream valley, were only surveyed on foot and certainly still contain undisclosed occupational units.

The excavations near the quarry yielded six homogeneous occupational units (I, II, III/1976, I and III/1977, I/1978) of which five were associated with large basin houses and two were workshop clusters (V/1977 and III/1978). The remaining cuts or trenches furnished either isolated pieces or were almost sterile. The assemblages varied in number of tools, fluctuating between 31 pieces and 574 pieces. Of the basin houses, two were partially or almost totally destroyed by the quarry (I and III/76), and one was almost entirely truncated by recent deflation which left only the very bottom of the basin, considerably reducing it in diameter (I/1977).

The three of the basin houses at the northern edge of the quarry are placed on a regular arch of a circle with the diameter of 200 m. The straight distance separating the houses varies between 35 m and 36 m (cf. Fig. 12). The regular spacing of these three houses, obviously not induced by the morphology of the terrace, strongly indicates that the units were erected as a planned settlement composed of at least three houses.

The two remaining basin houses are either single unit

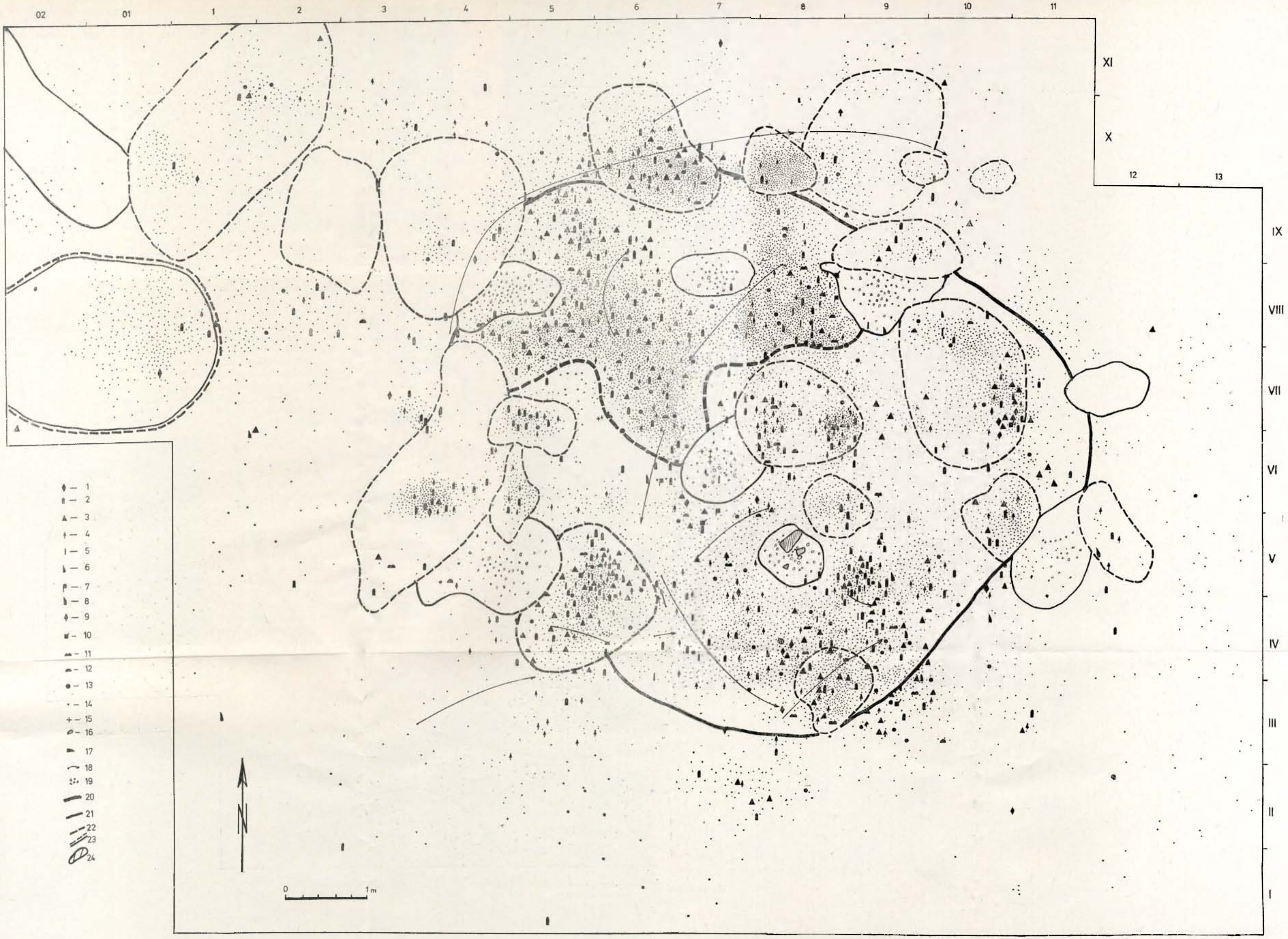


Fig. 13. Rydno II/76, horizontal distribution of artifacts and various pits

1 -- cores; *2* — end-scrapers; *3* — burins; *4* — burin spalls; *5* — perforators and groovers; *6* — backed pieces; *7* - microburins; *8* — truncated pieces; *9* — pedunculated pieces; *10* — raclettes; *11* — denticulated pieces; *12* — retouched pieces; *13* — other tools; *14* — debi age and waste; *15* — scraps of burnt bones; *16* — stones; *17* — ground blades and flakes; *18* — articulating pieces; *19* — gravel in gravel heaves; *20* — limit of basin houses (red sands); *21* — gravel heaves; *22* — windfall pits; *23* — modern pits; *24* — charcoal filled pits

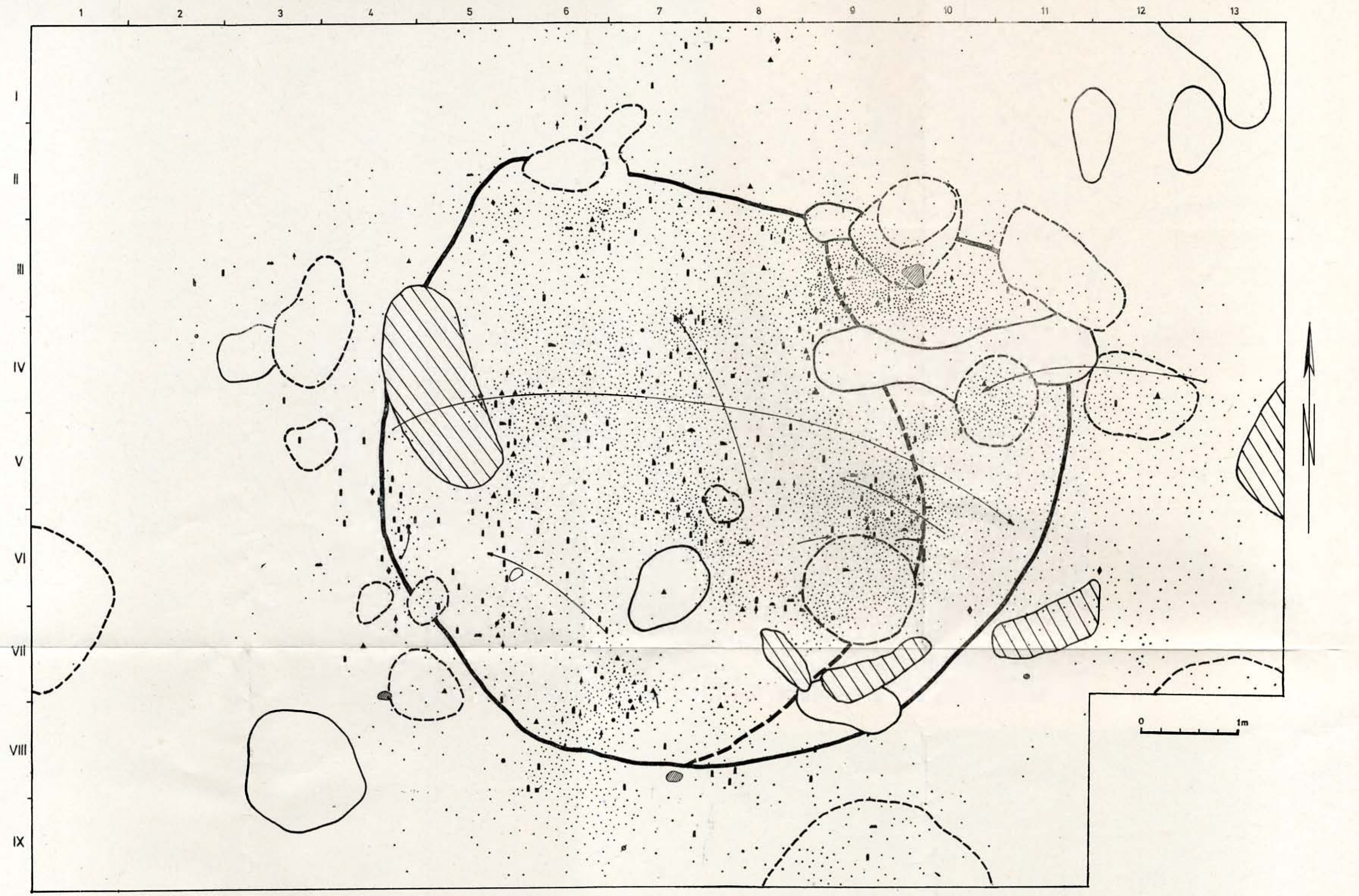


Fig. 14. Rydno III/77, horizontal distribution of artifacts and various pits

Key as on Fig. 13

camps or a larger settlement composed of two units. The destruction of one of these, together with the suspected pre-excavation removal of most of the artifacts from Cut I/1977, makes all more pushed studies on that matter impossible. It is interesting to note that the nearby site of Rydno IX/1959 (cf. Fig. 2) also contained a seemingly single basin house associated with a relatively rich lithic assemblage.

The two workshops, in Cut V/1977 and III/1978, cannot be, for the moment, associated with other settlement units. The only sign of an association would be the discovery of articulating pieces linking the workshops with the house units. No such pieces were yet found; however the work on the problem is still at an initial stage.

All of the assemblages in cuts and trenches near the quarry belong to the Arch Backed Piece complex of upper Alleröd and early Younger Dryas, except for some traces of the Masovian in Cut V/1977, Mesolithic and perhaps Neolithic in Cut I/1978.

In two cuts (II/1976 and III/1977), the basin houses were not destroyed by deflation or sand exploitation, a fact which permitted both the study of preserved details and horizontal distribution within the object (Fig. 13 and 14).

The basins appear as red to reddish, shallow semi--circular areas, heavily secondarily disturbed, and containing numerous stone artifacts. The sizes of these red areas are almost identical, measuring ca 725 cm (W—E axis) by 675 cm (N—S axis), in Cut II/1976, and 710 cm (W—E axis) by 650 cm (N—S axis), in Cut III/1977. The bottom of the basins is at ca 40 cm to 50 cm below the surface, often showing various pockets hanging down to ca 100 cm (cf. Fig. 15), or it is broken by gravel heaves

Fig. 15. Rydno I/76, cross-section of the basin house showing two red pockets, looking north

Fig. 16. Rydno II/76, cross-section of the basin house with a gravel heave in the center

(Fig. 16). The pockets are, in fact, formed by various pits which cut through the basins.

The fill of the basins is made up of terrace, alluvial sands containing admixture of hematite powder resulting in the coloring of the fill. The most intense color is at the bottom of undisturbed parts and in the oldest pockets which do not show any admixtures of other sediments or the development of illuvial horizons. The color fluctuates between 5 R 4/8 (red) and 10 R 4/8 to 5/8 (red). Near the edges, the color of the fill grades through a light red (2.5 YR 6/6) and reddish yellow (5 YR 6/8) into a lighter reddish yellow (7.5 YR 6/8) which is the color of the illuvial (B_2), podzolic soil horizon. The admixture of powdered hematite is rather low, varying between 1.48% and 0.88% of weight (analyses by Barbara Winter, Institute of Basic Geology, Warsaw University).

It is obvious that the outlines of the basins are not sharp and the passage into regular B_2 horizon is gradual. Similarly, the upper section is slightly masked by the development of the most intense illuvial horizon. In spite of these post-depositional changes, caused by the development of soil, the general outlines are quite easy to recognize and the contrast between the intense coloring of the inner section of basins and the B_2 horizon is quite conspicuous.

The basins are heavily damaged by the development of several post-depositional phenomena. Perhaps the most perceptible are various pits cutting through the fill. The most easy to spot are shallow, charcoal filled pits in Cut III/1977, most possibly associated with the XIX century charcoal production which took place in the area after 1864.

Much more complex are the pits filled with the surrounding sands and showing development of various soil horizons or containing redeposited pedogenic formations. It seems that most of these are resulting from the windfallen trees leaving pits of variable size formed by the removal of sediment by upthrown roots (Fig. 17).

Fig. 17. Rydno II/76, cross-section of the basin house with a windfall pit

In the result, the hole is being gradually filled by surrounding sediments, products of decaying wood etc., and after the levelling, the fill is penetrated by colloids and subjected to leaching and accumulation of podzolic horizons.

Observations at various stages of filling of modern windfall pits enormously help in understanding the dynamics of this complex phenomenon. At the first stage, immediately after the fall, the pit is subjected to gravitational sliding of loosened gravel and larger elements rolling down the slopes and concentrating at the bottom. The gravels form a sort of thin layer indicating the edges of the pits. Later, the surrounding sediments, together with pieces of more or less decomposed wood, enter the hole showing a tendency to concentrate heavier elements, especially flat, at the center. Simultaneously, the walls at upper section expand outward assuming lower values of the angle. Larger pieces, gravel, pebbles and stone artifacts, exposed during expansion of the walls, descend toward the bottom and center of the pit.

When filled, the pit is subjected to changes resulting from pedological phenomena and chemical processes. One of the latter is the wood destillation leaving concentrations of charcoal in the pit. A more loose texture of the fill permits, on one hand, removal and the decomposition of humic particles and, on the other, deeper percolation of colloidal elements. In the result, the pit becomes more and more illuvial, loosing its primary mottled appearance and bedding. Advanced stages of pedological, post-levelling changes are seen in the pits whose fills form a downward extension of the B horizon of the soil and appear as pockets hanging from illuvial horizons.

The pits found in the basin houses show various stages of aging and, in all cases, except for the charcoal-filled holes, are believed to have originated as the windfalls. Majority of these contain increased number of artifacts in the center. It is clear that the lithics were funneled down from the surrounding sediment during the process of filling. The age of the pits is certainly differing, an observation indicated by the fact that some of the seemingly oldest pits are penetrated by gravel heaves, and the others are developed after the formation of the heaves. It cannot be excluded that the oldest windfall pits are those with the fill entirely composed of the red sand and which appear as the red pockets hanging from the floor of the basins (e.g., Fig. 15). Obviously, the sub-surface sites deposited on the III Kamienna Terrace were subjected to the damages by the windfalls at least from the Alleröd and throughout the Holocene.

Another phenomenon causing disturbances in the horizontal distribution of artifacts and damages in the primary shape of the red basins are gravel heaves (Fig. 16 and 18). In the cross section, the heaves appear as the

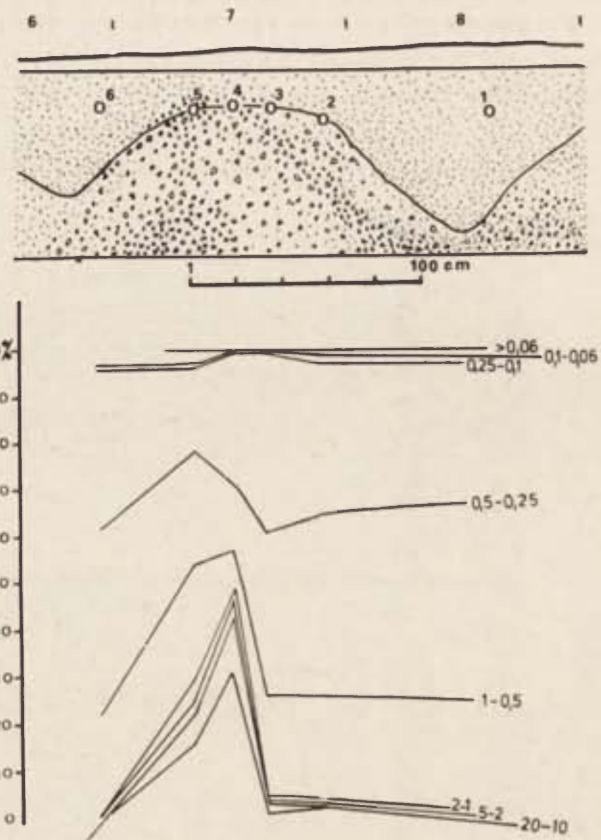


Fig. 18. Rydno II/76, cross-section of the gravel heave cutting into basin house and its grain-size analysis. Analysis by B. Winter

upthrown humps of underlying terrace sands and gravels with the most coarse sands and gravels forming the core of the hump. Only the uppermost portions of the heaves are included in the formation of the B_2 soil horizon (Fig. 18), while the lower and middle sections are always of similar color as the B/C and C zones.

In the horizontal section, the gravel heaves are rounded to oval and are often cutting or cut by other pits (cf. square III/5 in Cut II/1976). In all cases, the heaves are cutting into the hematite colored basins. The presence of lithic artifacts in the heaves is strictly limited to the uppermost portion of these structures. Some of them do not contain any lithics at all.

The interpretation and understanding of the gravel heaves is quite difficult. Particularly because the original bedding and structuring of the upper section of the terrace have been destroyed by the root actions associated with pedological processes. In the light of gathered evidence, it is most likely that the majority of the gravel heaves are formed as frost phenomena in the conditions of a higher water table, perhaps during Younger Dryas, a hypothesis which would agree with the age of the hematite reddened basins. The coarse texture of the heaves permits easier percolation of colloids and results in poor accumulation of ferruginous elements.

What are, then, the red basins and confined to them artifacts? Today, after years of excavations of the complex of Rydno, it is certain that the hematite enriched sands represent remains of chemically changed, cultural anthropogenic sediments whose coloration resulted from the admixture of powdered ochre. All of the humic components of the layer were destroyed by acidic, pedogenic phenomena. The preservation of the anthropogenic, cultural sediment was possible only in the structures which were sunk below the surface and then filled with the surrounding sands. The remaining on the surface culturally altered sediments were either deflated or chemically destroyed and removed or displaced by percolating water. All of the underground cultural structures known from Rydno contain an admixture of powdered hematite (cf. Schild 1967; Schild, Marczak, Królik 1975).

All things considered, it is certain that the red basins are the remains of cultural structures sunk into the terrace. It is quite possible that they were relatively large, living houses covered by roofs and representing the same type of construction, a fact indicated by their similar characteristics in Cut I/1976, III/1976 and I/1977. Heavily damaged, similar structures occurred at Rydno IX/1959 and perhaps at Rydno IV/1937. Both sites are also associated with the assemblages classified within the Arch Back Piece complex.

A quick, superficial examination of the horizontal distribution of artifacts indicates that in spite of secondary displacement, caused by windfall pits and gravel heaves, the lithics are largely confined to the basins (cf. Fig. 13 and 14). This situation is repeated at the remaining sites containing similar large red basins. The general confinement of the artifacts of the basins is so obvious that it does not need any additional, numerical testing procedures.

Although the horizontal distribution of artifacts in the two complete basins has been altered by post-depositional phenomena, the disturbance is relatively limited. Therefore, the distribution of three major tool classes, the end-scrapers, burins and perforators, have been tested for any eventual patterning. The following procedures are considered as an attempt to analyse the distributions in a more formal way by using several methods of measuring the significance of the co-occurrence of tool groups, their random versus non-random distribution, as well as the contingency of the co-appearance. The following methods have been used in the experiment: a — Clark and Evans nearest-neighbour method (Fig. 19–26; Clark, Evans 1954; Golachowski, Kostrubiec, Zagożdżon 1974; Chojnicki, Czyż 1972); b — Lexis' coefficient of dispersal and concentration of points (Steinhaus 1947; Golachowski, Kostrubiec, Zagożdżon 1974, 107); c — X^2 statistics

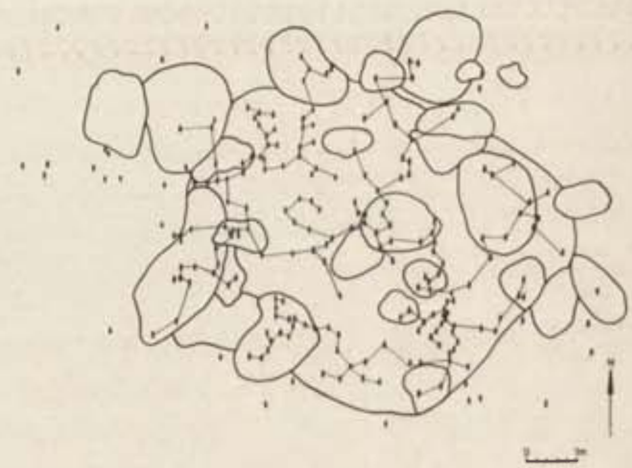


Fig. 19. Rydno II/76, nearest neighbour network of end-scrapers

Fig. 20. Rydno II/76, nearest neighbour network of burins

(Kershaw 1978); d — Contingency coefficient of Nešataev (1971).

The obtained results are not entirely satisfactory, a typical case also in other disciplines dealing with similar problems. Nevertheless, some important hypotheses are suggested. At Rydno II/1976, the distribution of end-scrapers, as measured by the nearest-neighbour method gave the value of $R = 1.13$. In the cases where $1 < R < 2.15$ the distribution is considered to be intermediate between the random and ideally, regularly dispersed.

In the light of Lexis' coefficient, the distribution of end-scrapers appears to be random or regular ($L = 0.61$) when the used squares are measuring 0.25 m×0.25 m; and, on the other hand, it is placed between random and clustered if the squares are measuring 0.50 m×0.50 m. The X^2 statistics (squares of 0.25 m×0.25 m and 0.50 m× 0.50 m) indicate the non-random distribution.

The dispersal of borers perforators and groovers at Rydno II/1976, according to the nearest-neighbour method, is close to random ($R =$

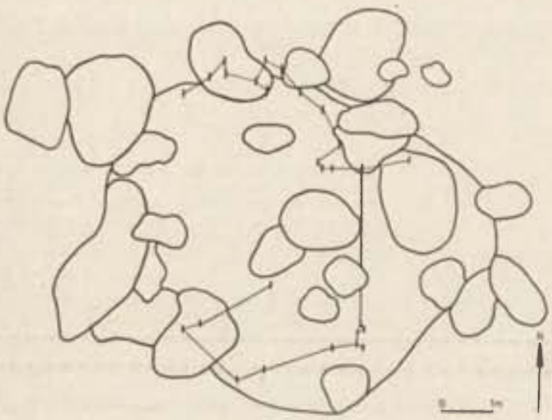


Fig. 21. Rydno II/76, nearest neighbour network of perforators borers and groovers

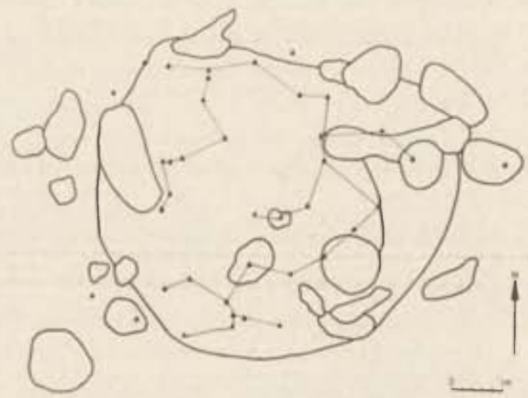


Fig. 24. Rydno III/77, nearest neighbour network of burins

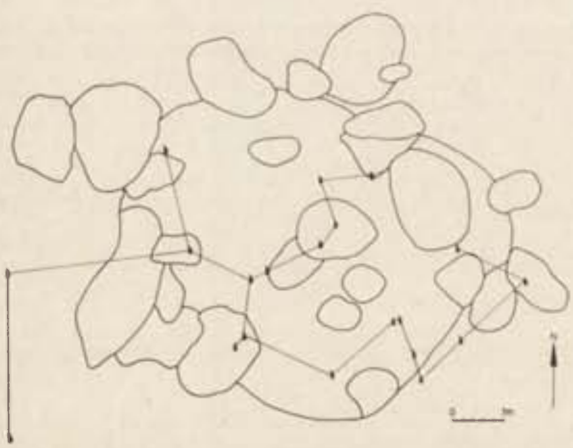


Fig. 22. Rydno II/76, nearest neighbour network of backed elements

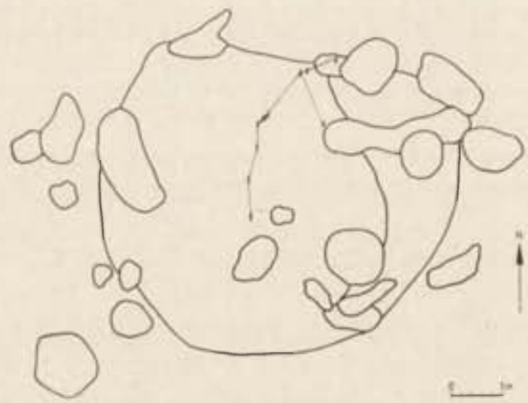


Fig. 25. Rydno III/77, nearest neighbour network of perforators, borers and groovers

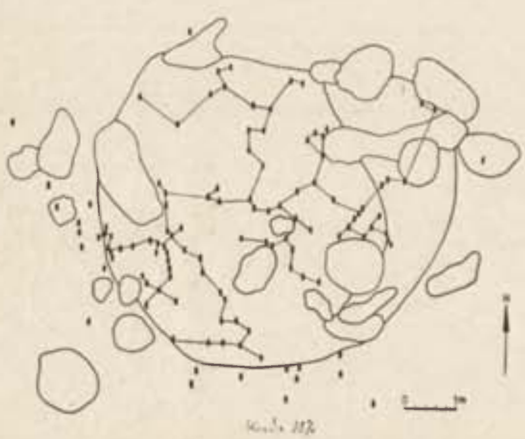


Fig. 23. Rydno III/77, nearest neighbour network of end-scrapers

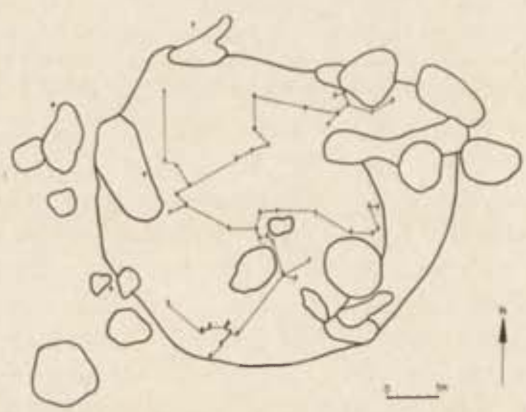


Fig. 26. Rydno III/77, nearest neighbour network of burin spalls

= 0.91); or, according to Lexis' coefficient, near the ideally regular, the latter even if the two sizes of the squares are used (0.25 m×0.25 m, $L = 0.23$; 0.50m×0.50 m, $L = 0.50$). According to the X^2 statistics, the distribution of borers, perforators and groovers is non-random.

The distribution of backed elements at the same site could be either random ($R = 1$), or close to ideally regular ($L = 0.14$ and $L = 0.31$ respectively). The X^2 statistics indicates the non-random distribution.

At Site III/1977, the distribution of end-scrapers is considered to be the following: intermediate between random and ideally dispersed ($R = 1.13$); close to ideally regular (squares of 0.25 m×0.25 m, $L = 0.46$); intermediate between random and clustered (squares of 0.50 m×0.50 m, $L = 4.13$); or, according to the X^2 statistics, non--random.

The distribution of burins at the same site could be placed between random and ideally dispersed ($R = 1.24$; $L = 0.55$ when the squares measure 0.50 m×0.50 m). On the other hand, it is indicated as close to ideally dispersed ($L = 0.35$, when the squares measure 0.25 m×0.25 m) or non-random (X^2). The perforators borers and groovers at Rydno III/1977 show the distribution close to the clustered one ($R = 0.37$).

The contingency of co-occurrence of burins and burin spalls show variable results depending on the size of the squares. The value of the coefficient fluctuates between $C = 0.83$ nad $C = 0.39$ (squares measuring 0.50 m×0.50 m and 1.0 m×1.0 m respectively). The X^2 test used as an indication of the significance of co-occurrence of these two elements shows the significance of the differences in the squares measuring 0.25 m×0.25 m and their non-significance in the squares of 0.50 m×0.50 m.

In short, the results are variable, heavily depending on the used scale, size of sampling units (squares) and the method (cf., e.g., Dacey 1973; Hodder, Orton 1976, 30). The use of other, perhaps sharper, methods is advocated, as well as simple observation and evaluation of the clustering. Thus, in spite of the obtained results, it could be seen that the perforators, borers and groovers are clustering in relatively small areas in the northern, southern and central sections of the two basin houses, perhaps indicating functional spacing.

An extremely interesting problem brought about by the discovery of the three houses forming a common camp was the possibility of testing whether the inventories of these houses were identical or not. Clearly comparable size and type of the houses suggested that their inhabitants might have formed similar social units, perhaps the nuclear or extended families. The comparison of qualitative elements of the three assemblages showed their high similarity (Fig. 27), as expressed by the presence of the same tool groups and their categories (cf. Tables I and II). On the other hand, the quantitative differences (Fig. 28) among major tool classes at Rydno I/76 and II/76, the

Rydno	II/76	I/77	III/76	Mine III/78	II/77	III/77	I/76	I/78
II/76		+	++	–	–	++	+	–
I/77			++	+	+	+	+	–
III/76				++	+	++	++	–
Mine III/78					–	++	++	–
II/77						++	–	–
III/77							++	–
I/76								–
I/78								

Fig. 27. Matrix showing contingency of qualitative elements (Nesataev's test) of eight assemblages with arch backed pieces

++, contingency significant at the 0.01 per cent level of P; +, contingency significant at the 0.05 per cent level of P; –, contingency statistically insignificant. Order of assemblages as in Table I

only two of the three assemblages with sufficient number of tools, are statistically significant at the 0.01 level of P (Kolmogorov–Smirnov, λ test). Obviously, the difference is resulting from the highly diverging percentages of burins and end-scrapers in the two inventories. It seems quite possible that these diversities could have been resulting from a variable stress on some functions performed by the two social units, most possibly hide processing (end--scrapers) and organic tool making (burins). If so, one can explain these differences as caused by various sex and/or age structuring of the individual families forming the settlement.

A comparison of all of the recently recovered assem-

Rydno	II/76	I/77	III/76	Mine III/78	II/77	III/77	I/76	I/78
II/76		–	–	–	–	++	++	++
I/77			–	–	–	–	–	++
III/76				–	–	+	–	++
Mine III/78					–	+	+	+
II/77						–	–	–
III/77							+	+
I/76								+
I/78								

Fig. 28. Matrix showing significance of the difference in quantitative composition of assemblages (Kolmogorov–Smirnov λ test)

Computation based on data presented in Table II; coding of significance as in Fig. 27; order of sites as in Table I

Table I. Summary of tool categories.

Tool Categories	Rydno II/76		Rydno I/77		Rydno III/76	
	n	%	n	%	n	%
End-scrapers:						
1 Simple	35+3K+2S	6,97	6+2K	22,86	1	1,89
2 Simple on retouched blanks	9+1P	1,74	1	2,86	1	1,89
3 Simple with converging, retouched sides	5	0,87	—	—	—	—
4 Nosed, shouldered or carenated	e+2Ś	1,39	—	—	—	—
5 Double	6	1,05	—	—	1	1,89
6 Double on retouched blanks	4+1K	0,87	—	—	—	—
7 Short and very short on large flakes	—	—	—	—	—	—
8 *Unguiforme*, short	38+2K+1Cn	7,14	1	2,86	6	11,32
9 *Unguiforme*, very short	40+2J	7,32	2+2K	11,43	3	5,66
10 *Unguiforme*, very short on retouched blanks	11	1,92	—	—	—	—
11 Double, very short	4	0,70	—	—	1	1,89
12 Double, very short on retouched blanks	3	0,52	—	—	—	—
13 Circular and semi-circular	4	0,70	—	—	—	—
14 Other forms	2+1K	0,52	—	—	—	—
15 Undetermined fragments	34+1S	6,10	—	—	3	5,66
Combined tools:						
16 End-scrapers with burins	5+1JS	1,05	—	—	1	1,89
20 End-scrapers with perforators	—	—	—	—	—	—
Burins:						
22 Dihedral, symetric	2	0,35	2	5,71	—	—
23 Dihedral *déjeté*	7	1,22	—	—	—	—
24 Dihedral, angled	13+1R	2,44	—	—	1	1,89
25 On a truncation, symmetric	6	1,05	—	—	3	5,66
26 On a truncation, asymmetric	13+1Ś+1J	2,61	4	11,43	4	7,55
27 Transverse on retouch	3+1K	0,70	—	—	—	—
28 Transverse on a notch	16+1P	2,96	1	2,86	2	3,77
29 Transverse on a blunt edge	4+1Ś	0,87	—	—	—	—
30 Transverse on a sharp edge (*Corbiac*)	—	—	—	—	—	—
31 On a snap	31	5,40	—	—	—	—
32 Single blow, longitudinal	1	0,17	—	—	1	1,89
33 Multi-blow, arched	3+1P	0,70	—	—	—	—
34 Flat	5	0,87	—	—	—	—
36 Multiple on truncations	9	1,37	1+2K	8,57	6	11,32
37 Multiple, dihedral	1+1P	0,35	1	2,86	—	—
38 Multiple on snaps	2+1T	0,52	—	—	—	—
39 Multiple, mixed	15+1P+3K+3J	3,83	3	8,57	1K	1,89
40 Other forms	1	0,17	—	—	1J	1,89
41 Undetermined fragments	9+1Ś	1,74	—	—	5	9,43
Perforators, borers and groovers:						
42 Various perforators and groovers	21+1R	3,83	—	—	—	—
43 Zinken	—	—	—	—	—	—
44 Various borers	3	0,52	—	—	—	—
45 Micro-perforators and micro-borers	—	—	—	—	—	—
46 Double	2	0,35	—	—	—	—
Backed forms:						
47 Pointed, straight backed blades	1	0,17	—	—	—	—
49 Pointed, arch backed blades	—	—	—	—	—	—
50 Pointed, arch backed blades with retouched base	—	—	—	—	—	—
51 Blunt backed blades, arched and straight	—	—	—	—	—	—
52 Partially backed blades	—	—	—	—	—	—
55 Pointed, straight backed bladelets	1+1Ś	0,35	—	—	—	—
57 Pointed oblique, straight backed bladelets	1+1K	0,35	—	—	—	—
58 Pointed, arch backed bladelets	6+1K	1,22	—	—	—	—
59 Pointed, arch backed bladelets with retouched base	—	—	—	—	—	—
60 Fully arched, backed bladelets (segments)	1 OB	0,17	—	—	—	—

Taxa according to Schild (1975)

Rydno-Mine III/78		Rydno II/77		Rydno III/77		Rydno I/76		Rydno I/78		Rydno V/77	Rydno III/78
n	%	n	%	n	%	n	%	n	%	n	n
1+2K	2,78	4	12,90	14+1K	6,10	4+1Ś	1,96	—	—	5	—
—	—	—	—	6	2,44	—	—	—	—	—	—
1	0,93	—	—	4	1,63	—	—	1	3,13	—	—
4	3,70	1	3,23	4	1,63	1	0,39	—	—	—	—
1	0,93	—	—	2	0,81	1	0,39	—	—	1	—
1	0,93	—	—	8	3,25	1	0,39	—	—	—	—
10	9,26	—	—	—	—	1	0,39	—	—	—	—
4	3,70	2	6,45	27+2K+1J	12,20	11	4,31	—	—	—	—
8	7,41	1	3,23	18+1K+1J	8,13	13	5,10	—	—	4	—
—	—	2	6,45	10	4,07	—	—	—	—	—	—
1	0,93	—	—	4	1,63	2	0,78	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	1	3,23	7	2,85	1	0,39	—	—	—	—
—	—	1	3,23	—	—	5+1K+1Ś	2,75	—	—	—	—
5	4,63	1	3,23	11	4,47	3	1,18	2K	6,25	—	—
1J	0,93	—	—	—	—	3	1,18	—	—	—	—
—	—	—	—	—	—	1	0,39	—	—	—	—
1	0,93	—	—	1	0,41	4	1,57	1K	3,13	—	—
2+1R	2,78	—	—	2	0,81	11	4,31	—	—	—	—
2+1J	2,78	4	12,91	4+1K	2,03	10+1Ś	4,31	—	—	—	—
2	1,85	—	—	6	2,44	2	0,78	—	—	2K	—
4+1J	4,63	—	—	2+1K	1,22	13	5,10	1K	3,13	—	—
1	0,93	—	—	1+1J	0,81	2	0,78	—	—	—	—
1	0,93	—	—	—	—	3	1,18	—	—	—	—
1	0,93	—	—	2	0,81	4	1,57	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
3+1K	3,70	—	—	3	1,22	9	3,53	1K	3,13	—	—
3+2R+1T	5,56	—	—	—	—	5	1,96	2K	6,25	1	—
—	—	—	—	—	—	—	—	—	—	—	—
2	1,85	—	—	3	1,22	2	0,78	—	—	—	—
2+1K	2,78	—	—	2	0,81	8	3,14	—	—	—	—
—	—	2	6,45	1	0,41	3	1,18	—	—	—	—
—	—	—	—	1	0,41	—	—	—	—	—	—
2	1,85	—	—	8+1K	3,66	20	7,84	2	6,25	—	—
—	—	—	—	—	—	2	0,78	—	—	—	—
—	—	—	—	1	0,41	5	1,96	—	—	—	—
—	—	—	—	6+1K	2,85	19+1Ś	7,84	2K+1Ś	9,38	—	—
—	—	—	—	1	0,41	2	0,78	—	—	—	—
1	0,93	—	—	—	—	2	0,78	—	—	—	—
—	—	—	—	1	0,41	—	—	—	—	—	—
—	—	1	3,23	2	0,81	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—
1	0,93	—	—	—	—	—	—	—	—	—	—
1	0,93	—	—	—	—	1	0,39	—	—	—	—
1	0,93	—	—	—	—	—	—	—	—	—	—
—	—	1	3,23	1	0,41	—	—	—	—	—	—
—	—	—	—	—	—	3	1,18	—	—	—	1J
—	—	—	—	1K	0,41	1	0,39	1	3,13	—	—
—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—

Tool Categories	Rydno II/76		Rydno I/77		Rydno III/76	
	n	%	n	%	n	%
62 Partially backed bladelets	1+1T	0,35	—	—	—	—
63 Pointed, straight backed bladelets, microlithic (less than 3 cm)	1K	0,17	—	—	—	—
66 Pointed, arch backed bladelets, microlithic	2	0,35	—	—	—	—
71 Undetermined fragments of backed bladelets (categories 55–70)	1	0,17	—	—	—	—
72 Elongated backed bladelets, various forms	—	—	—	—	—	—
73 As category 72 but with truncated base	—	—	—	—	—	—
74 Rectangular or truncated backed bladelets	—	—	—	—	—	—
80 Other forms of backed bladelets	1	0,17	—	—	—	—
81 Fragments of backed bladelets different from categories 54, 71	—	—	—	—	—	—
Microburins:						
82 Krukowski's microburins	3	0,52	—	—	—	—
83 Simple	2	0,35	—	—	—	—
Truncated pieces:						
84 Transverse	1	0,17	1	2,86	—	—
85 Oblique	3	0,52	—	—	—	—
87 Micro-truncations (less than 3 cm), oblique	—	—	—	—	—	—
90 Micro-truncations, very oblique (less than 30°)	1	0,17	—	—	—	—
94 Micro-truncations, transverse	—	—	—	—	—	—
Pedunculated points:						
100 Ahrensburgian and Hintersee	—	—	—	—	—	—
101 Large Bromme (Lyngby)	1	0,17	—	—	—	—
102 Small Bromme	1+1Ś	0,35	—	—	—	—
Raclettes:						
117 Typical	—	—	—	—	—	—
118 Atypical	5	0,87	—	—	—	—
Notches and denticulates:						
119 Notched pieces	12	2,09	1+2K	8,57	2	3,77
120 Denticulated pieces	8	1,39	—	—	—	—
Retouched pieces:						
122 Continuous	2	0,35	—	—	—	—
124 With fragmentary retouch	25+1Ś+1T	4,70	—	—	5	9,43
Other tools:						
126 Unlisted tools	26	4,53	—	—	—	—
127 Undetermined fragments	53	9,23	3	8,57	5	9,43
	574		35		53	

Code of raw materials: Cn — erratic, chocolate flint, J — Jurassic flint from Cracow-Wielun Upland, JS — jasper, K — Cretaceous, erratic flint, T — other Turonian flints,

blages classified within the Arch Backed Piece techno-complex show their considerable qualitative similarity (Table I, Fig. 27) while the quantitative characteristics are quite dissimilar (cf. Table II, Fig. 28) and significantly different at least at the 0.05 level of *P*. In spite of these differences, in most cases caused by the variability in the percentages of burins, end-scrapers and perforators, the assemblages are characterized by a low ratio of other tool groups, particularly the backed elements, except for the assemblage from Rydno I/78 (Tables I and II). These general characteristics are similar with the previously recovered inventories (Rydno IV/37, IV/57, I/57, IX/59), and are clearly dissimilar with the assemblages of the same taxonomic complex known from the sites which are not associated with the mine (except for the assemblages from Tarnowa, Voievodedom of Poznań, and Całowanie, Layer IV, Cut IX E). Generally, the sites located beyond the complex of Rydno are characterized by elevated percentages of backed elements.

Formal clustering of the assemblages recently excavated at Rydno is based on the qualitative differences within tool groups as expressed by the value of the Kolmogorov—

Continuation of Table I

Rydno-Mine III/78		Rydno II/77		Rydno III/77		Rydno I/76		Rydno I/78		Rydno V/77	Rydno III/78
n	%	n	%	n	%	n	%	n	%	n	n
–	–	–	–	–	–	–	–	1+1K	6,25	–	–
–	–	–	–	–	–	–	–	–	–	–	–
1	0,93	–	–	–	–	1	0,39	–	–	–	–
1	0,93	1	3,23	–	–	–	–	1	3,13	–	–
–	–	2	6,45	–	–	1	0,39	1Cn	3,13	–	–
–	–	–	–	–	–	–	–	–	–	–	–
1	0,93	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	1	0,39	–	–	–	–
–	–	–	–	–	–	–	–	1	3,13	–	–
–	–	–	–	–	–	–	–	1+1K	6,25	–	1
1	0,93	–	–	2	0,81	2	0,78	–	–	–	1
–	–	–	–	1	0,41	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	2	0,78	–	–	–	–
–	–	–	–	–	–	–	–	–	–	1	–
–	–	–	–	1Ś	0,41	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	2	0,81	–	–	–	–	1	–
2	1,85	–	–	2	0,81	5	1,96	–	–	–	–
3+1K	3,70	2	6,45	9	3,66	6	2,35	–	–	1	–
10	3,26	–	–	2	0,81	–	–	1K	3,13	2	1
–	–	–	–	3	1,22	4	1,57	–	–	–	–
5+1K	5,56	1	3,23	16	6,50	13	5,10	2	6,25	3	2
1	0,93	–	–	5+3Ś+1K	3,66	7+1Ś	3,14	4K	12,50	–	–
4	3,70	4	12,90	24	9,76	29	11,37	1+3K	12,50	–	2
108		31		246		255		32		21	8

flint, OB — obsidian, P — banded Jurassic flint of Krzemionki type, PA — sandstone, R — Rauracian flint, Ś — gray dotted, Turonian
no symbol — mined chocolate flint

Smirnov λ test (Fig. 28). This taxonomy obtained by the nearest-neighbour technique, and believed not to be cultural in character, shows the formation of two clear groups while several assemblages remain dispersed. The population, however, includes several poor inventories whose formal, numerical placement is not entirely reliable. Nevertheless, the structuring of tool groups in the richest assemblages (Rydno II/76, I/76, III/77 and Rydno-Mine III/78) is significantly different.

The General Structure of the assemblages (Tables III and IV) shows consistent dominance of Group II and III. However, the numerical differences separating the assemblages are, in most cases, statistically significant (Fig. 29). Two inventories (Rydno V/77 and III/78), on the other hand, clearly stand apart showing typical workshop characteristics as expressed by very low percentages of tools.

Another interesting question associated with the assemblages belonging to the Arch Backed Piece techno-complex is their raw material structure. Although always characterized by dominating proportions of the chocolate flint, seemingly mined at the outcrops located some 15 km to 20 km to the north of Rydno (see Schild 1976), the raw

Table II. Blockdiagram of major tool groups
1 — end-scrapers; 2 — end-scrapers combined with other tools; 3 — burin; 4 — borers and perforators; 5 — backed pieces; 6 — truncations; 7 — microburins; 8 — retouched pieces; 9 — raclettes; 10 — pedunculated points; 11 — other tools

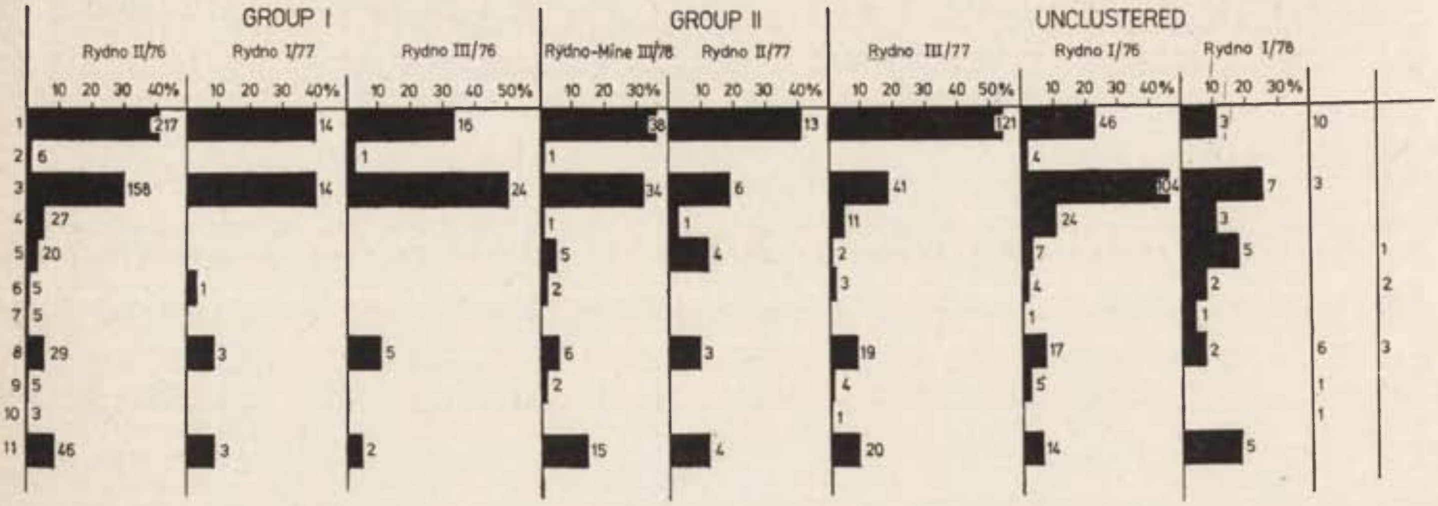


Table III. General Struc-

Group	Tool Categories	Rydno II/76 n	Rydno II/76 %	Rydno I/77 n	Rydno I/77 %	Rydno III/76 n	Rydno III/76 %
	1	2	3	4	5	6	7
I	Core preparation and early exploitation:						
	1 Cortex flakes	267+4P+1S+2K	5,90	7+3K	4,37	49+2K	8,60
	2 Pre-cores	—	—	—	—	—	—
	3 Initially struck cores	—	—	—	—	—	—
	4 Flakes and blades of early removal showing traces of pre-core preparation	21+2S	0,50	2	0,87	14	2,36
II	Flakes exploitation:						
	5 Single platform cores for flakes	1+1R	0,04	—	—	—	—
	6 Flakes from single platform cores	715+20Ś+2K+3R	15,93	40+6K	20,09	113	19,06
	7 Opposed platform cores for flakes	—	—	—	—	—	—
	8 Flakes from opposed platform cores	16	0,34	—	—	3	0,51
	9 Changed orientation cores for flakes	7+1Cn	0,17	—	—	4	0,67
	10 Flakes from changed orientation cores	1860+63Ś+11P+ +7K+2R+2Cn	41,87	65+12K	33,62	98+11K	18,38
III	Blade exploitation:						
	11 Single platform cores for blades	4	0,09	1	0,44	1	0,17
	12 Changed orientation, single platform cores for blades	7+1J	0,17	—	—	—	—
	13 Cortex blades	29	0,62	2+1K	1,31	11	1,85
	14 Blades from single platform cores	73+1Ś	1,59	5+2K	3,05	23+2K	4,22
	15 Opposed platform cores for blades	—	—	1	0,44	—	—
	16 Blades from opposed plaftorm cores	68+1K	1,49	—	—	2	0,34
	17 Undetermined blades and fragments	573+5Ś+2K	12,49	34+3K	16,16	167	28,16
IV	Mixed exploitation:						
	18 Changed orientation cores for blades and flakes	—	—	—	—	7	1,18
V	Core rejuventation:						
	19 Core tablets	22+1Ś+1P	0,52	—	—	—	—

material variability is quite significant (cf. Tables I and III). The next in percentage is the Cretaceous, erratic flint which at one site (Rydno I/78) is dominating. The Jurassic flint of the Cracow-Wieluń Upland, and the gray, dotted Turonian flint from the north-eastern footslopes of the Holy Cross Mountains are present only in the richest assemblages. Furthermore, the exotic, seemingly from the Tokay area, obsidian and the red and/or yellowish jaspers, from Pieniny Mountains or Slovakia, occur in some assemblages (Tables I and III). The significance of the difference in the structuring of raw materials shows Fig. 30.

Another interesting phenomenon observed among the sites of the Arch Backed Piece technocomplex of Rydno is an obvious numerical variability of the assemblages. Thus some of the clusters which are fully excavated and appear as closed, homogeneous occupational units, contain less than 50 tools (Rydno IV/57, I/57, I/78); the others account for over a 100 to slightly over 200 tools (Rydno IX/59, III/77); while a few may include over 500 tools (Rydno II/76).

It is believed that the number of tools and debitage in the *kshemenitsas* of Rydno is basically reflecting the total length of occupation, as well as the number of persons in the unit. If so, the large, three unit camp near the quarry, as well as Site III/77, may represent long occupations of the place and/or cases of repeated settling of the same house by the same social unit.

Another interesting phenomenon observed at Rydno is the low frequency of arch backed pieces at most of the sites and particularly at the richest ones. It is generally believed that at least some of the backed pieces were used as projectile points, while the others were used as knives or the insets of cutting, composed tools. The use of some backed pieces as projectile points (arrows) is suggested by the find of a point deeply embedded in the

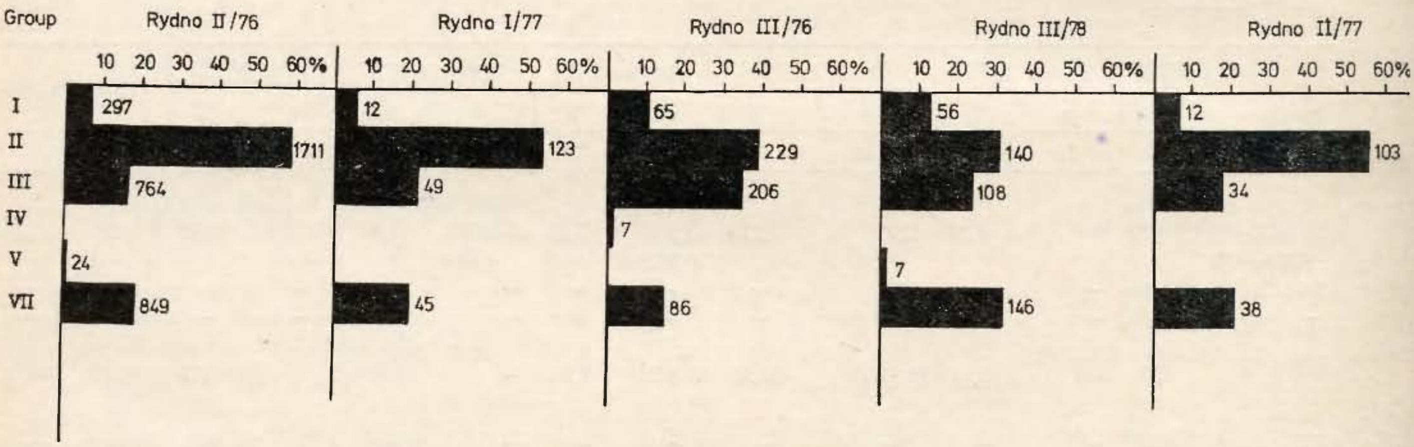
ture of Inventories

Rydno Mine III/78		Rydno II/77		Rydno III/77		Rydno I/76		Rydno I/78		Rydno V/77		Rydno III/78	
n	%	n	%	n	%	n	%	n	%	n	%		
8	9	10	11	12	13	14	15	16	17	18	19	20	
34+8K+ +2Cn+4R	10,50	9	4,84	122	5,14	123+ +2K+1Ś	5,83	3+8K+ +4Cn	9,93	66+1K+ +1R	14,02	57	8,23
1+1Cn	0,44	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	1,31	3	1,61	13+1Ś	0,59	42 +2Ś	2,04	–	–	3	0,62	12	1,73
1K	0,22	–	–	–	–	–	–	–	–	1	0,21	–	–
69+3K+ +2Cn+3J	16,85	36	19,35	720+ +3JS+ +1K	30,52	491+ +18Ś+ +2K	23,65	13+ +23K+ +2Cn	25,17	140+ +3K+3R	30,10	254	36,65
1J	0,22	–	–	1	0,04	–	–	1	0,66	–	–	–	–
4	0,88	–	–	11	0,46	2	0,09	–	–	–	–	–	–
2+3K+1Cn	1,31	1	0,54	1+1K	0,08	7+1Ś	0,37	1K	0,66	2	0,41	–	–
45+2J+4K	11,16	60+ 3K+3PA	35,48	674+ 11K+2Ś	28,96	423+ 21Ś+1K	20,62	13+8K	13,91	50+10K	12,37	145	20,92
–	–	–	–	2	0,08	–	–	1+1K	1,32	1	0,21	–	–
–	–	–	–	1	0,04	4	0,19	–	–	1K	0,21	–	–
17+2K	4,16	–	–	13+1K	0,59	56+1Ś+ 1K	2,68	2	1,32	10+1K	2,27	23	3,32
10+3K+2J	3,28	10+1K	5,91	78+3K+ +2Ś	3,50	137+6Ś	6,62	4K+2Cn	3,97	44+5K	10,10	47	6,78
1K	0,22	–	–	2+1Cn	0,13	1	0,05	–	–	1	0,21	–	–
2	0,44	3	1,61	10+1JS	0,46	10	0,46	–	–	9+2K	2,27	9	1,30
50+5J+16K	15,54	18+1K	10,22	382+2K+ +8Ś+5JS	16,74	270+ +1Ś+1K	12,59	11+14K	16,56	89+6K	19,59	127	18,33
–	–	–	–	–	–	1	0,05	1K	0,66	–	–	–	–
6+1K	1,53	–	–	4	0,17	42+ +1Ś+2K	2,08	–	–	8	1,65	9	1,30

1		2	3	4	5	6	7
VI	Undetermined:						
20	Undetermined cores and their fragments	1		–	–	3	
21	Undetermined flakes	4798+56Ś+15K+ +8P+6R		55+6K+3Cn		590+11K	
22	Chips	3403+57Ś+10K+1R		31+12K		1429	
23	Chunks	159+2Ś+5K+2P		7+8K		169+9K	
VII	Tools and tool production waste:						
24	Retouched tools	530+14K+11Ś+ +5P+3T+1Cn+6J+ +1JS+2R+1OB	12,36	27+8K	15,28	51+1K+1J	8,94
25	Burin spalls	275	5,92	10	4,37	33	5,56
		13167		350		2804	

Code of raw materials as in Table I

Table IV. Blockdiagram showing Ge-



Rydno	II/76	I/77	III/76	Mine III/78	II/77	III/77	I/76	I/78	V/77	III/78
II/76		–	+ +	+ +	–	+ +	+ +	+ +	+ +	+ +
I/77			–	+ +	–	–	–	–	+ +	+ +
III/76				+ +	+	+ +	+ +	–	+	+ +
Mine III/78					+ +	+ +	+ +	+ +	+ +	+ +
II/77						–	–	–	+	+ +
III/77							+ +	+ +	+ +	+ +
I/76								–	+ +	+ +
I/78									+ +	+ +
V/77										+ +
III/78										

Fig. 29. Matrix showing significance of the difference in Genera· Structure of assemblages (Kolmogorov—Smirnov λ test)

Computation based on data presented in Table IV, coding of significance as in Fig. 27; order of sites as in Table I

Rydno	II/76	I/76	III/76	Mine III/78	II/77	III/77	I/76	I/78	V/77	III/78
II/76		+ +	–	+ +	–	–	–	+ +	–	–
I/76			+ +	+	+ +	+ +	+ +	+ +	+ +	+ +
III/76				+ +	–	–	–	+ +	–	–
Mine III/78					–	+ +	+ +	+ +	+ +	+ +
II/77						–	–	+ +	–	–
III/77							–	+ +	–	–
I/76								+ +	–	–
I/78									+ +	+ +
V/77										–
III/78										

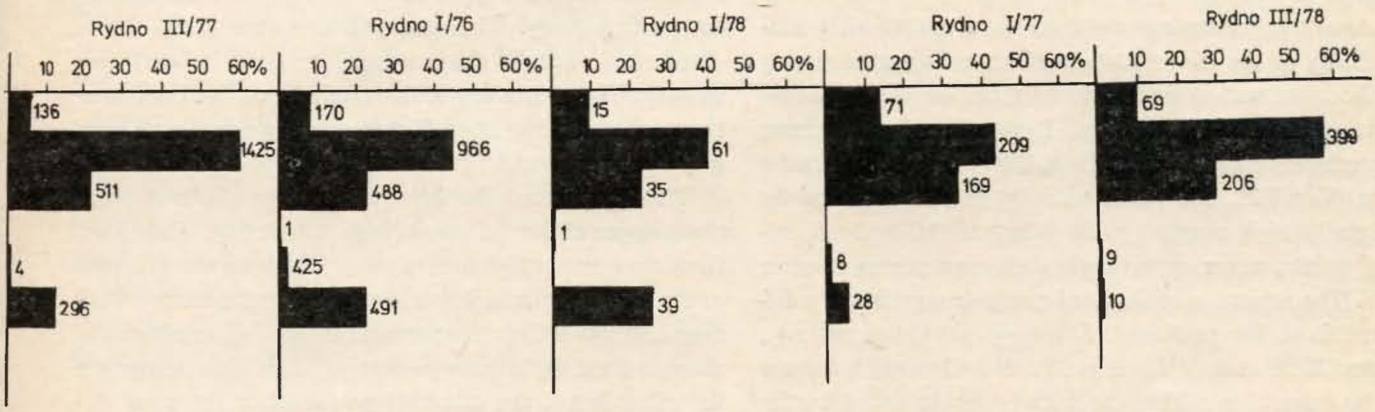
Fig. 30. Matrix showing significance of the difference in raw material structuring (Kolmogorov—Smirnov λ test)

Computation based on data presented in Table III; coding of significance as in Fig. 27; order of sites as in Table I

Continuation of Table III

8	9	10	11	12	13	14	15	16	17	18	19	20	
1		—		1		2		1K		—	—	—	—
250+3J+ +1K+1R		113+1K		1637+1K+ 1Ś+5JS		1496+1Ś		10+20K+ +2Cn		502+5R		438	
299+14K		72+9K		2708+4K+ +1Ś+4JS		3715+ +9Ś+4K		51+61K+ +4Cn		587		2798	
51		3		32+3K+ +1JS		181+2Ś		4+11K+ +4Cn		84		95	
95+6K+ +3J+3R +1T	23,63	34	16,67	229+10K+ +3J+4S	10,37	249+ +5Ś +1K	11,80	9+21K+ +1Ś+ 1Cn	21,19	19+2K	4,33	7+1J	1,15
33+2K+3J	8,32	7	3,76	50	2,11	233+3Ś	10,92	4+2Cn+ +1K	4,64	7	1,44	2	0,29
1077		384		6770		7571		319		1662		4024	

neral Structure of inventories, restricted



jaw of a giant deer dated to Alleröd and seemingly associated with the Arch Backed Piece complex of Western Europe (Wouters 1956).

A low frequency, therefore, of backed elements in the sites of Rydno would imply a base camp character of the assemblages or functions eliminating, to some extent, the necessity of hunting. Near the mine of Rydno, the latter would also suggest a participation in the exchange of goods and a group ownership of the mine.

It seems that there is no particular regularity in the variability of sites versus their distance from the mine, except for the suggestion that all of the sites located at a distance larger than 500 m or separated from the mine by natural barriers, e.g., the bog of "Babica", are rather poor (Rydno I/57, IV/57, IV/37). On the other hand, those located close to the mine, except for I/78 (cf. Figs 13, 14), are dense and rich or very rich in tools and debitage, perhaps inhabited for a longer time. The tool structure of the assemblages occurring very close to the mine, as Site Rydno-Mine III/78 (ca. 100 m), is similar to the assemblages occurring slightly farther from the quarry. It cannot be excluded that the location of sites, in fact, is in

Table V. Summary of tool groups of some Masovian assemblages Rydno IV/57, Central *Kshemenitsa*, according to Schild (1967), Rydno II/56, according to J. K. Kozłowski (1963)

Categories	Rydno IV/57		Rydno II/56		Rydno-Mine Cut I/77 Pit 1 and vicinity
	n	%	n	%	n
1. End-scrapers	19	19,00	19	29,69	1
2. End-scrapers combined w. others	1	1,00	—	—	—
3. Burins	41	41,00	21	32,81	—
4. Borers	6	6,00	—	-	—
5. Backed pieces	—	—	—	—	—
6. Microburins	—	—	—	—	—
7. Truncations	4	4,00	2	3,13	1
8. Masovian points	7	7,00	9	14,06	4
9. Shouldered points	2	2,00	—	—	—
10. Geometrics	—	—	—	—	—
11. Raclettes	—	—	—	—	—
12. Denticulated pieces	12	12,00	5	7,81	2
13. Retouched pieces	1	1,00	—	—	—
14. Other tools	7	7,00	8	12,50	5
Total	100		64		13

relationship to the degree of control exercised by the group over the mine.

On a later level, during Younger Dryas and the use of the mine by Masovian groups, the situation differed from that preceding this period. First of all, a few other elements appeared. Among them perhaps one of the most important was the presence of large workshops processing the chocolate flint. The General Structure of these assemblages differs from that of "living" sites by showing a high stress on blade processing. The workshops also include traces of hematite working in the form of powdered ochre appearing in the fill of man made pits, and, in some cases, they contain exotic raw materials (obsidian, jasper, Jurassic flint from Cracow-Wieluń Upland, Volinian flint, gray dotted Turonian flint, etc.), often all of them in the same assemblage, e.g., Rydno IX/59. The presence of these raw materials, usually imported from distant areas, undoubtedly express the range of traffic, a fact of particular importance at such a complex as Rydno.

Another interesting question is a remarkable dissimilarity of the tool structure of assemblages occurring at the mine and those recovered from larger, seemingly more permanent loci as e.g., Rydno IV/57, containing the remains of a pit house. Thus, the assemblage from the mine (Cut I/77, Pit 1 and vicinity) is characterized by extremely high percentage of pedunculated and willow-leaf points, never occurring in such proportions at other sites. The structure of the tool group is significantly different from the structure of "living" sites such as, e.g., Rydno II/56 and IV/57 (Fig. 31). The General Structure of the assemblages from the mine is characterized by the domination of the group of blade exploitation with a very low value of the group of core preparation. Because of the functional association of pedunculated and willow-leaf points, clearly indicating their primary use as arrowheads (e.g., mounted in arrows at the Deer Island graveyard on the Onega Lake), it is believed that the recovered Masovian assemblage from Cut I/77 represents a particular inventory of the debitage and tools left by the mining party. This occupation seems to be short-lived and, beside the mining, engaged in everyday hunting. The processing of the catch, as well as the extensive tool production and flint processing must have been quite insignificant.

Rydno	IV/57	II/56	Mine I/77
IV/57		–	+ +
II/56			+ +
Mine I/77			

Fig. 31. Matrix showing significance of the difference in quantitative composition of tool groups in some Masovian assemblages from Rydno (Kolmogorov—Smirnov λ test)

Computation based on data presented in Table V, coding of significance as in Fig. 27; *1* — Rydno IV/57; *2* — II/56; *3* — Rydno—Mine I/77

It appears that the Masovian camps show at least three major classes of assemblage structuring. Therefore, there are some camps with more or less common structure of the tool group, similar to that found at locations occurring outside of the mine; several of the *kshemenitsas* are characterized by a heavy stress on flint processing; on the other hand, the assemblages found at the mine demonstrate unusually high frequencies of projectile points.

GENERAL CONCLUSIONS

It seems that the flourishing of the mining accompanied by the apparently extensive exchange of goods and complex ownership status of the mine is mainly associated with the Final Paleolithic. The post-Paleolithic use of the mine is certain, however much reduced in extent and output. Several factors are responsible for the fact that the presence of the Rydno hematite at sites located outside of this complex is difficult to show. Nevertheless, it is certain that the ochre gravel together with quartz gravel of the Łyżwy type occur at several *kshemenitsas* of Całowanie, some 100 km to the north-east of Rydno. According to chemical and physical analyses (see Appendix) their association with the mine of Rydno is almost certain.

The number of prehistoric occurrences near the mine of Nowy Młyn, their distributional, quantitative as well as qualitative variability, overpass those known from the areas surrounding flint mines, never showing similar complexity; although, both are located in the same geographic region (cf. Fig. 1). There is no doubt that the mine of Rydno must have formed a very special prehistoric center, perhaps serving not only the far-reaching exchange, as shown by the presence of exotic raw materials, but also fulfilling some social functions of the band societies gathering in the area. It is believed that the variability, structuring and location of the settlements belonging to the Rydno complex reflect their place and role in the exchange and mining of the red ochre.

It is quite possible that the groups belonging to the Arch Backed Piece assemblages located close to the mine, in the western section of the complex, and characterized by relatively rich *kshemenitsas* (Rydno IX/59, I–III/76, III/77, Rydno-Mine III/78), exercised a special control over the exploitation of the mine, perhaps a sort of group ownership of the area. The poor assemblages, on the other hand, clearly concentrated in the eastern, farther section of the complex (Rydno IV/37, I North/57, IV East/57, V/57, XIII/59), seem to represent relatively short-lived settlements of temporary character, perhaps closely coinciding in time with the period necessary for the acquirement of the ochre, either by digging or exchange. The third category of assemblages, however, such as that present at Rydno I/78, are poor, isolated and made almost entirely from an exotic, erratic flint of low quality. The occurrence of these assemblages suggests single family groups or small task units arriving from distant areas for a short stop at the place.

All of the categories of occurrences appear to be interlocked within a well established system of ochre acquirement, seemingly different from that, much simpler, serving the obtention of flint. The difference could be attributed to the obvious association of the red ochre with magic and beliefs.

The small societies represented during the Younger Dryas and early Preboreal by the assemblages classified within the Masovian cycle also appear to have formed a multifacetted system of ochre acquirement and distribution. During this time, however, the location of settlements has no significant meaning, for both the large flint processing oriented units (Rydno I–III/57, IV/59, XI/59, VII/59 and I/80), as well as the ordinary, living site-like assemblages (Rydno II/56, IV Main/57, VIII/57) occur in the same areas and do not show any specific patterning. At several settlements the acquirement or exchange of ochre is closely related to the larger than usual processing of flint, presumably intended for further traffic.

All of the occupations of the Masovian cycle, including those associated with intense flint processing, appear to be relatively short-lived, a fact seemingly indicated by the presence of low number of tools at individual loci (almost always below 100 pieces). It is believed that the relatively short-lived character of the Masovian occupations reflects a more nomadic way of life. This change, in relation to the preceding Alleröd interstadial, is clearly attributed to a new environmental situation and the adaptation to the tundra and park tundra environment of the Younger Dryas, a fact also conspicuously seen in the settlement patterning on the European Plain, beyond the complex of Rydno. A strikingly different structure of the inventories occurring at the mine itself (Cut I/77, Pit 1 and vicinity) indicates that the ochre was also exploited during very short stops by the groups who lived at the very place of quarring. This dichotomy, perhaps, reflects certain territoriality of Masovian groups as well as variable status of the ownership.

The concentration of sites making up the complex of Rydno, as well as their variability, illustrate both the paleoeconomic and the cultural importance of the hematite. It seems certain that the differences seen in the character and location of the occupations indicate not only the fact that the ochre was a commodity high in demand, but also suggest significant variability in the ownership status and territoriality of human groups, all parts of complex cultural systems. The necessity of trade was obviously generated by these differences, selective occurrences of raw materials as well as the need for common gatherings bonding dispersed groups of Final Pleistocene hunters in more integrated bio-cultural entities.

Spring 1980

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Abbreviation

PA — Przegląd Archeologiczny, Poznań, Wrocław

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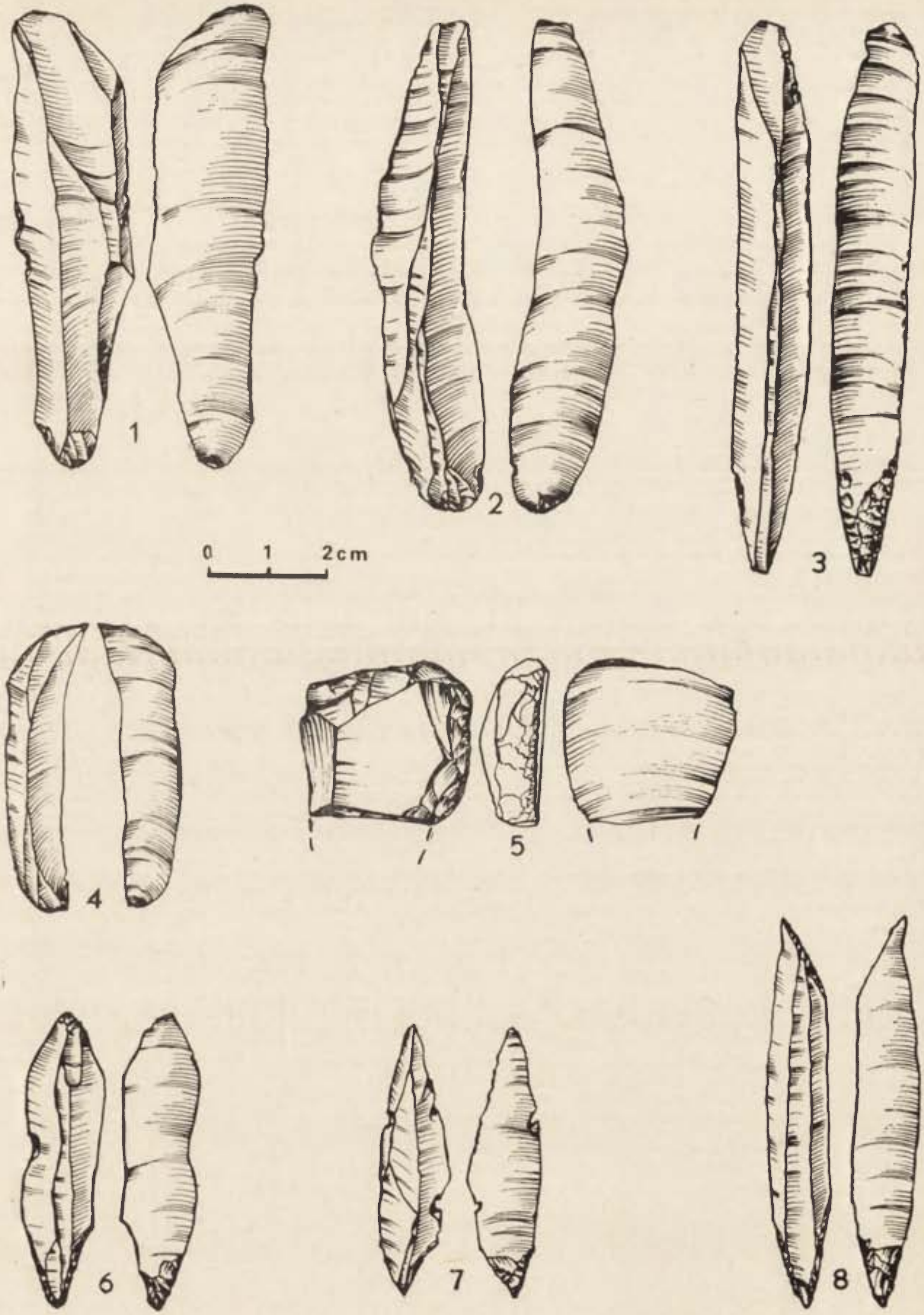

Plate I. Rydno—Mine, Trench 1/77, Pit 1 and vicinity

1, 2 – blades from opposed platform cores; *3, 6–8* – Masovian, willow-leaf points; *4* – arch tipped bladelet; *5* – end-scraper

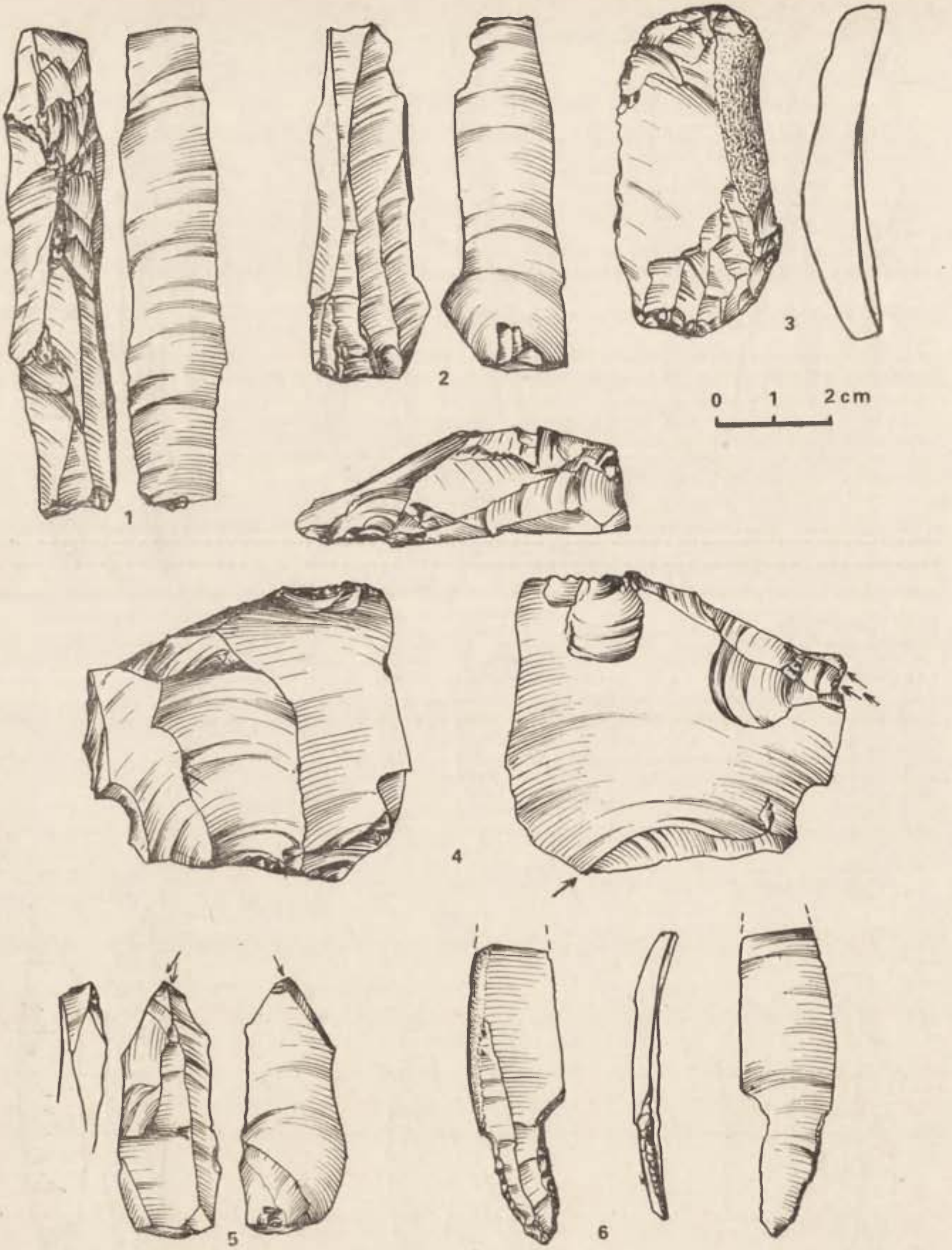

Plate II. Rydno—Mine, Cut III/79, Multi—Unit Quarry

1 — Masovian blade with traces of pre-flaking surface preparation; *2* — Masovian blade; *3* — end-scraper; *4* — multiple burin, possibly Arch Backed Piece complex; *5* — dihedral burin, possibly Masovian; *6* — pedunculated blade (?)

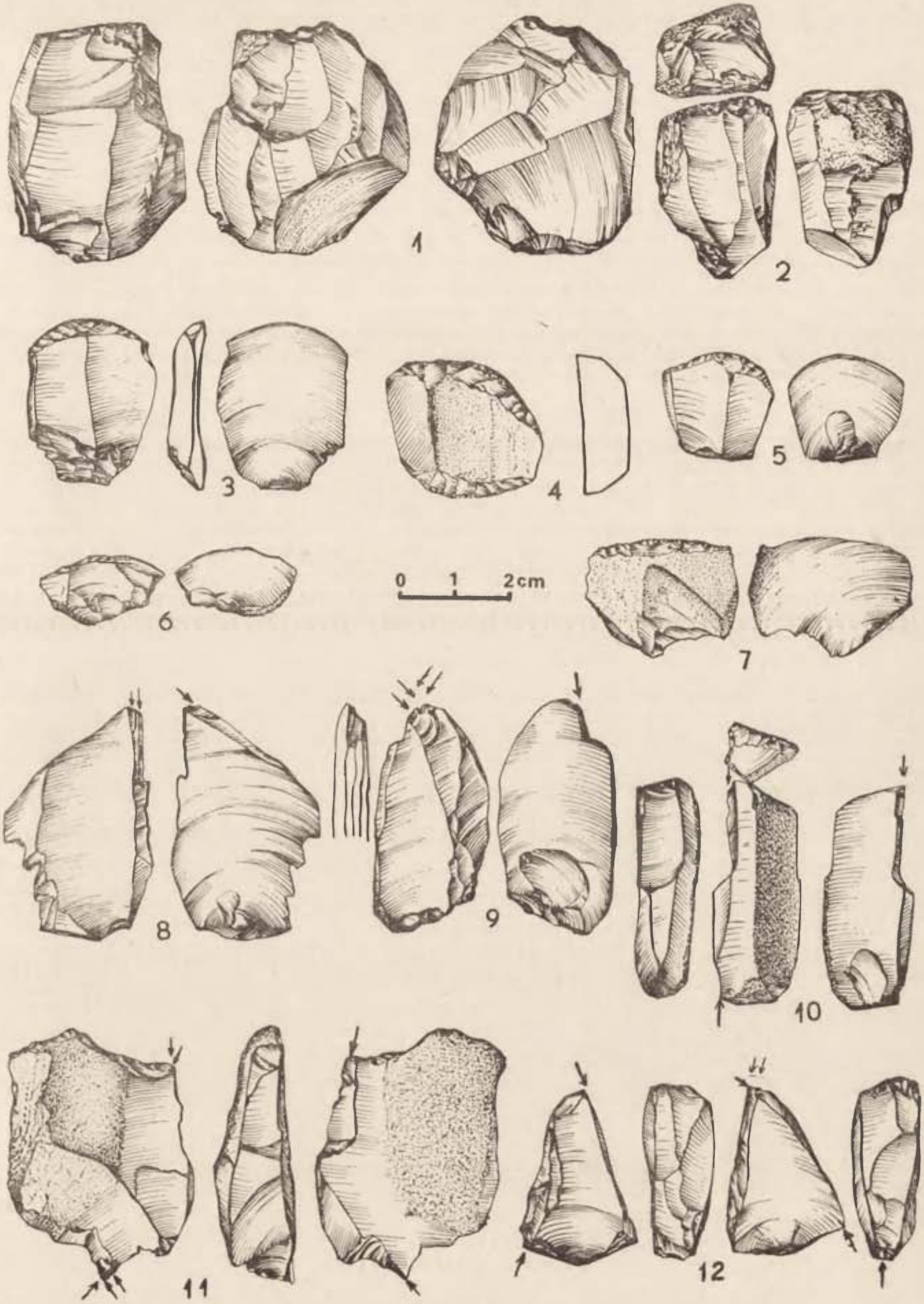

Plate III. Rydno I/76

1, 2 – cores; *3–7* – various end-scrapers; *8–12* – various burins

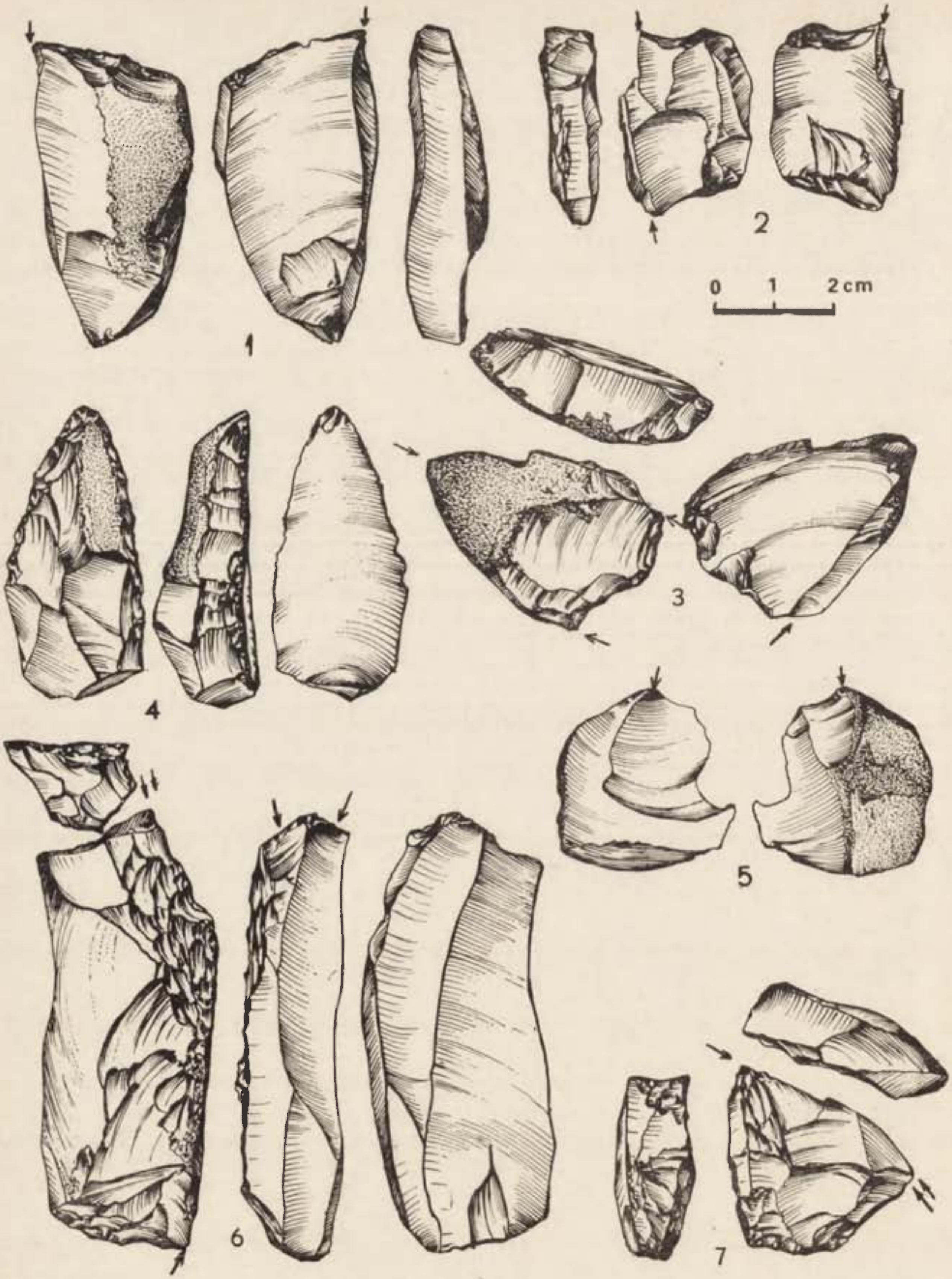

Plate IV. Rydno I/76

1–3 and *5–7* — various burins; *4* — groover

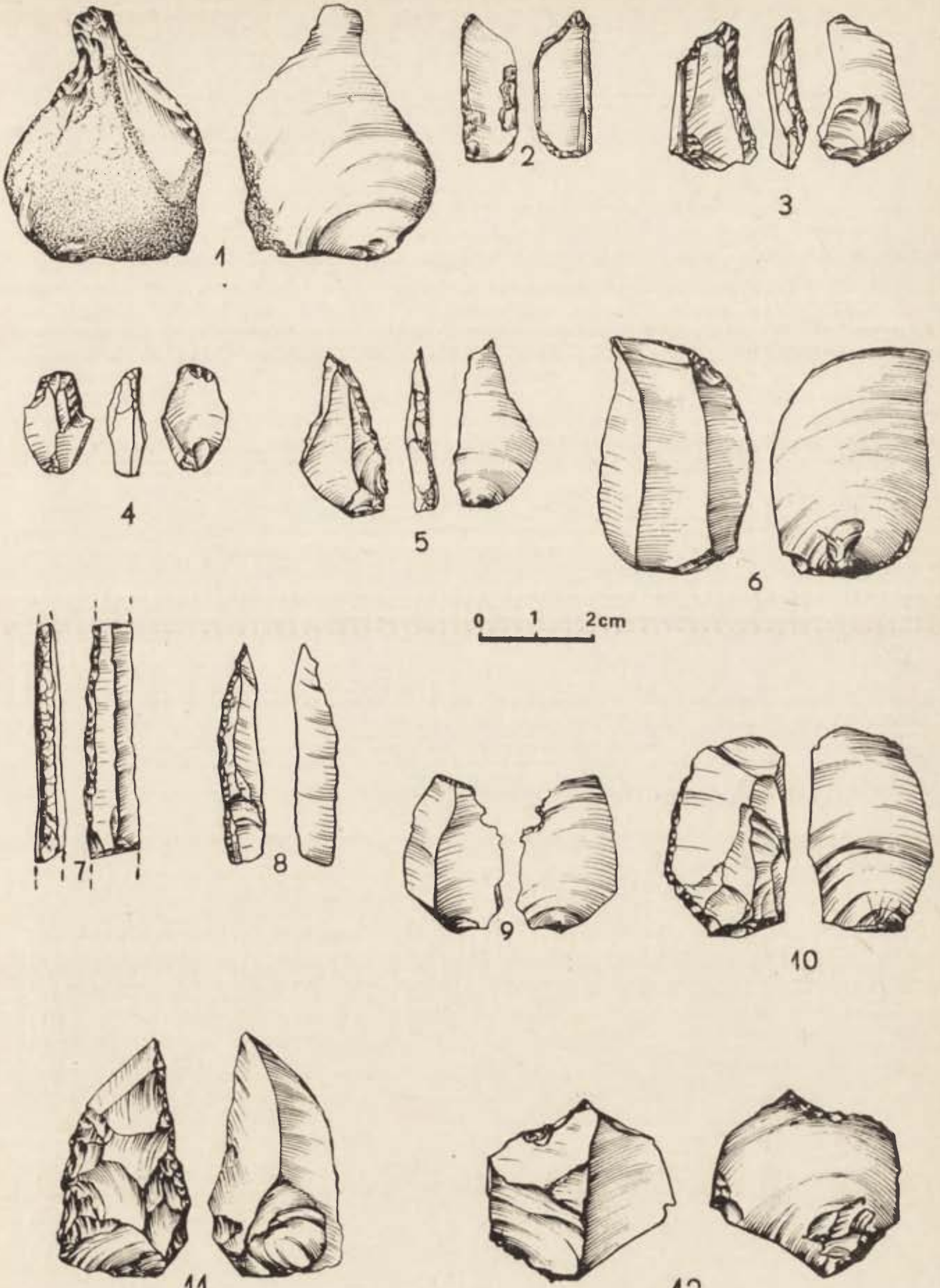

Plate V. Rydno I/76

1-4 — various groovers; *5, 6* — arch backed flakes; *7* — straight backed blade; *8* — arch backed bladelet; *9* — truncated flake; *10, 11* — retouched flakes; *12* — notched flake

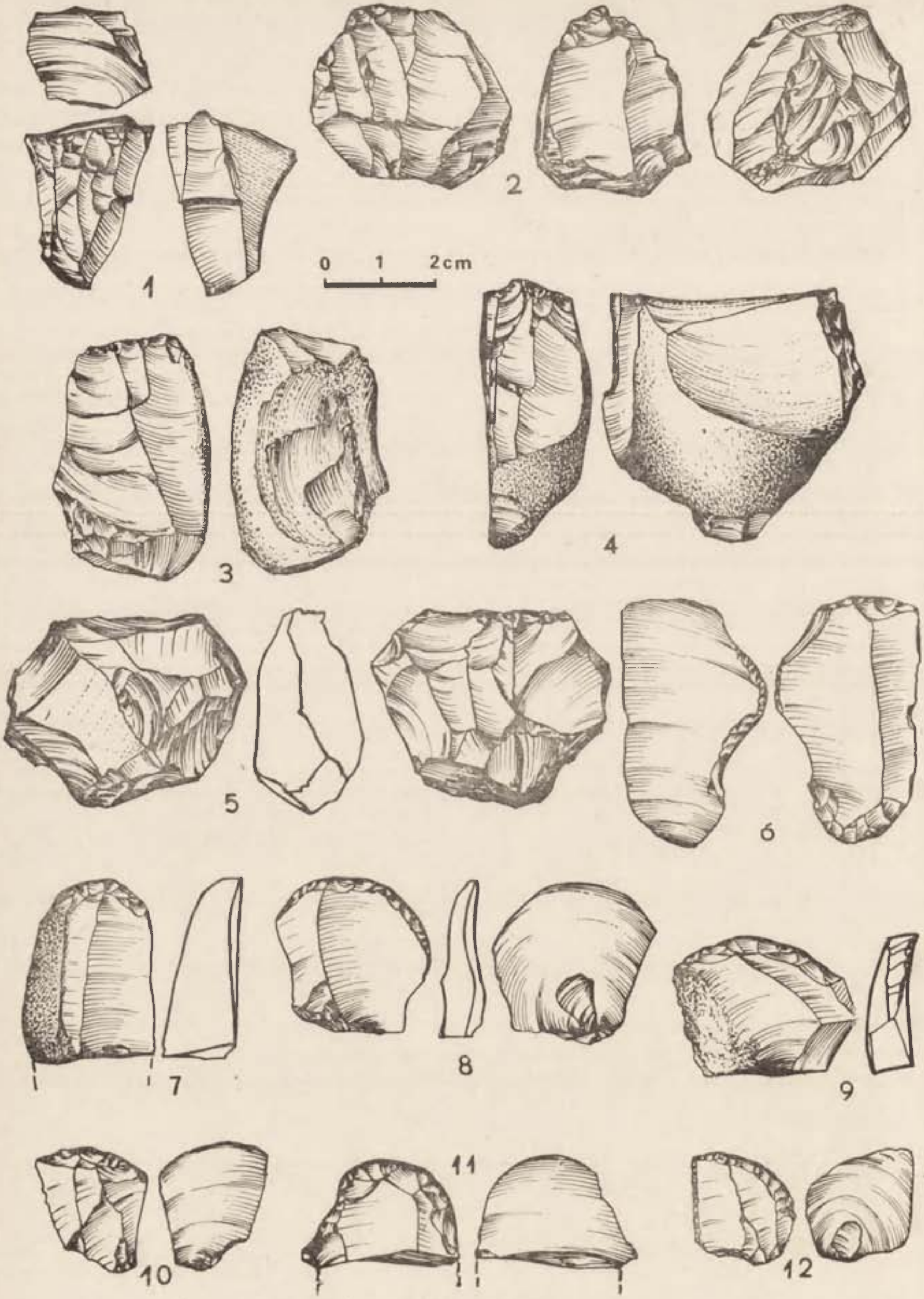

Plate VI. Rydno II/76

1-5 — various cores; *6-12* — various end-scrapers

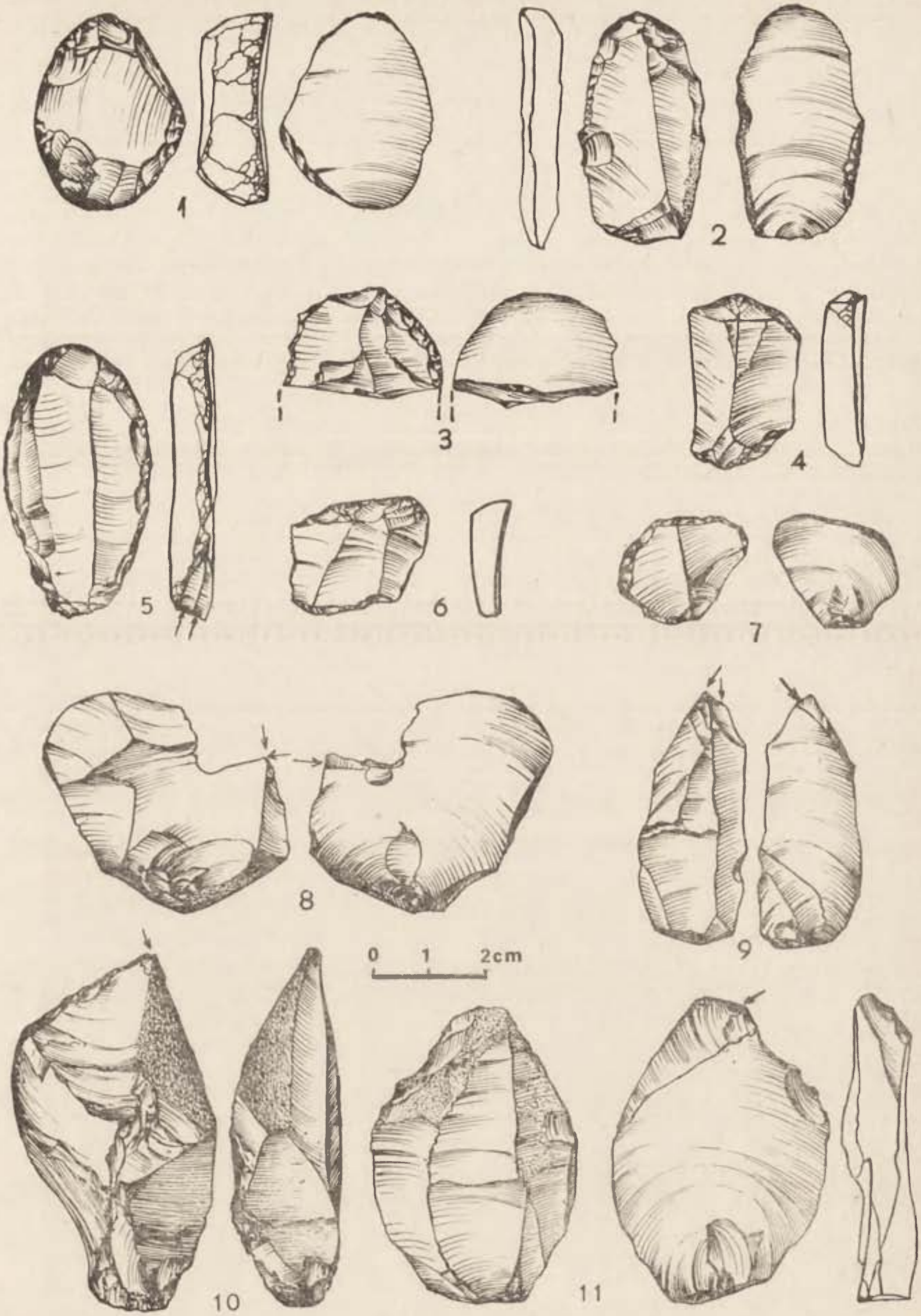

Plate VII. Rydno II/76

1–7 — various end-scrapers; *8–11* — various burins

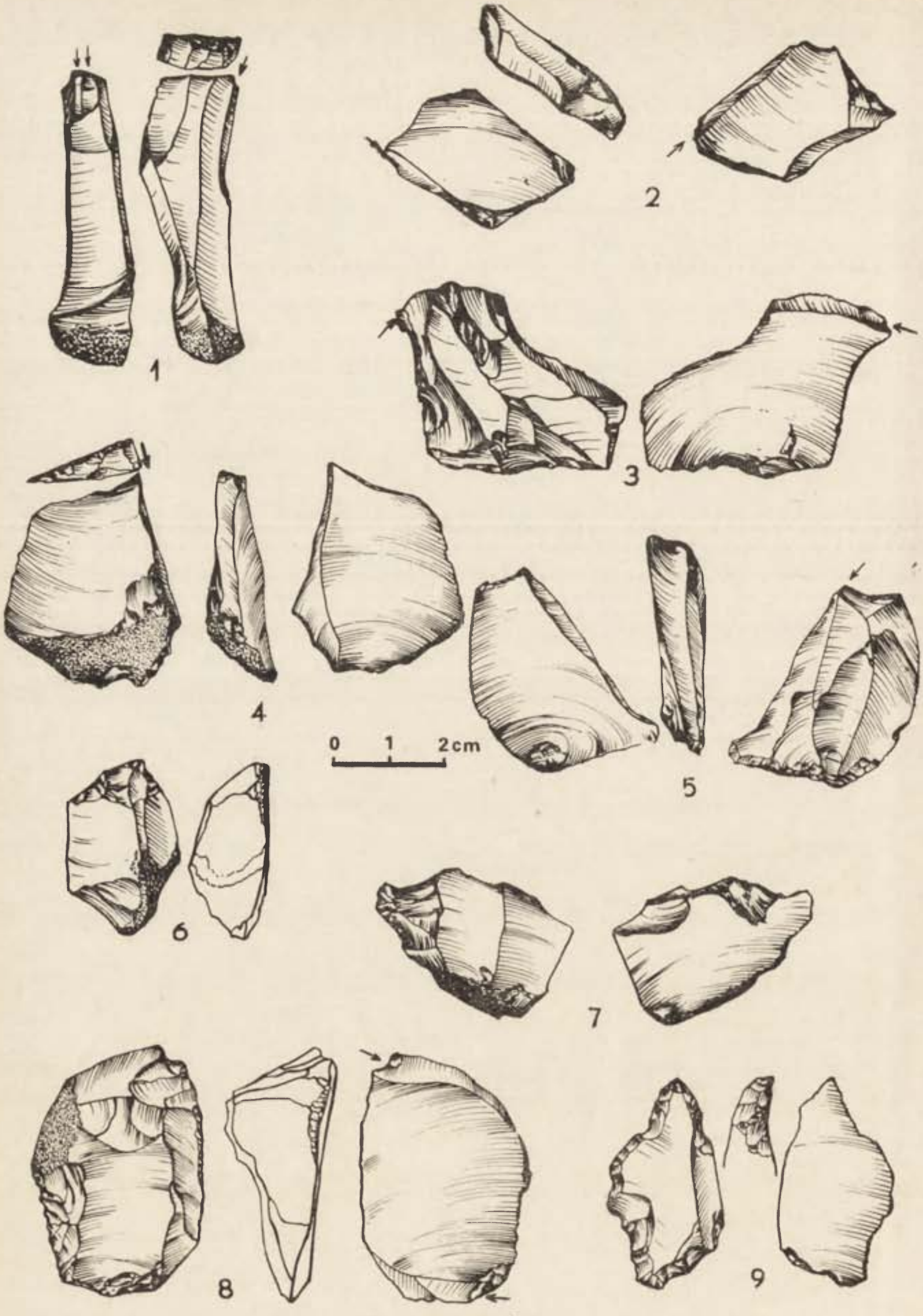

Plate VIII. Rydno II/76

1–5, 8 — various burins; *6* — bec; *7* — groover; *9* — *zinken*

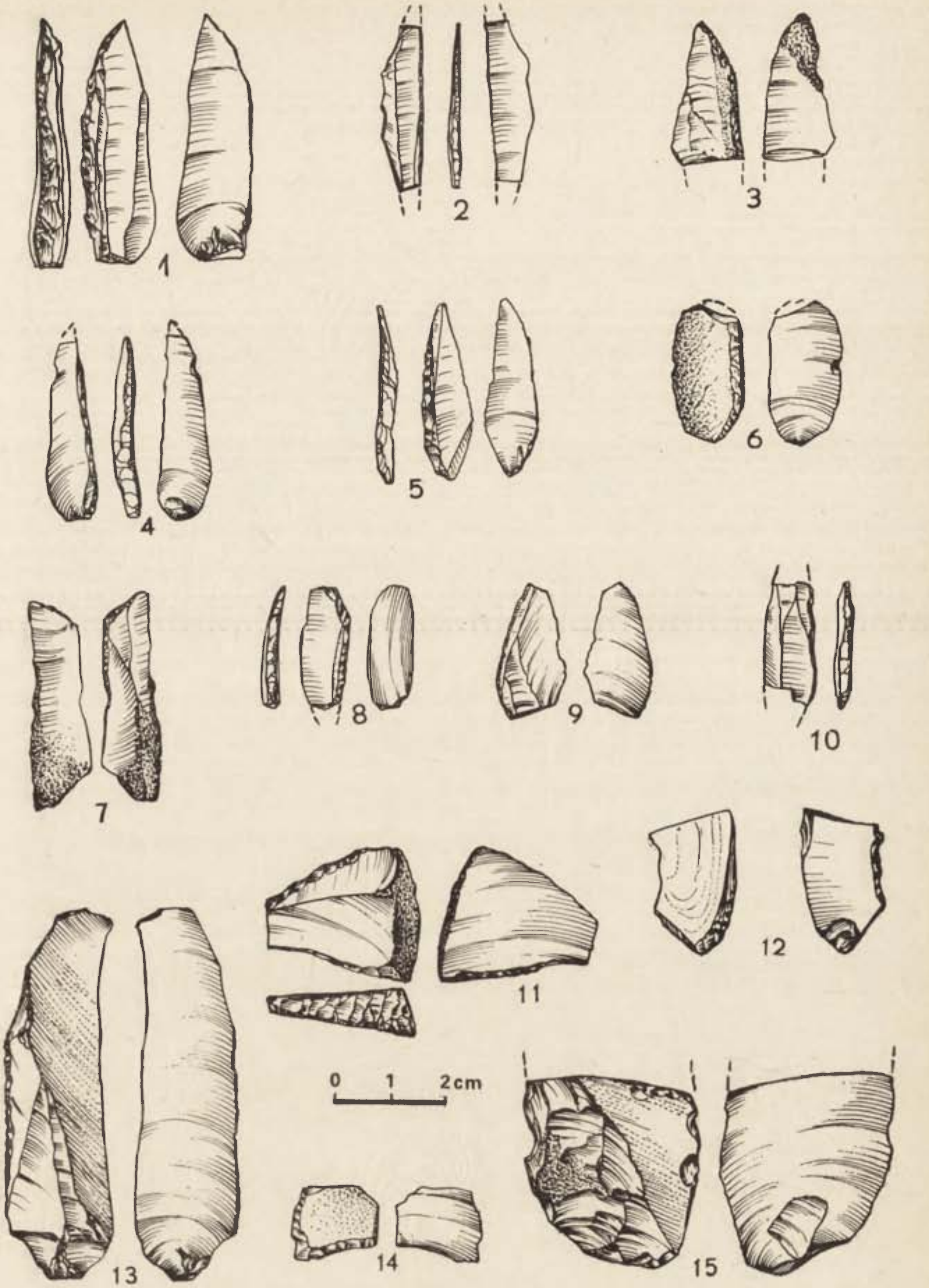

Plate IX. Rydno II/76

1 – pointed, arch backed blade; *2, 4,* – straight backed bladelets; *3, 5,* 10 – arch backed bladelets; *6* – backed flake; *7* – backed and truncated bladelet; *8, 9* – arch backed flakes, the latter made of obsidian; *11–13, 15* – various retouched pieces; *14* – be

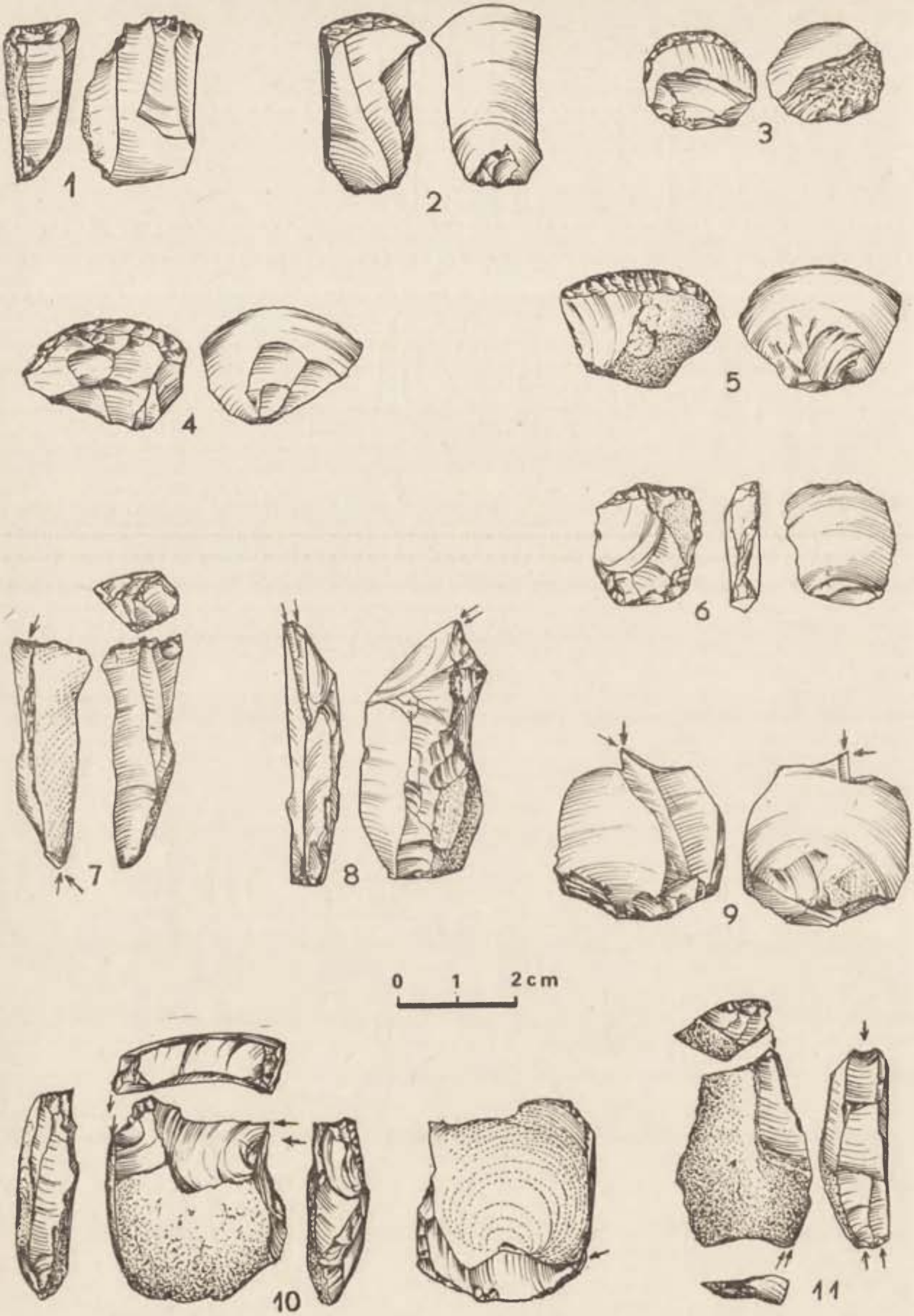

Plate X. Rydno I/77

1 – core; *2–6* – various end-scrapers; *7–11* – various burins

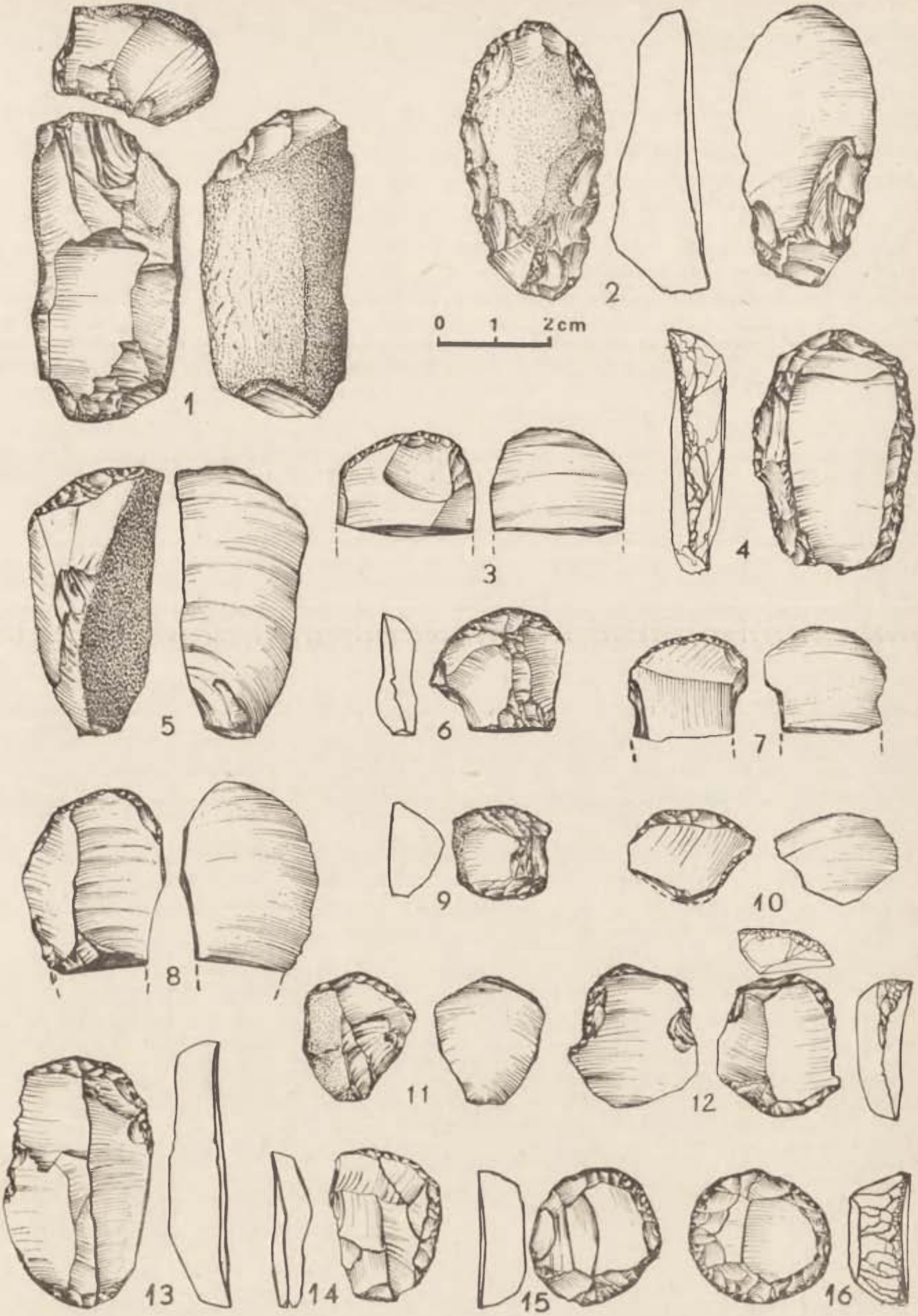

Plate XI. Rydno III/77

1 – core; *7–16* – various end-scrapers

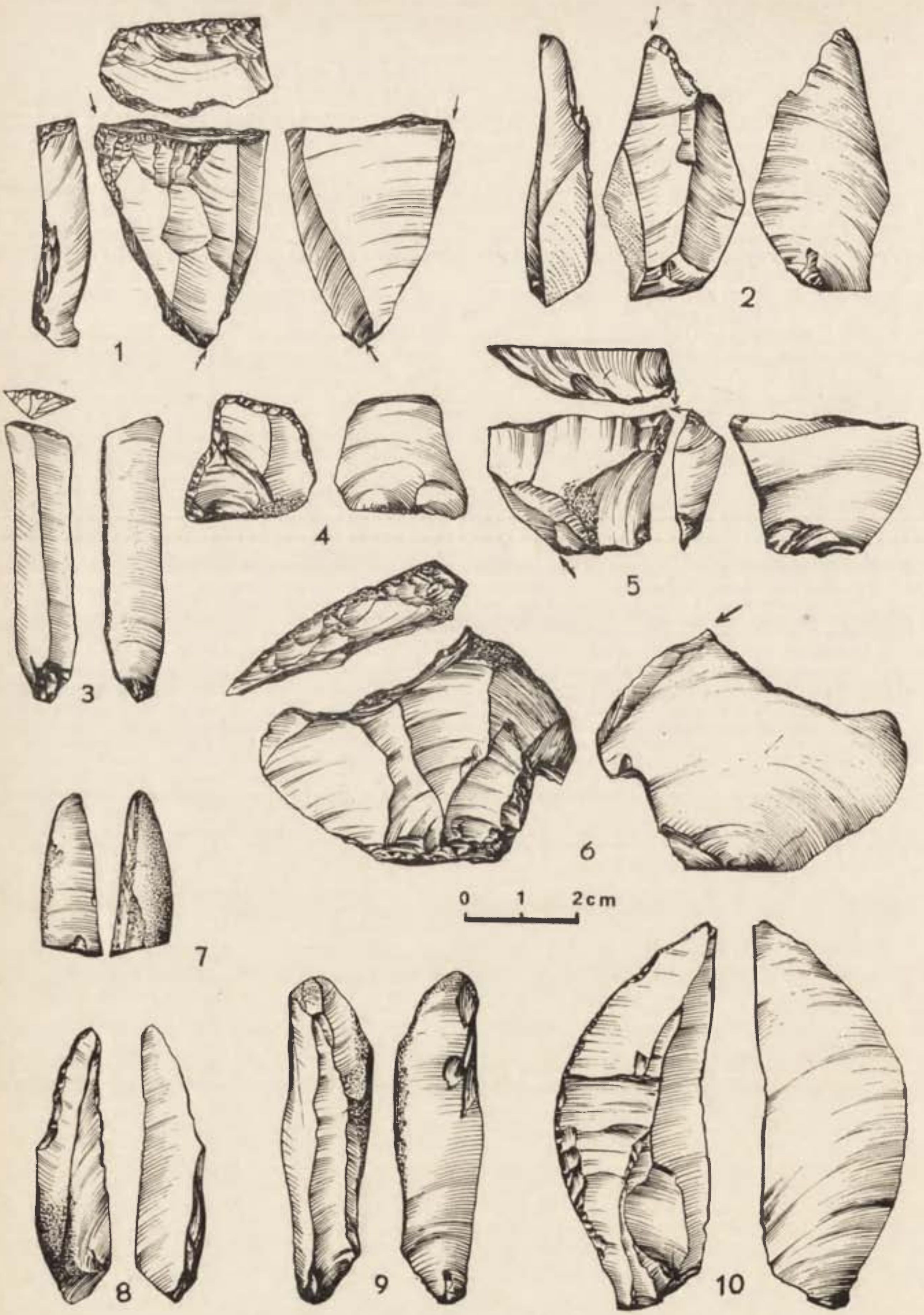

Plate XII. Rydno III/77

1, 2, 5, 6 — various burins; *3* — truncated blade; *4* — *raclette*; *7, 9* — blades with ground tips; *8* — perforator; *10* — retouched flake

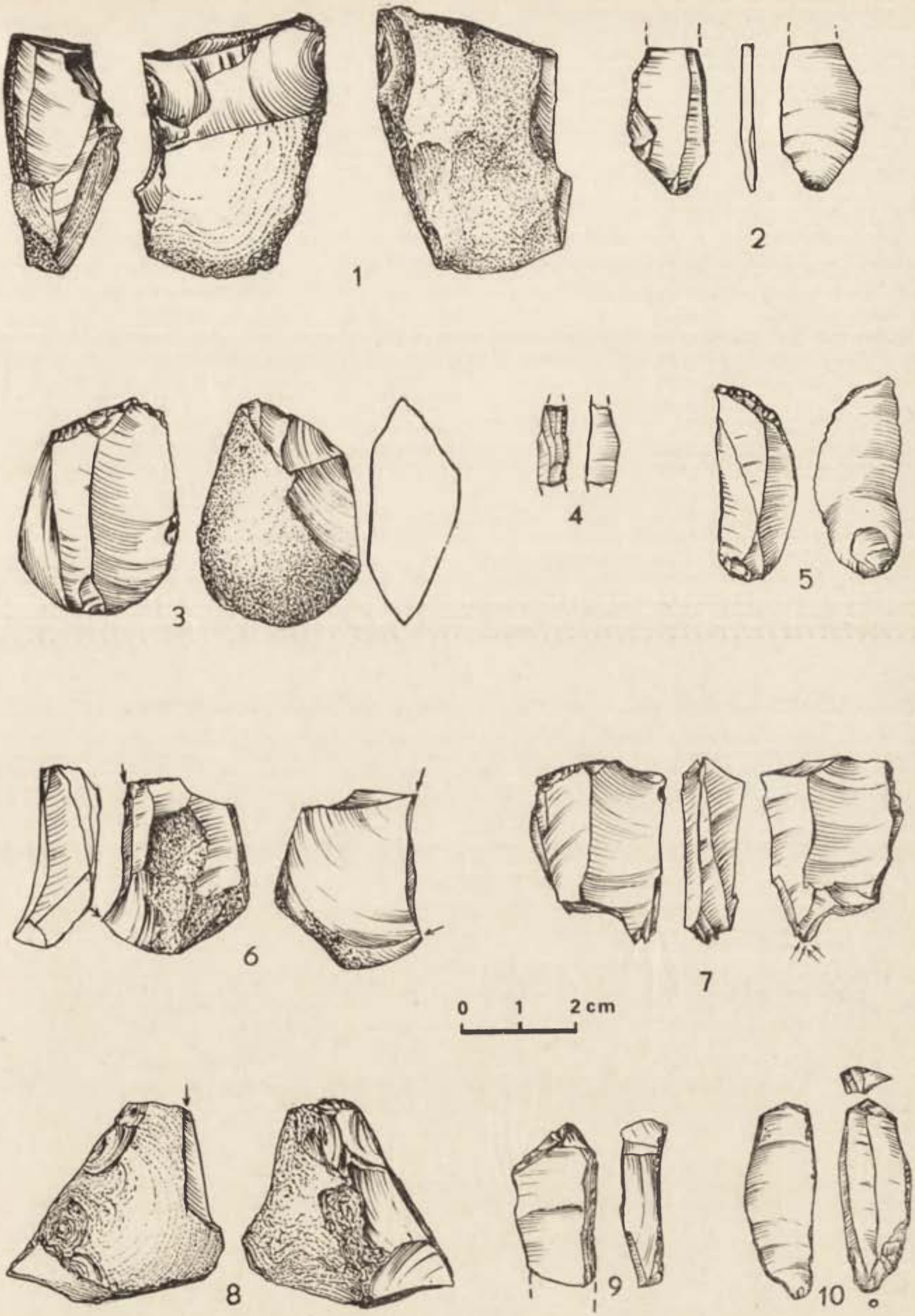

Plate XIII. Rydno I/78

1, 3 – cores; *2, 5* – arch backed bladelets; *4* – straight backed bladelet; *6–8* – various burins; *9* – be[illegible]; *10* – perforator

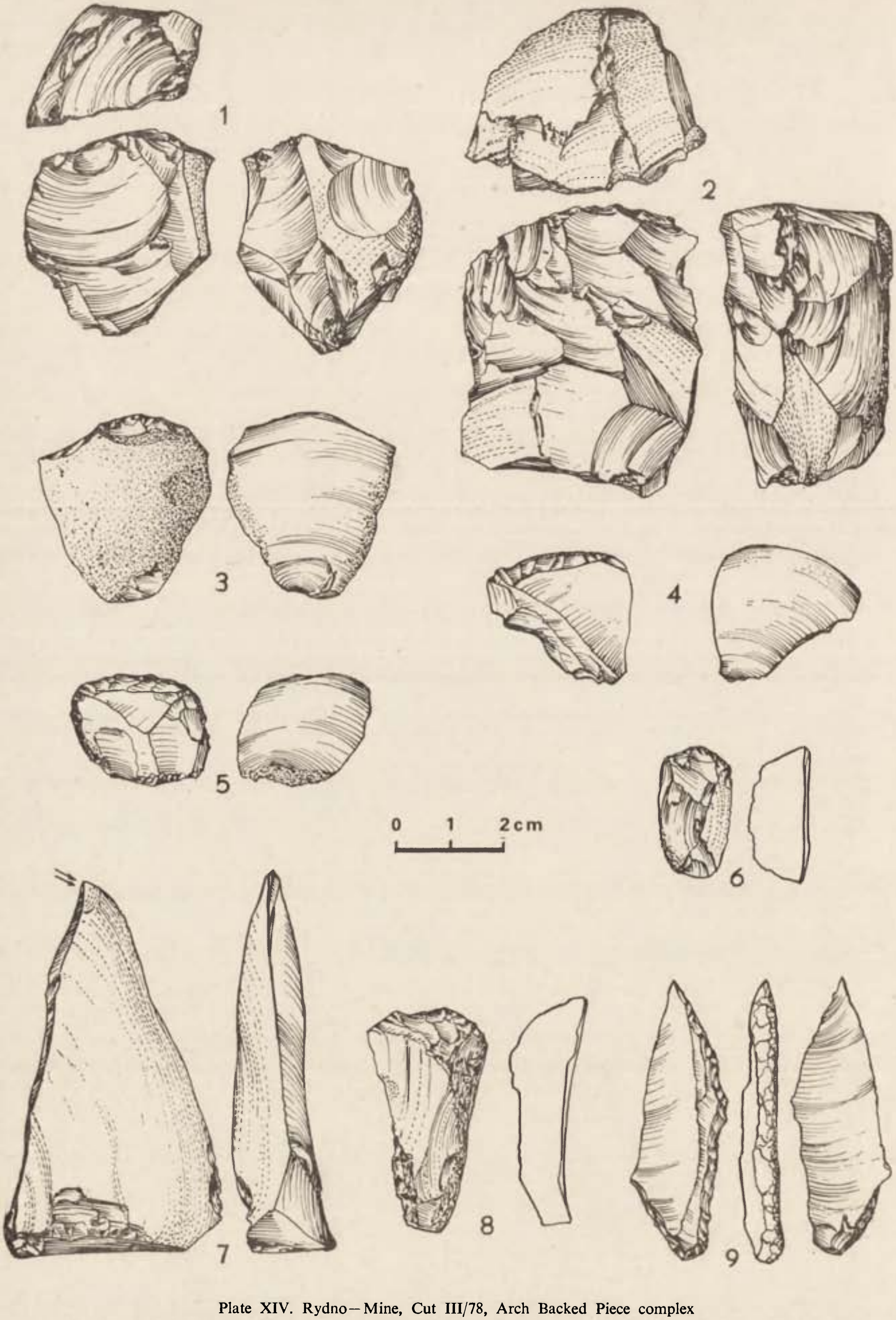

Plate XIV. Rydno—Mine, Cut III/78, Arch Backed Piece complex

1, 2 — cores; *3–6, 8* — various end-scrapers; *7* — burin; *9* — arch backed blade with retouched base

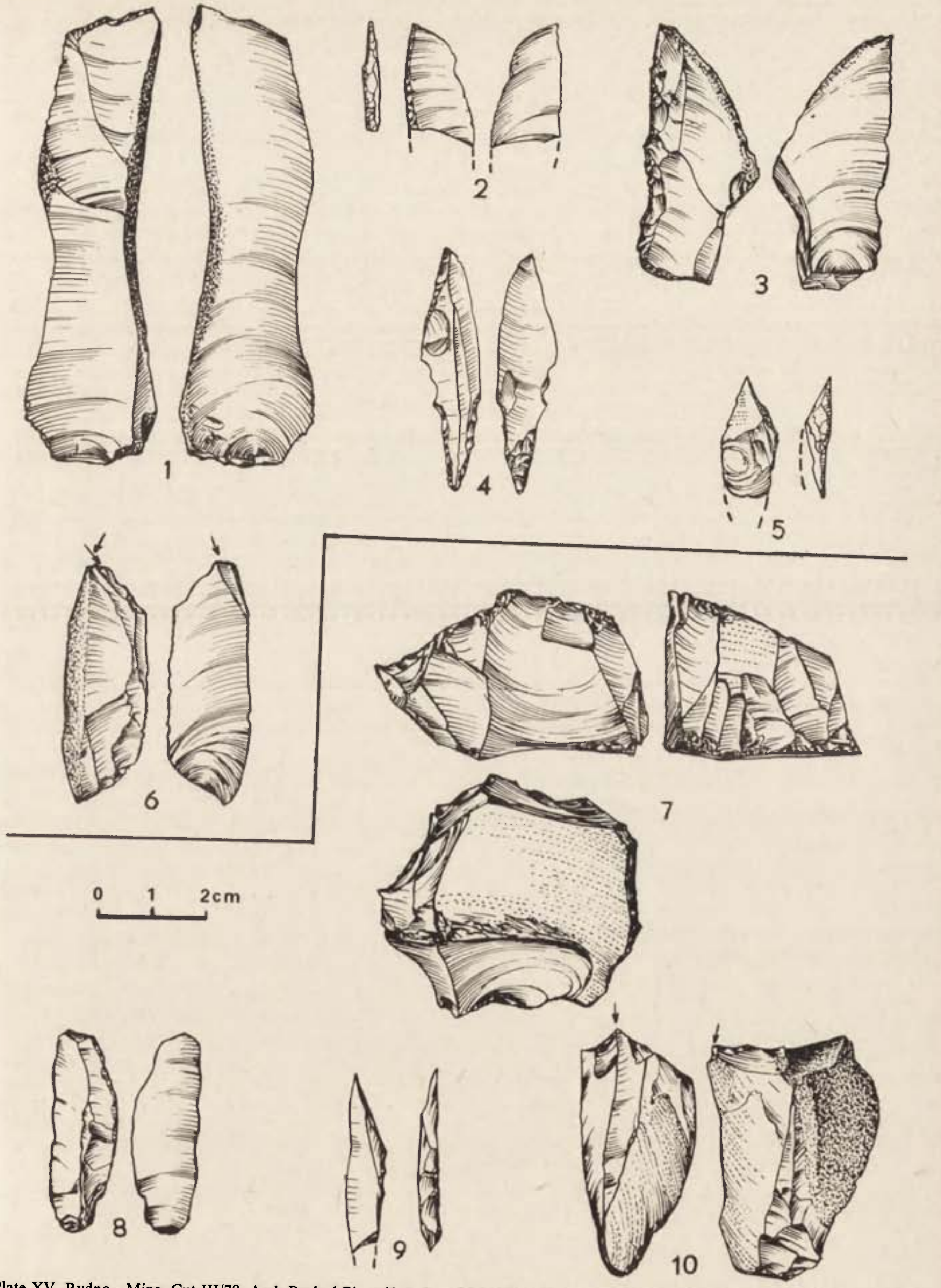

Plate XV. Rydno—Mine, Cut III/78, Arch Backed Piece (*1–3*, *5*) and Masovian (*4*, *6*) complexes; Rydno—Mine, Cut I/79. Concavity 1 (*7–10*)

1 – truncated blade; *2* – blunt tipped, backed bladelet; *3* – retouched flake; *4* – pedunculated point; *5* – pointed, arch backed bladelet; *6* – dihedral burin; *7* – core; *8* – partially backed, arched bladelet; *9* – pointed, arch backed bladelet; *10* – burin on a truncation

APPENDIX

ZDZISŁAW HENSEL

PHYSICAL AND CHEMICAL EXAMINATION OF HEMATITE GRAINS FROM RYDNO AND CAŁOWANIE

A series of hematite graines from the ochre mine of Rydno, as well as those from the Final Paleolithic settlement of Całowanie, near Warsaw[1] (Table 1), had been submitted to the Central Laboratory of the Institute of the History of Material Culture for further analyses. The analytical procedures used were as follows: 1 — Spectrographic analysis of emission; 2 — Structural X-ray analysis; 3 — Thermic analysis of DTA and TG.

Table 1. Provenance of submitted samples

N	Cl sample number	Locality	Field season	Additional date
1	6570	Rydno-Mine	1977	Trench 1, Sq. B/1, Depth 90–120 cm
2	6571	,,	1977	Trench 1, Sq. C-D/10, Depth 42–75 cm
3	6572	,,	1977	Trench 1, Sq. C-D/10, Depth 76–105 cm
4	6573	Całowanie, near Warsaw	1968	Cut XII, Level III, Mid--Alleröd
5	6574	,,	1967	Cut IX, Level IV, Conc. W., Late Alleröd
6	6575	,,	1968	Cut XI, Level V, early Younger Dryas

1. SPECTROGRAPHIC ANALYSIS

The chemical composition of submitted hematite grains has been obtained by quantitative, spectrographic analysis of 17 samples. The analyzed material (20 mg of each sample), mixed with graphite and the standard (germanium), was placed in the containers of graphite electrodes and then induced in the A. C. arc. The grid spectrograph (PGS-2) was used to perform the analyses[2], the results of which were calibrated according to the iron ore standards of the British Chemical Standards (Table 2).

Table 2. Quantitative results of spectrographic analysis as determined by classic chemical methods

N	CL sample number	Percentages by weight (approximate)						
		Fe	Si	Mg	Ca	Al	Ti	Mn
1	6570 A	70,12 50,76	12	2,0	0,38	1,8	0,44	0,02
2	B	64	12	2,0	0,30	2,2	0,60	0,003
3	6571 A	66	14	2,0	0,27	2,2	0,72	0,09
4	B	68	8	1,4	0,28	1,7	0,20	0,05
5	6572 A	52	11	1,5	0,25	2,0	0,51	0,03
6	B	45	17	1,3	0,25	2,5	0,52	0,02
7	6573 A	55	8	1,6	0,35	1,7	0,30	0,003
8	B	40	22	1,2	0,32	3,0	0,68	0,001
9	C	58	9	1,8	0,52	1,7	0,36	0,001
10	CI	55	12	1,7	0,40	1,7	0,51	0,001
11	6574 A	60	16	1,7	0,40	2,3	1,0	0,001
12	B	66	17	2,0	0,40	2,0	0,80	0,001
13	6575 A	50	19	1,8	0,25	2,7	1,10	0,001
14	B	35	23	1,1	0,20	3,4	0,70	0,001
15	C	45	27	1,3	0,35	4,4	1,00	0,003
16	D	35	27	1,2	0,20	2,0	0,75	0,001
17	E	32 30,73	22	1,1	0,30	4,0	0,90	0,001

2. STRUCTURAL X-RAY ANALYSIS

The identification of the phase composition of the submitted materials was done by structural X-ray analysis. The procedure included the emission of a cobalt lamp, induced by the 40 kV voltage and the anode current intensity of 15 mA. The X-rays were filtered by the Fe filter; the $K\ \alpha$ wave length was equal to 1,790A. The samples were irradiated in the Debay-Scherer-Hull cameras with the use of a flat camera. Two differing physical states of samples were examined: 1 — intact hematite grains; 2 — Powdered, in an agate mortar, grains mixed

Table 3. Identification characteristics of hematite and lepidocrocite as compared with obtained radiographic date

N	d_{hkl} Actual	I	d_{hkl} Fe_2O_3	I	d_{hkl} FeO OH	I
1	6,1	100			6,25	100
2	3,64	20	3,66	10		
3	3,30	20			3,29	80
4	2,70	80	2,69	70		
5	2,51	60	2,51	40	2,46	70
6	2,20	20	2,18	20		
7	1,927	20			1,932	70
8	1,84	20	1,835	30		
9	1,688	40	1,68	50		
10	1,487	10	1,485	10		
11	1,45	40	1,44	20	1,452	10

[1] The author is grateful to Professor Schild for sumbitting the samples excavated by him at Rydno and Całowanie.

[2] The analysis was made by Mrs. L. Koziorowska.

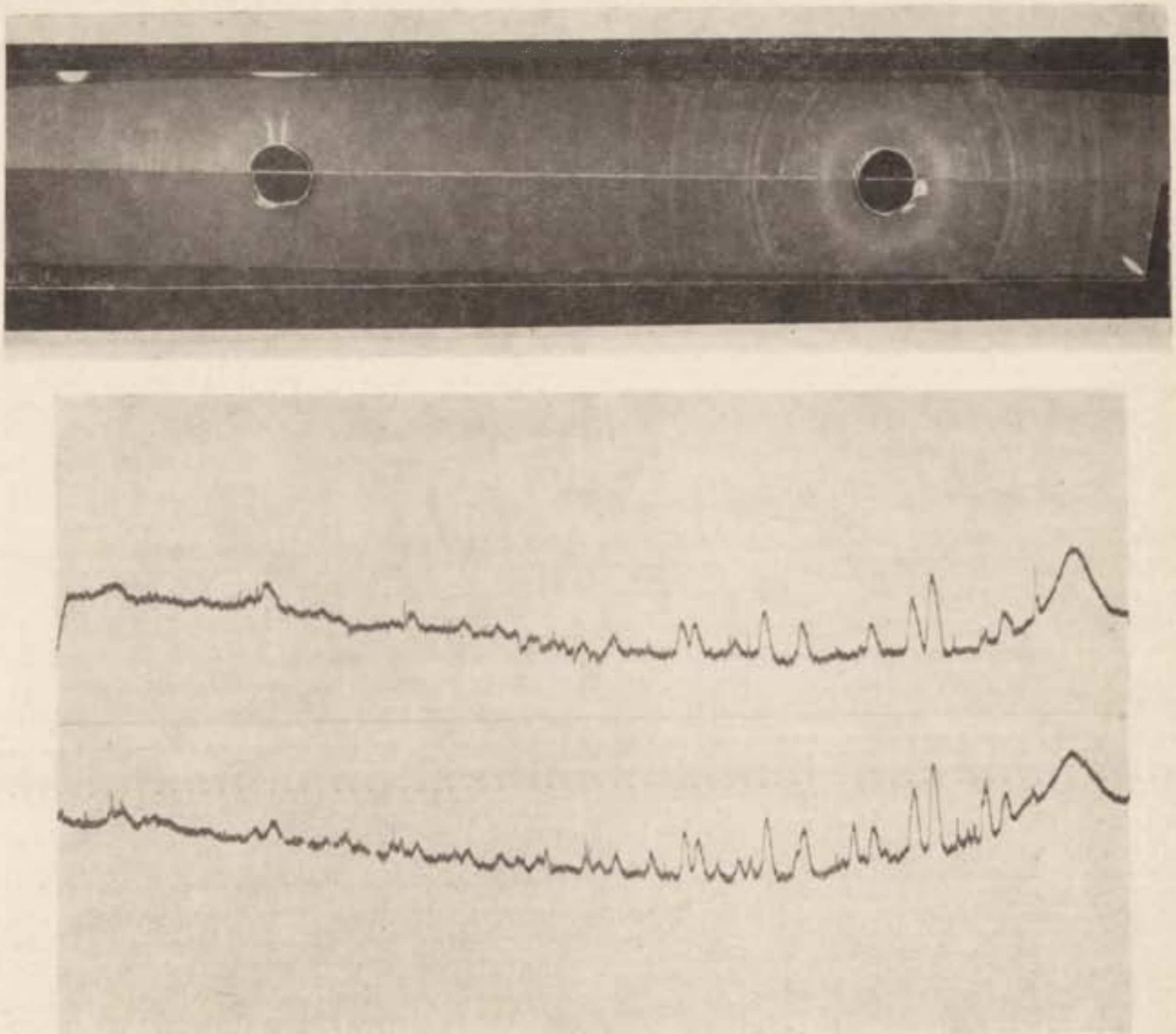

Fig. 1. Radiographs of powdered hematites.
a — sample N. 4; *b* — sample N. 2; *c* — microphotometric curve of radiograph a; *d* — microphotometric curve of radiograph b

Table 4. Comparative chemical composition of iron ores from the mines „Staszic", in Rudki, Holy Cross Mountains

N	Ore	Major components in per cent						Loss in per cent
		Fe	Mn	SiO_2	Al_2O_3	CaO	MgO	
1	Red ore: mixture of hematite and limonite	37,93	0,41	20,00	16,41	0,28	0,36	8,81
2	Hematite "cream": pure hematite with admixture of silt	43,06	—	15,34	15,22	0,22	0,25	7,26
3	Specular (pure) hematite	60,04	0,61	5,94	1,95	0,33	0,26	6,53

with Canada balsam and then rolled in the form of rods, measuring ca. 0,5 mm in diameter. The obtained results[3] are shown on Table 3 and Figure 1.

[3] The identification was based on tests published by E. Przybora (*Rentgenostrukturalne metody identyfikacji minerałów i skal*, Warszawa 1957, p. 322 f., test 339 and 344).

3. THERMIC ANALYSIS

The thermal characteristics of the samples were obtained with the help of the Derivatograph thermoanalizer of Hungarian make. The samples were powdered and heated, in the air, in the platinum containers. Because of the va-

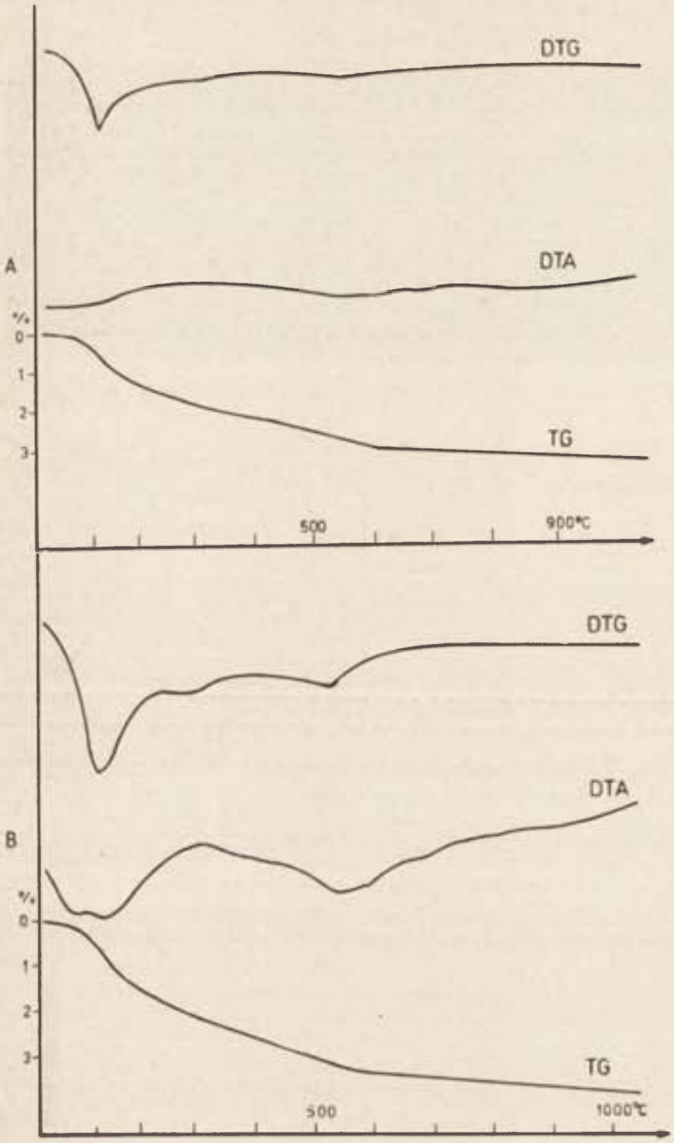

Fig. 2. Termographs of sample
a – CL 6571/2/, 600 mg, sensitivities. TG-100, DTG-1/5, DTG-1/10; *b* – CL 6573/4/, 710 mg, sensitivities: TG-100, DTG-1/3, DTA-1/3

riable size of the samples the total volume of each sample was used. The obtained results[4] are shown on Fig. 2.

The structural analyses clearly indicate that all of the samples from both sites are of the same type. At both sites, the grains are composed of hematite (Fe_2O_3), silicon dioxide (SiO_2) and the lepidocrocite (FeO OH). According to the chemical composition of samples and the comparison with other hematite ores from the Holy Cross Mountains (Table 4)[5], it seems most likely that the ochre from Całowanie was mined at Rydno.

[4] The interpretation of thermic diagrams was helped by information published by M. Borkowska and K. Smulikowski (*Minerały skałotwórcze*, Warszawa 1973, p. 24).

[5] K. Bielenin, *Starożytne górnictwo i hutnictwo żelaza w Górach Świętokrzyskich*, Warszawa—Kraków 1974, p. 98.

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