14th Symposium of the International Work Group for Palaeoethnobotany
Kraków, Poland 17–23 June 2007

Excursion guidebook

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Published with the financial support of the Jagiellonian University

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PART. 1. THE NIECKA NIDZIAŃSKA BASIN – OUTLINE OF GEOGRAPHY AND VEGETATION

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INTRODUCTION

During our excursion we will visit three interesting places: two steppe reserves ("Krzyżanowice" and "Wały") and an archaeological site – Stradów. They are situated within the Niecka Nidziańska (Nida river) basin macroregion (Fig. 2). This macroregion is the southern part of the more extensive geographical unit – the Wyżyna Małopolska upland. It borders with the Wyżyna Śląsko-Krakowska upland (from the west), the Wyżyna Lubelska and Roztocze uplands (from the east) and with the Kotlina Oświęcimska and Kotlina Sandomierska basins (from the south) – Fig. 1.

GEOGRAPHICAL DESCRIPTION

The area of the Niecka Nidziańska basin (4,684 km^2) is a wide depression, of elevations between 100 and >400 (mostly 200–300) m a.s.l., with the Nida river valley as its NW–SE axis. Presence of hummocks and secondary basins allows distinguishing eight geographical sub-units (mesoregions) – Fig. 2:

- Płaskowyż Jędrzejowski plateau
- northern part of the Płaskowyż Proszowicki plateau
- Garb Wodzisławski hummock
- Garb Pińczowski hummock
- Dolina Nidy valley
- Niecka Solecka basin
- Niecka Połaniecka basin
- Wyżyna Miechowska upland

The area has a diversified relief and varied rock and soil cover. On elevated areas loess cover dominates, with outcrops of lime-rich silicate rocks, gypsum and Tertiary limestones (especially within erosion slopes and ravines). Soils, formed on those deposits, are mainly chernozem-like (phaeozems) and rendzinas. Within river valleys, Holocene deposits like sands, gravels and silts prevail. Soils formed there are mainly alluvial ones.

Płaskowyż Jędrzejowski plateau (738 km^2) is situated between Pilica, Nida, Biała Nida and Mierzawa rivers. The elevations are between 270 and 326 m a.s.l. and the entire area is softly leaning from the west to the east. It is built of Cretaceous marls, partially covered with Quaternary sands and clays. Prevailing type of soil are rendzinas, mainly used as arable land. Forest areas are sparse. Forest communities are represented mainly by oak-hornbeam woods (on fertile soils) and pine woods (on sandy places).

Wyżyna Miechowska upland (963 km^2) is a transient area between the Niecka Nidziańska basin and the Wyżyna Śląsko-Krakowska upland. It is the highest part of the Niecka Nidziańska basin – its elevation reaches over 400 m a.s.l. The area is built of lime-rich silicate rocks and Miocene oozes. There are numerous outcrops of lime-rich silicate rocks. Prevailing share of soils is formed on loess, and mainly used as arable land.

Płaskowyż Proszowicki plateau (770 km^2) is a secondary tectonic basin, built of Miocene sediments covered with loess. The upland area, divided into wide hills, is deforested and used

as arable land (there are very fertile soils here – chernozems – derived from the loess substratum).

Garb Wodzisławski hummock (513 km^2) is a Cretaceous anticline 40 km long and 10 km wide, elevated between 261 and 368 m a.s.l. The geological substratum consists of chalk rocks covered with loess. The loess cover is dissected with dense system of ravines and flat-bottomed accumulation valleys. The area of the Garb Wodzisławski hummock is mainly used as an arable land, but there are significant forest areas preserved in its northeastern part.

Dolina Nidy valley (305 km^2) is 2–3 km wide and has flat, wet and periodically inundated bottom, covered with alluvial soil, used mostly as meadows and pastures. Peats occur within old-river bed situated within the valley. On the valley slopes there are also sandy terraces.

Niecka Solecka basin (208 km^2) is situated to the east of the Dolina Nidy valley. Its area is built of Miocene gypsum, forming domed hills and hill ranges. Its elevation reaches over 260 m a.s.l. In the gypsum substrate there are well-developed karst forms like: caves, valleys, subsidence basins, sinks, etc. On the gypsum rocks thermophilous grasslands occur. Sulphate springs, connected with occurrence of gypsum substrate, can be also found within the Niecka Solecka basin.

Garb Pińczowski hummock (257 km^2) is elevated between 293–330 m a.s.l., and forms an uplift between The Niecka Solecka and the Niecka Połaniecka basins. It is built of Jurassic and Cretaceous rocks, covered partially by Miocene sediments: sandy marls, limestones and gypsums (the latter in Busko town vicinity).

Niecka Połaniecka basin (930 km^2) is a graben situated between the Garb Pińczowski hummock and the Pogórze Szydłowskie upland (a part of the Wyżyna Kielecka upland). The axis of the basin is formed by the Wschodnia and Sanica rivers. It is filled with Miocene gypsums, sands and sandstones partially covered with Quaternary deposits. In the gypsum substrate there are well-developed karst features and it is covered by thermophilous grasslands. There are sulphur deposits originating from gypsum (extracted near Grzybów town). The bottom of the Niecka Połaniecka basin forms a 40–50 m high cliff towards the Kotlina Sandomierska basin.

Climate of the Niecka Nidziańska basin displays features pointing to its continental character: it is characterized by the occurrence of frosty and long winters and hot summers, relatively low annual precipitation and high mean annual temperature (especially in comparison to surrounding regions). Annual precipitation is about 620–630 mm (about 100 mm less than in Kraków) and average temperatures are: 7–8°C (annual), 17–18°C (in July). Maximum temperature reaches over 30°C and minimum about -30°C, so annual amplitude could reach about 60°C. Microclimate depends strongly on local relief, e.g. in ravines there are significant thermal and moisture differences between slopes with southern and northern exposure. Besides, snow cover vanishes more quickly on slopes with southern exposure.

PLANT COVER

The described area has a varied plant cover. Forest areas occupy no more than 10% of the whole described area and form isolated "islands" scattered among arable lands, meadows and pastures. Low forest cover is a result of two main factors: edaphic conditions (areas with gypsum, chalk, partially loess are naturally deforested) and human activity (the major part of the area featuring both fertile soils and relief promoting agriculture, had been being deforested since 6th millennium BC and turned into arable lands, meadows, and pastures).

I. Forest communities[1]

Forests are represented by following communities:

[1] nomenclature and systematics of plant associations, if not stated otherwise, is based on: MATUSZKIEWICZ W. 2005. Przewodnik do oznaczania zbiorowisk roślinnych Polski. Wydawnictwo Naukowe PWN, Warszawa.

- alluvial forest with *Populus alba, P. nigra, Alnus glutinosa, Fraxinus excelsior* and narrow-leaved *Salix* species (*Alnenion glutinoso-incanae, Salicion albae*) and with *Quercus robur, Ulmus* species and *Fraxinus excelsior* (*Ulmenion minoris*), only fragmentarily preserved on the bottoms of river valleys, on alluvial soils;
- oak-hornbeam forest (*Tilio-Carpinetum*) – a climax community in the discussed area. The stands are composed mainly of *Carpinus betulus, Quercus robur, Tilia cordata,* with different admixture of other species as *Acer platanoides, A. pseudoplatanus.* Shrub layer is composed mainly by *Corylus avellana.* Most characteristic components of herb layer are e.g.: *Stellaria holostea, Ranunculus cassubicus, Carex pilosa, C. umbrosa* (characteristic for these forests only in the Niecka Nidziańska basin). *Fagus sylvatica* occurs frequently in this type of forest even forming pure beech stand in the northern part of the discussed area. In the area of the Niecka Nidziańska basin there is a characteristic local subcommunity on medium moisture habitats (*Tilio-Carpinetum astrantietosum* with the predominance of *Astrantia major* in the herb layer) and a local variety with distinguishing species: *Aconitum moldavicum, A. variegatum, Cephalanthera damasonium* and *Galium boreale*. Patches of oak-hornbeam forests occur as a scattered "islands", occupying areas not promoting agriculture. The forest communities mentioned above occur within valley slopes and hilltops on different types of soils (e.g. brown soils, rendzinas, etc.);
- sycamore forests and maple-lime forests (*Tilio platyphyllis-Acerion pseudoplatani*) with *Tilia platyphyllos, Acer pseudoplatanus* and *A. platanoides* as predominants and other trees (e.g. *Carpinus betulus, Quercus petraea, Fraxinus excelsior*) as an admixture. Herb layer is rich in species, especially nitrophilous ones e.g. *Lunaria rediviva, Polygonatum verticillatum, Senecio fuchsii.* Those communities occur rarely within steep, rocky slopes of ravines;
- thermophilous oak forest (*Potentillo albae-Querceum*). Tree stand and shrub density is very small, so the forest is very thin (it resembles savanna woodland). Tree layer is composed mainly of *Quercus robur* with admixture of *Pinus sylvestris, Betula pubescens* and others. Herb layer is well developed and rich in species (it is the richest herb layer occurring in Polish forest communities). It is a composition of species originating from three ecologically different groups: weakly calciphilous species (e.g. *Vincetoxicum hirundinaria*), helio- and thermophilous ones (e.g. *Potentilla alba*), mesotrophic and medium acidophilous ones (e.g.: *Vaccinium myrtillus, Trientalis europaea, Pteridium aquilinum*). Besides, species typical for moisture meadows also occur there (e.g.: *Serratula tinctoria, Succisa pratensis, Laserpitium prutenicum, Gladiolus imbricatus*). Species characteristic to *Quercetalia pubescenti-petraeae* order are: *Campanula persicifolia, Hypericum montanum, Lathyrus niger, Melittis melissophyllum, Tanacetum corymbosum.* Within described area, there is a local subcommunity described from only one site (neighbourhood of Książ village) – *Potentillo albae-Quercetum rosetosum gallicae.* It varies from the typical form in terms of occurrence of the following species: *Tanacetum corymbosum, Rosa gallica, Molinia arundinacea, Sanguisorba officinalis, Adenophora liliifolia, Astrantia major, Ranunculus cassubicus,* and of lack of species typical for coniferous forest (*Vaccinio-Piceetea* class). The above-mentioned communities occur on hilltops on rendzinas, brown soils, clayey soils and those formed on loess substratum. The origin of thermophilous oak forests can be antropozoogenic or autogenic. The first case refers to most of their patches, especially those occupying fertile habitats and representing particular subcommunities like: *Potentillo albae-Quercetum trollietosum, P.a.-Q. rosetosum gallicae, P.a.-Q. astrantietosum, P.a.-Q. poëtosum.* Their origin is connected with human activity from the Neolithic Age till the 1960-ties on habitats of

oak-hornbeam forest (*Tilio-Carpinetum*) or acidophilous oak forests (*Luzulo-Quercetum/Calamagrostio-Quercetum*). Those activities consisted in: cattle grazing (meadows were used mostly for hay producing), mowing of herb layer and raking of forest litter. Thus, shrubs and young trees were eliminated, that resulted in tree stand loosening and thus allowing more light to herb layer. This, combined with continuous diaspore supply (carried on animals' fur) caused spreading of grassland species connected with sunny and dry habitat to these forest fragments. As a result of discontinuation of described activities after the 1960s, a process of vanishing of many thermophilous oak forest patches has started (natural succession leading to reestablishment of the original forest phytocoenoses), that would be a proof of the theory of their anthropogenic character. The second case (autogenic character) refers to not numerous patches, formed on sandy-gravel substrate, whose origin can be related to human activity, but they may be treated as a permanent component of plant cover and potential natural vegetation. Those patches are threatened mainly by inappropriate forestry (mainly tree cutting and introducing of coniferous species that leads to soil podzolization blocking off community regeneration). Summing up, forest communities of anthropogenic character need active protection measures to survive.

- pine forests (*Vaccinio myrtilli-Pinetum*, presently *Leucobryo-Pinetum*). The tree layer consists of *Pinus sylvestris* with admixture of *Betula pubescens* and (on the discussed area) *Picea abies* and *Abies alba*. Shrub layer, of low density, consists of young trees of the above-mentioned species as well as *Sorbus aucuparia, Euonymus europaeus* and *E. verrucosus*. In the herb layer *Calluna vulgaris, Vaccinium myrtillus* and grass species: *Festuca ovina* and *Deschampsia flexuosa* are to be found. Characteristic feature is a well-developed moss layer consisting of *Pleurozium schreberi, Hylocomium splendens* and *Leucobryum glaucum*. The above-mentioned communities (rare within the described area) occur on exclusively on barren soils (mainly on glacifluvial sand areas within loess cover).

II. Shrub communities

On S or SW facing warm and dry slopes, frequent are thermophilous brushwoods like *Peucedano-Coryletum* community. It occurs commonly on rendzinas, brown soils, avoiding gypsum (this is too dry substrate for tree and shrub vegetation). This community forms a kind of mosaic built of forest, forest margins, shrub and thermophilous grassland species (of *Rhamno-Prunetea, Trifolio-Geranietea* and *Festuco-Brometea* classes). Trees (*Quercus robur, Q. petraea, Pinus sylvestris*) form an open canopy: the undergrowth is composed of various shrubs (mainly of *Corylus avellana* and *Cornus sanguinea*). In herb layer there are numerous thermophilous species from *Trifolio-Geranietea* and *Festuco-Brometea* classes e.g. *Peucedanum cervaria, Geranium sanguineum, Campanula persicifolia, Laserpitium latifolium, Melittis melissophyllum, Tanacetum corymbosum, Trifolium alpestre, T. rubens.*

III. Herb communities

IIIA. *Thermophilous grasslands*[2]

Perhaps the most interesting phytocoenoses on the described area are thermophilous grasslands (*Festuco-Brometea* class). They occur on S- (rarely W- or E-) facing dry and sunny slopes, on soils formed as a rule on shallow-lying rocky substratum, as rendzinas, brown soils (on limestone, gypsum, marl, chalk), or even chernozems (on loess). Those soils are alkaline, rich in calcium carbonate, and warm. On such habitats there are special

[2] nomenclature and systematics of plant associations in this subchapter is based on: MEDWECKA-KORNAŚ A. & KORNAŚ J. 1972. Zespoły stepów i suchych muraw. In: W. SZAFER & K. ZARZYCKI (eds), Szata roślinna Polski. 1, pp. 352–366. Państwowe Wydawnictwo Naukowe, Warszawa and MATUSZKIEWICZ W. 2005., *op. cit.*

microclimatic conditions: high temperature of air and soil, that enables occurring of thermophilous species. Difficulties with water supply eliminate mesophilous species, thus additionally favouring xerophytic species. In herb layer there is a predominance of xerophytic grass species e.g. *Stipa joannis, S. capillata, S. pulcherrima, Koeleria gracilis, Festuca sulcata, F. pallens, F. valesiaca*. Apart from grasses, many interesting and rare orchids (*Orchis pallens, O. ustulata, O. purpurea, Cypripedium calceolus*) and dicotyledons occur there, like: *Carlina onopordifolia, Astragalus danicus, Adonis vernalis, Scorzonera purpurea, Linum hirsutum, Inula ensifolia*. This mixture of colourful species and grasses give these grasslands a magnificent look during the flowering season.

Generally, in Poland thermophilous grasslands are represented by *Festucetalia valesiacae* order (*Festuco-Brometea* class). The communities of the mentioned order are of continental-Mediterranean range type. Floristically and genetically they refer to the steppes of Pontic-Pannonian Province of Euro-West Siberian Region. The order comprises three alliances (their associations are described in Table 1.):

- *Seslerio-Festucion duriusculae* – comprising thermophilous and calciphilous grasslands on steep rocks with the only one association *Festucetum pallentis*. Those grasslands are of natural, relic character in Poland;
- *Festuco-Stipion* – comprising grasslands of rather scattered structure with predominance of thermophilous, tuft grass species (mainly *Festuca valesiaca* and species of *Stipa*) and significant share of spring therophytes, occurring on particularly dry and warm slopes and hilltops on rendzinas. Those communities are similar to real *Stipa* steppes of the steppe zone in the southeastern Europe. Many sites of them in Poland have a relic character. Following associations belong here: *Sisymbrio-Stipetum capillatae*, *Potentillo-Stipetum capillatae* and *Koelerio-Festucetum rupicolae*;
- *Cirsio-Brachypodion pinnati* – comprising grasslands of dense structure with predominance of the turf-forming grass species and with numerous dicotyledonous perennial species. They occur on dry and warm slopes and hilltops (but not as extremely dry as in *Festuco-Stipion* case) on rendzinas and chernozem type soils. Those communities refer to so-called "northern steppes" or "flowery, meadow steppes" of the forest-steppe zone in the southeastern Europe. These grasslands are mainly of semi-natural origin, requiring continuous extensive grazing and/or mowing and in case of abandonment transforming quickly into shrub communities and then into forest. Following associations belong here: *Inuletum ensifoliae, Thalictro-Salvietum pratensis, Adonido-Brachypodietum pinnati, Seslerio-Scorzonerietum purpureae, Origano-Brachypodietum* and *Carex glauca-Tetragonolobus maritimus* community.

A part of thermophilous grassland communities (*Sisymbrio-Stipetum* and *Potentillo-Stipetum*) has a character of extrazonal fragments of steppe vegetation, much poorer in species in comparison to that occurring in southern Europe. The rest of those communities, especially rocky thermophilous grasslands and secondary, species poor thermophilous communities occurring on deforested areas are not counted among steppe vegetation.

Thermophilous grasslands occurring in different parts of Poland are geographically and floristically varied. In the south, that was covered by ice-sheet only during the maximum glaciation, they formed earlier than in the northern part of the country. That resulted in species impoverishment of thermophilous grasslands towards the north of the country. These grasslands also consist of varied floristic elements, arriving during successive migration waves. Those waves had been coming to Poland from non-glaciated areas lying to the SW, S

and SE of our country (refuges of old, probably Tertiary steppe and rocky vegetation). The migration routes were as following:

- Podolian route from Bessarabia and Podolia through the Wyżyna Lubelska and Małopolska uplands up to Lower Vistula valley;
- Moravian route from the Pannonian Basin through Moravia and Moravian Gate to Upper Silesia and the Wyżyna Małopolska upland and northwards along the valleys of Vistula and Warta rivers;
- Brandenburgian-Pomeranian route from Turingia (Thüringen) through Middle Elbe Basin to Upper Vistula and Odra river valleys and to Upper Silesia.

As a result of varied migration routes, patches of thermophilous grasslands in different parts of Poland have its own specific species e.g. in the Wyżyna Lubelska upland – species coming along the Podolian route, as *Astragalus onobrychis, Echium rubrum, Cytisus albus*; in the Wyżyna Małopolska upland – species coming along the Moravian route, as *Teucrium botrys, Linum hirsutum, Ranunculus illyricus*; and in the Lower Odra – species coming along the Brandenburgian-Pomeranian route, as *Anthericum liliago, Stipa pulcherrima.*

The origin of thermophilous grasslands occurring in Poland is still a subject of numerous botanical studies and, to some extent, controversy. There is a theory claiming that a part of these communities is of natural, relic character and can be remains of open, postglacial vegetation (especially communities occupying river valley slopes). These communities (e.g. *Festucetum pallentis*) can persist without human activity such as pasturage, mowing, removing of shrubs. However, the origin of majority of thermophilous grasslands in Poland is connected with expansion of the Neolithic culture, which initiated some kinds of husbandry like burning primeval forests and gaining grounds for agriculture and grazing. These communities still need to be continually mowed, grazed or burnt out (in order to remove shrubs and young trees encroaching there as a result of succession process). Otherwise they could not persist longer than 30–50 years because they would transform into thermophilous brushwood and finally to the climax community – oak-hornbeam forest. Succession rate depends, among others, on the substratum: communities occurring on gypsum (very dry habitat, least convenient for shrubs and trees) change slowly, whereas those on marls or clays – faster.

In Poland thermophilous grasslands occur within regions of more continental climate (low annual precipitation and hot summers) – mainly within the uplands (the Wyżyna Malopolska, Wyżyna Śląsko-Krakowska, Wyżyna Lubelska and West Volhynia uplands, in Silesia, in Przemyśl city neighbourhood) and in the northern part of the country, in Lower Vistula and Odra river valleys. Those communities used to occupy considerable areas in the past, but nowadays most of their habitats is converted into arable lands and their remains are preserved only in small and scattered areas unfit for agricultural use (those occurring on very shallow-lying rock substratum or on steep slopes). Sometimes thermophilous grasslands form as secondary communities on abandoned arable lands as a result of secondary succession.

IIIB. *Meadow and tall-herb communities*

Fertile, moist or wet hay meadows and pastures of *Calthion palustris, Molinion caeruleae* and *Cnidion dubii* alliances (*Molinio-Arrhenatheretea* class, *Molinietalia* order) occur within flat bottoms of river valleys. They are represented mainly by: *Molinietum caeruleae, Angelico-Cirsietum oleracei, Cirsietum rivularis, Scirpetum silvatici, Violo-Cnidetum dubii.* There are several interesting species occurring in those communities e.g.: *Cirsium canum, Cnidium dubium, Symphytum bohemicum, Trifolium patens.* In the areas of moderate ground water level, fresh hay meadows and pastures of *Arrhenatherion* and *Cynosurion* alliances (*Molinio-Arrhenatheretea* class, *Arrhenatheretalia* order): *Arrhenatheretum elatioris* and *Lolio-Cynosuretum* occur.

Meadows and pastures are communities of semi-natural origin, connected with human husbandry (mowing, grazing) lasting from the Neolithic Age till now. Leaving of traditional ways of use results in changing them into bush (and eventually forest) communities after 30-50 years.

Along watercourses find their place hygrophilous tall-herb fringe communities of *Filipendulion ulmariae* alliance. There are communities of natural origin, which occurred originally on forest margins and became a floristic reservoir for semi-natural hay meadows of *Molinietalia* order. Characteristic species are there: *Euphorbia lucida, E. palustris, Filipendula ulmaria, Geranium palustre, Hypericum tetrapterum, Lysimachia vulgaris, Lythrum salicaria, Stachys palustris, Thalictrum flavum, Valeriana officinalis* ssp. *officinalis, Veronica longifolia.*

IIIC. *Other communities*

Dry and sandy places are occupied by arenicolous grasslands mainly of *Koelerion albescentis* alliance (*Koelerio-Corynephoretea* class).

Local ground depressions without water flow are occupied by patches of transition mires and calcareous fens (*Phragmitetea* class and *Magnocaricion* order; *Scheuchzerio-Caricetea* class and *Scheuchzerietalia palustris* and *Caricetalia davallianae* orders) with rare and protected species e.g.: *Carex davalliana, Drosera rotundifolia, Ledum palustre, Liparis loeselii, Pedicularis palustris, Pinguicula vulgaris* ssp. *bicolor, Polygala amara, Sesleria uliginosa, Schoenus ferrugineus.*

Within middle course of the Nida river valley there are numerous oxbows with interesting communities of *Nymphaeion, Ranunculion* and *Potamion* alliances.

On gypsum substrate in wet places, especially in the surroundings of sulphate-saline springs (e.g. in the Busko town neighbourhood) there are patches of halophytic vegetation (*Puccinellio-Spergularietum salinae* association of *Puccinellion maritimae* alliance and *Glauco-Puccinellietalia* class) with characteristic species like: *Puccinellia distans, Bolboschoenus maritimus, Spergularia salina, Atriplex hastatum* var. *salinum* and a rare species *Zannichellia pedicellata. Ruppia maritima* had there once the only inland site in Poland.

In the discussed area there are also very interesting segetal communities formed on loess, gypsum and chalk substrata with calciphilous species of mainly Pontic and Pontic – Pannonian origin – *Caucalido-Scandicetum* and *Lamio-Veronicetum politae* associations. Characteristic species are: *Adonis aestivalis, Bupleurum rotundifolium, Caucalis platycarpos, Conringia orientalis, Galium tricornutum, Scandix pecten-veneris, Thymelaea passerina* (for the first association) and *Lamium amplexicaule, Veronica agrestis, V. opaca, V. polita* (for the second association).

THE VEGETATION HISTORY

Reconstruction of the vegetation history in the described area is rather difficult. Especially rendering the history of "steppe" associations is facing trouble because of lack of sites that would preserve fossil debris of species building those communities (with the exception of a few species like *Onobrychis arenaria, Crambe tatarica* and probably some *Alyssum* species found with Dryas flora fossil debris, that is a proof that in glacial period tundra floristic components coexisted with "cold steppe" components). Due to this fact, rendering of the history of steppe associations is mainly based on epiontologic method (geographic-floristical analysis of species ranges).

I. "Steppe" communities

Steppe vegetation existed in the described area already in late Pleistocene or in the beginning of Holocene. The species forming this vegetation could have arrived here by three routes (see

chapter on thermophilous grasslands). The oldest and pioneer association in the described area is considered *Sisymbrio-Stipetum capillatae*, which played similar role here as sandy grasslands of *Corynephoretalia* order in neighbouring areas. This assumption is based on the fact, that *Sisymbrio-Stipetum capillatae* comprises numerous species common with the oldest dune flora e.g. *Gypsophila fastigiata, Oxytropis pilosa, Astragalus danicus, Silene otites, Centaurea stoebe*. All those species are xerophytic and heliophytic ones and of wide geographical range. It is supposed, that they formed expansive initial communities (with *Stipa capillata* predominance) and occupied widespread, woodless loess areas. The other above mentioned associations of thermophilous grasslands are historically younger. They formed probably in older Holocene (especially during the period of postglacial climatic optimum). Some facts support the theory: the other associations occur mainly on substratum outcropping from loess cover (so their occurrence was related to younger erosion of postglacial period) and consist of thermophilous species, which could "come" here in warmer Holocene period. Occurrence of these species is a result of long-lasting process of their migration hither from different directions e.g. from the east (as *Adonis vernalis*), the southern Europe (as *Ornithogalum tenuifolium, Carlina onopordifolia*) in warmer Holocene period, occupying substratum outcropping from loess cover and replacing the pioneer association *Sisymbrio-Stipetum capillatae* as a result of secondary succession.

II. Forest communities

Some forest species like *Pinus cembra, P. sylvestris, Larix* and *Betula* species probably temporarily occurred here during the last glacial period. In the late glaciation (during its warmer oscillations) probably small more or less dense woodland fragments existed, consisting of *P. sylvestris, Larix decidua* ssp. *polonica* and *Betula* species (rather dry substratum lying under loess cover was inconvenient for forming dense pine-larch forests) forming a "forest islands" in original, grassland landscape. Significant climate warming at the beginning of Holocene period contributed to permanent forest succession. That succession had different course than in neighbouring areas, because of different regional climatic and soil conditions, inconvenient for trees of more humid climate and substrata (e.g. *Abies alba, Acer pseudoplatanus, Picea abies*), whereas *Fagus sylvatica* has been playing a secondary role in forest communities up to this day. Thermophilous brushwoods played always a major role in succession from thermophilous grasslands towards forest communities.

Present forest communities formed in late Mesolithic and Neolithic period, especially oak-hornbeam forest and alluvial ones. Mixed oak-pine forests and thermophilous oak forests are further elements in forest succession (about origin of thermophilous oak forests – see chapter PLANT COVER).

NATURE CONSERVATION

Within the Niecka Nidziańska basin there are three landscape parks: Nadnidziański, Kozubowski and Szaniecki.

Nadnidziański Landscape Park (23 164 ha) comprises middle and lower part of the Nida river valley, the Niecka Solecka basin and northwestern part of the Garb Pińczowski hummock. It was established in order to protect unique (in country scale) karst forms formed in gypsum (e.g. underground corridors, caves, rock gates, karst springs, karst lakes). Gypsum rocks are built of big crystals (up to 3,5 m long – one of the biggest gypsum crystals known in the world). Patches of thermophilous grasslands formed on the gypsum (mainly) substratum and the Nida river valley with many oxbow lakes and meanders are also protected here. Forest area are scattered and small (7% of the Park area), represented mostly by oak-hornbeam forest, pine forest and alder carrs. In the Park there are one of the biggest centre of occurring thermophilous and steppe vegetation in Poland. Patches pf peat bogs also occur there. The

well preserved patches of forest and non-forest vegetation are protected in 9 nature reserves: "Krzyżanowice" (western part of the hilltop built of marls and gypsums with numerous rock outcrops and karst forms; thermophilous grasslands and thermophilous insects); "Grabowiec" (oak-hornbeam forest complex on gypsum hilltop; karst forms; thermophilous grasslands with many Pontic species; the only one site of *Dictamnus albus* in Poland), "Skowronno" (thermophilous grasslands, quarry of 11th century), "Winiary Zagojskie" (gypsum hilltop covered with loess; thermophilous grasslands, especially „flowery steppe" association), "Przęślin" (small gypsum hilltop; outcrops of macro crystalline gypsum rocks; thermophilous grasslands; one of two known sites in Poland of *Arabis recta*; the only one site in Poland (and one of three sites in the world) of insect species *Donus nidensis* (weevil) – a xerothermic species of probably steppic origin, having a relict site in here), "Pieczyska" (mid-forest fen), "Skorocice" (gypsum outcrops; gypsum karst forms; thermophilous grasslands), "Skotniki Górne" (a part of gypsum hilltop with rich karst forms (ravines, caves with the longest – 200 m– gypsum cave in Poland); thermophilous grasslands), "Góry Wschodnie" (gypsum hummock with thermophilous grasslands).

Some very rare plant species occur within the Park e.g.: *Arabis auriculata, Carlina onopordifolia, Dictamnus albus, Dorycnium germanicum, Ranunculus illyricus, Reseda phyteuma, Serratula lycopifolia, Sesleria uliginosa, Sisymbrium polymorphum, Veronica praecox, V. paniculata.*

Within the area of the Park there are many interesting monuments – old ramparts, churches. This region is significant for Polish history – the first Vistulans tribal territory was located here in 9th century with the capital in Wiślica town (where a cathedral church from the 14th century can be seen, built on the site of older, 12th century church).

Kozubowski Landscape Park (12 649 ha) comprises eastern part of the Garb Wodzisławski hummock with varied relief (loess ravines, gypsum and marl slopes) and the biggest forest areas within the Niecka Nidziańska basin. The Park has the biggest forest area (50% of its area) of all Parks within the Niecka Nidziańska basin. Forest communities are represented mostly by oak-hornbeam forests, pine forests and alluvial forests. Within the Park area there are patches of thermophilous grasslands and peat bogs. There are two nature reserves here: "Polana Polichno" (forest clearing with thermophilous grasslands) and "Wroni Dół" (a patch of oak-hornbeam forest with interesting species).

Within the area of the Park there are several rare thermophilous plant species e.g.: *Adonis vernalis, Ajuga chamaepitys, Anemone sylvestris, Anthericum ramosum, Aster amellus, Campanula bononiensis, C. sibirica, Carlina onopordifolia, Cerasus fruticosa, Cimicifuga europaea, Cirsium pannonicum, Chamaecytisus ruthenicus, Crepis praemorsa, Dorycnium germanicum* (one of three sites in Poland), *Inula ensifolia, Lathyrus pannonicus* (the only one site in Poland), *Linum hirsutum, L. flavum, Muscari comosum, Ophrys insectifera, Ononis spinosa, Orchis ustulata, Potentilla alba, Reseda phyteuma, Sesleria uliginosa, Sisymbrium polymorphum, Stipa Joannis, S. capillata, Tanacetum corymbosum, Thalictrum minus* and even mountain species e.g. *Aruncus sylvestris, Aconitum variegatum, Veratrum lobelianum.*

Szaniecki Landscape Park (10 915 ha) comprises the middle part of the Garb Pińczowski hummock and southwestern part of the Niecka Połaniecka basin. It protects varied landscape with rich gypsum karst relief and patches of thermophilous grasslands, peat bogs, and halophyte vegetation. Many rare thermophilous, peat bog and halophyte species occurs there e.g.: thermophilous species: *Adonis aestivalis, A. vernalis, Arabis auriculata, Artemisia pontica, Astragalus danicus, Centaurea pannonica, Conringia orientalis, Eryngium planum, Erysimum odoratum, Euphrasia tatarica, Festuca sulcata, Gentiana pneumonanthe, Gentianella germanica, Inula ensifolia, Koeleria macrantha, Linosyris vulgaris, Linum hirsutum, L. flavum, Melampyrum arvense, Odontites lutea, Ononis spinosa, Oxytropis pilosa,*

Reseda phyteuma, Scabiosa canescens, Scorzonera purpurea, Sisymbrium polymorphum, Stipa joannis, S. capillata, Veronica praecox; alkaline peat bog species: *Carex davalliana, Liparis loeselii, Pinguicula vulgaris* ssp. *bicolor, Sesleria uliginosa, Tofieldia calyculata*; halophyte species: *Bolboschoenus maritimus, Bupleurum tenuissimum* var. *salinum, Spergularia salina.* In the nature reserve "Owczary" situated within the Park, halophyte vegetation formed around salt spring is protected.

Within the area of the Niecka Nidziańska basin there is also NATURA 2000 bird protection site: PLB 260001 "Dolina Nidy" comprising most of the Nadnidziański Landscape Park and its neighbourhood.

VISITED NATURE RESERVES

"Krzyżanowice" steppe reserve (established 1954) is situated in contact zone of the Niecka Solecka basin and the Nida river valley and reaches the height of 229 m a.s.l. It is located about 7 km south of Pińczów town and about 10 km west of Busko town. The reserve area is 15 ha and comprises a fragment of rock step ("cuesta") built of gypsum with thermophilous grassland communities (Fig. 3). Following associations occur there: *Sisymbrio-Stipetum capillatae, Seslerio-Scorzoneretum purpureae, Koelerio-Festucetum rupicolae, Inuletum ensifoliae, Thalictro-Salvietum pratensis* and *Carex glauca-Tetragonolobus maritimus* ssp. *siliquosus* community. The most interesting thermophilous plant species occurring there are: *Adonis vernalis, Astragalus danicus, Campanula sibirica, Inula ensifolia, Sisymbrium polymorphum, Stipa capillata, Tetragonolobus maritimus* ssp. *siliquosus, Thymus pannonicus, and Veronica praecox.*

Tables 2–7 (at the end of the booklet) show exemplary phytosociological relevés taken in most characteristic thermophilous associations in "Skorocice" reserve (ca. 8.5 km SE from "Krzyżanowice"). They are re-printed from the publication: MEDWECKA-KORNAŚ A. 1959. Végétation de la reserve steppique "Skorocice" (district Kielce, Pologne Méridionale). *Ochrona przyrody* **26**: 172–259.

„Wały" steppe reserve (established 1957) near Racławice village is located 16 km east of Miechów town at an altitude up to 365 m a.s.l. The reserve area is 5.81 ha and comprises southwest facing slopes built of marls and chalk cropping out locally and covered by loess. The rendzina soils on marl outcrops, too shallow to be cultivated, form a refuge for thermophilous grasslands, often referred to as "steppe" vegetation (Fig. 3). The reserve was formed to protect one of the most beautiful stands of *Inuletum ensifoliae* association, with an extremely vigorous population of about 10,000 to 12,000 individuals of *Carlina onopordifolia* – one of the rarest species in Poland (only four sites preserved). This monocarpic plant germinates in the gaps of the sward, on bare rendzina soil and forms leaf rosettes of up to 1 m in diameter, remaining sterile for a couple of years. They finally flower in late summer, produce fruits that ripen in autumn or in winter, and then die. Therefore, the plant is clearly connected with early succession stages on rendzina slopes. The reserve is also the locus classicus of the hybrid *Carlina* ×*szaferi* (=*C. acaulis* × *C. onopordifolia*). There are also another interesting and rare species occurring in the reserve, e.g.: *Adonis vernalis, Anemone sylvestris, Campanula sibirica, Cerasus fruticosa, Cirsium pannonicum, Inula ensifolia, Linum hirsutum, L. flavum, Ophrys insectifera.*

The "Wały" reserve was originally grazed and new gaps in the sward were continuously formed by grazing animals. When the reserve was set aside in 1957, grazing was prohibited, but this regulation was not efficiently enforced, especially in the SEE part of the reserve, which is surrounded by arable fields. Consequently, there was a marked invasion of shrubs in the WNW part of the reserve adjoining the forest, but the vegetation in the SEE corner still remains more open with *Carlina onopordifolia* seedlings appearing in the gaps and encroaching on the neighbouring fields which have since been abandoned. This very clearly indicates that *Inuletum ensifoliae* is a seral plant community, which can be maintained (with all interesting components) only through continuous disturbance (e.g. grazing).

PART. 2. PREHISTORY AND EARLY HISTORY OF THE LOESS UPLANDS OF WESTERN LESSER POLAND

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STONE AGE (*Marek Nowak*)

I. Palaeolithic and Mesolithic

Within the region in question, except for Kraków and its immediate surroundings, Palaeolithic finds are very scarce (Fig. 4). Less than twenty individual artefacts (cores and flakes) discovered both on loess sites and in the surface layer. They are dated at either the Middle or Upper Palaeolithic. The only site where excavation work was carried out (Jaksice) held artefacts connected with the Aurignacian culture (ca 35 000 BP).

Many more Palaeolithic sites and artefacts were found in Kraków city and its vicinity, especially north of the city. Almost one hundred open and cave sites, as well as several hundred stray finds, delivered numerous objects dating back to the period between the Eemian interglacial and the late Vistulian. Of special importance is the site in Kraków in Spadzista Street, where a complex of settlements from the Upper Paleolithic was discovered, connected with the East-Gravettian tradition (23–21 000 BP); the site is notable for the extraordinary number of mammoth bones.

So far, no Mesolithic artefacts have been found in western Lesser Poland, which is rather typical of loess regions of Central and Eastern Europe. Just a few sites are known in the neighbourhood of Kraków (e.g. in Glanów and Ściejowice villages, recently investigated). However, it has been established that Mesolithic finds concentrate east of the loess uplands of western Lesser Poland, in a different ecological zone whose conditions remind those of lowlands.

II. Neolithic

The loess uplands of western Lesser Poland offer, as compared with other regions of Poland, an extremely rich set of data concerning the Neolithic period, in contrast to the Paleolithic and Mesolithic. These uplands were densely settled and exploited for practically the whole period between ca 5400 BC and 2300 BC. The Neolithic settlement is represented by more than ten cultural phenomena as defined in traditional archaeological terminology.

IIA. *The Linear Band Pottery Culture (LBK)*

Just as in other Central European regions, the beginning of the Neolithic was marked here by the appearance of the LBK. Its earliest stage (ca 5400 BC) is practically not represented in western Lesser Poland: only one site, Zofipole, can be definitely classified as belonging to that stage. The remains of the so-called Zofipole stage (ca 5300 BC, which is approximate to the ačkova / Flomborn stage elsewhere) were uncovered in a few sites in the region of Kraków. The most numerous artefacts of the LBK belong to the *Notenkopfkeramik*, or Music Note Pottery (ca 5200–4900 BC). During the later stages of the LBK, the loess uplands of western Lesser Poland were under the influence of a style-setting centre in present-day western Slovakia, the Želiezovce group/culture. Yet, the number of sites connected with it is smaller; interestingly, the latest phase of the Želiezovce culture is not represented at all. Altogether, there are over 200 LBK sites in the discussed region.

These sites concentrate mainly along the valleys of left tributaries of the Upper Vistula river (the Dłubnia, the Szreniawa, and the Nidzica rivers); less so along the Vistula river valley as such (Fig. 5). Characteristically of LBK settlements is the tendency to form micro-regional concentrations (*Siedlungskammern)*. The micro-regions of the LBK, with areas not exceeding ca 100 square km, are interspersed within regions of overall lower concentration of such finds. Topographically speaking, the vast majority of the sites are located on low-lying benches above floodplain, in proximity to the rivers.

LBK sites in western Lesser Poland resemble those present in other regions. The settlement consisted of several longhouses (Fig. 6). The state-of-the-art research has identified larger settlements, with up to ten such structures, and smaller settlements of 1–4 longhouses. In the discussed region, over ten skeleton graves were unearthed in sediment layers. Separate LBK burial grounds, as in case of the entire Polish territory, have not been found.

The obtained palaeo-economic data demonstrate that the economy of the LBK groups in western Lesser Poland was similar to the standard LBK model. Both in the plant and animal economy, domesticated species are predominant. The palinological data (Fig. 7) suggest the LBK economy does not demand large territories.

IIB. *The Lengyel-Polgar Complex*

The problem of the LBK disappearing in western Lesser Poland and a new, emerging culture unit, the Lengyel-Polgar Complex, is a complicated and controversial one. Some authors claim that after 4800 BC, when the LBK groups had finally ceased to exist, there was a nearly 200-year-long hiatus in settlement in the region. Other researchers, however, approach this hypothesis critically. They suggest that the discontinuity between the LBK and the Lengyel-Polgar Complex is an apparent one and results from lack of ceramic evidence of the late LBK and the early Lengyel-Polgar Complex, which evidence is usually present in the basin of the middle Danube. Then, in the development of pottery stylistics in western Lesser Poland, different trends can be observed, which are unique for the region. Consequently, no obvious reasons are discerned to suggest a gap in Neolithic settlement following ca 4800 BC. Therefore, depending on which hypothesis we accept, the beginnings of the Lengyel-Polgar Complex can be estimated either at 4800 BC or 4600 BC. The Lengyel-Polgar Complex is a concept used in Polish specialist literature and refers to a wide range of cultural phenomena that developed in the basins of the Vistula and the Oder until ca 3500 BC. These phenomena evolved, in many aspects, under the influence of and in contact with the regions situated in the basin of the middle Danube. The influences came from the centres of the Lengyel culture (western Hungary, south-western Slovakia, Lower Austria, Moravia) as well as of the Polgar cultural complex (existing in the Tisza basin, including the cultures like: Theiss, Herpaly-Csöszhalom-Oborin, Tiszapolgár, Bodrogkeresztúr). The matter is further complicated by the strong influences of Stroked Pottery Culture, noticeable until ca 4500 BC. In effect, the concept embraces about twenty units of the status of culture or archaeological group, a few of which can be found in the loess uplands of western Lesser Poland.

The situation of sites of the Lengyel-Polgar Complex generally resembles that of the LBK sites, both in the topographic aspect and in relation to one another. A difference is the larger number of the former (about 250). As with the LBK sites, the Lengyel-Polgar Complex sites are the most numerous in the region of Kraków. Yet, as compared with the LBK sites, a surprisingly high proportion of the Lengyel-Polgar Complex sites were uncovered in the valleys of the Nidzica, and the Szreniawa rivers and also within Kraków city (Fig. 9)

There is relatively scarce evidence so as to recreate the appearance and functions of settlements in this cultural formation. A number of uncovered houses (Fig. 8) and analogical evidence from other regions (Kuyavia) point to the continued LBK patterns. The settlements were small and the number of houses varied from a few to below twenty. If the evidence concerning western Lesser Poland was interpreted in the way Grygiel and Bogucki interpreted the evidence concerning Kuyavia, one could expect to find separate, autonomous households within such settlements. The Lengyel and Polgar units tend to comprise a great deal of sites with earthen structures (*Rondels*, defence settlements). In western Lesser Poland, few of these have been identified; practically the only structure of this kind is a moat and palisade forming an oval enclosure of a late Lengyel-Polgar settlement in Bronocice village (Fig. 10). It is possible such structures were raised also in the Kraków region (in Modlnica village).

The flora and fauna structures continue to manifest the dominance of the 'domesticated' brands of economy. According to Kruk, the demand for space, and hence interference with environment, were higher than in the LBK, which is indirectly corroborated by the palinological data.

This unit left remains of flint mining in southern parts of the Wyżyna Krakowsko-Częstochowska upland, and of salt-making in the region of Kraków, on the right bank of the Vistula river. The later horizon of the Lengyel-Polgar Complex is characterised by the presence of copper artefacts, and formally it may be categorised as belonging to the Aeneolithic.

IIC. *The Funnel Beaker Culture (TRB)*

At about 4000/3900 BC, in the loess uplands of western Lesser Poland, there appeared the earliest sites of an entirely new archaeological unit, the Funnel Beaker Culture. The origin of this cultural phenomenon, which extended over the most regions of Central Europe, is among the most complex issues of the Central European Neolithic. Without going into detail, one may state that TRB groups in western Lesser Poland obviously had ties with lowland TRB groups. Even migratory moves from the Polish Lowlands (the eastern group of the TRB) into upland regions (including western Lesser Poland) cannot be excluded. On the other hand, later units of the Lengyel-Polgar Complex must have contributed as well to the ultimate development of the southeastern group of the TRB (which embraced, among others, the loess uplands of western Lesser Poland).

In the loess uplands of western Lesser Poland there have been found many more sites of the TRB (ca 1000) (Fig. 11) than of the LBK and the Lengyel-Polgar Complex, which parallels the trends observed in this aspect in other regions of Central Europe that were settled by TRB. Furthermore, the spatial distribution of the TRB sites is more even: unlike the LBK and the Lengyel-Polgar sites, they do not tend to concentrate in limited micro-regions. Another feature of TRB settlement is that a large number of sites (and in some places, e.g. in the micro-region of Bronowice, even the majority of sites) are located in the 'higher' topographical zones, namely in valley margins and plateau. These zones were practically uninhabited by LBK or Lengyel-Polgar settlers. Summing up, one may conclude that the Funnel Beaker Culture involves Neolithic settlement in all topographical zones landscape filled with Neolithic settlement (compare Figs. 12, 13, and 14)

TRB settlements were of various sizes. Some of them (very few, e.g. Bronocice, see Fig. 15) could even amount to about 20 hectares; there were also middle-sized (ca 5–10 ha)

and small (under 5 ha) settlements as well as encampments (under 1 ha). As viewed by Kruk and Milisauskas, in the western loess uplands, the network of TRB settlements functioned hierarchically: there was a central, large settlement, middle-sized settlements as well as small settlements and encampments. The remains of houses found on TRB sites are of much interest, but very rare. Probably TRB houses had a different structure than that of the LBK and Lengyel-Polgar houses and this is why they did not leave so clear archaeological traces. By analogy with other TRB groups from different regions, it may be surmised that in western Lesser Poland TRB dwellings were rectangular or polygonal houses woven over a loose structure of poles, or less durable huts.

TRB burial rites were of an entirely different character than rites performed in the LBK and the Lengyel-Polgar Complex. Some premises behind the statement are that dead bodies were laid in a different manner (i.e. extended position), there were separate burial grounds and there appeared the megalithic idea. In this context, it should be noted that in the loess uplands of western Lesser Poland a unique variety of the megalithic rite developed: probably due to shortage of material, i.e. erratic blocks, megalithic structures were raised out of timber and earth; so called megaksylos were found at Słonowice village (see separate chapter) and Zagaje Stradowskie village (Fig. 16).

The TRB economic system in the loess uplands of western Lesser Poland also had its specific features as compared with the LBK and the Lengyel-Polgar Complex. It is said the system was aimed at extensive exploitation of vast areas, not only in river valleys but in high plains as well. Thanks to the common use of fire, large cleared areas were used to extensively grow cereal crops. As the soils inevitably got barren, the process was renewed, which brought about, for the first time in the Holocene, anthropogenic deforestation of considerable parts of the loess uplands. Also breeding was more important than in the LBK and the Lengyel-Polgar Complex, and anyway it affected larger areas, not exclusively the surroundings of settlements (pasture breeding). With time, as deforested areas expanded, the TRB cultural environment could gradually produce the semi-nomadic breeding facies. It is worth observing that the TRB economy, including the region in question, had a number of attributes that can be related to the concept of secondary products revolution. For instance, some ornaments on clay vessels show draught animals and four-wheeled carts.

Until about 3500 BC, the TRB culture was in existence parallel to the latest Legyel-Polgar groups. Significantly, in the region of Kraków, where settlements of the latter are the most numerous, traces of the TRB culture are vestigial. In the second half of the fourth millennium BC, the loess uplands of western Lesser Poland saw yet another, very interesting cultural transformation. They were influenced by the Baden culture, which was evolving at the time in the basin of the middle Danube. The influences were of various nature. Definitely, in the neighbourhood of Kraków, which is a small area, there existed a settlement enclave of the Baden culture immigrants (around 100 sites). Outside the area, stylistic influences of the Baden culture (chiefly in pottery) can be felt as affecting later TRB groups ('Badenisation'). Eventually, the process resulted in an almost complete disappearance of 'funnel beaker' features at the turn of the fourth and third millennia BC. The Baden culture characteristics, although transformed against the TRB background, became predominant.

IID. *The Late Neolithic (Globular Amphora Culture and Corded Ware Culture)*

In the loess uplands of western Lesser Poland only a few isolated finds were uncovered that are connected with the Globular Amphora Culture. On the other hand, Corded Ware sites can be identified from the beginning of the third millennium BC onwards. According to Włodarczak, in relation to this region, it seems pointless to apply the original chronological and typological classifications concerning this cultural complex that spanned over broad territorial expanses. Traditional classifications presumed the existence of at least three main chronological horizons of development: the pan-European horizon, the Central European

horizon and the horizon of local groups. However, in 'our' area from ca 2800 BC, the Corded Ware Culture evolved along two parallel paths: (i) the pan-European and Central European (with burial mounds) and (ii) the local one (with flat graves). The problem of the origin of the Corded Ware Culture is not going to be addressed here in detail, but it appears indispensable to focus on the fact that in western Lesser Poland one can assume, at least to some extent, the impact of the TRB background on the formation of the local Corded Ware variety.

Almost all uncovered Corded Ware sites are sepulchral sites with either flat graves or barrows (Fig. 18). The number of identified settlements does not exceed twenty. The overall number of Corded Ware sites amounts to one hundred (Fig. 17). Their distribution is slightly similar to that of TRB sites: they can be found mainly in valley margins and plateaux.

The small number of settlements made researchers hypothesize about the nomadic or semi-nomadic economy of the people of the Corded Ware Culture. Such an economic system would be a natural continuation of processes inaugurated under the TRB. The progress of deforestation could initiate breeding economy, which had been going on outside permanent settlements. However, due to inadequate palaeo-zoological data and other relevant data, the issue is rather problematic.

The transition from the Neolithic to the Bronze Age (ca 2300/2200 BC) in western Lesser Poland was notable for the incidental presence of limited populations of the Bell Beaker Culture people, probably groups of horse-riding nomads (3 sepulchral finds). At that time, against the background of the Corded Ware Culture, the early Bronze Age groups of the Mierzanowice Culture were formed.

ARCHAEOBOTANY OF THE NEOLITHIC (*Maria Lityńska-Zając*)

This guidebook is based on results of the analyses of plant macro-remains from a few selected Neolithic sites from the Loess Uplands of western Lesser Poland (western Małopolska) (located in South Poland). Most of the sites examined are situated in two centres, in Kraków-Nowa Huta city and near Kazimierza Wielka town. Botanical materials were collected from different settlements' features, such as pits, hearths, houses and postholes. Different numbers of samples were studied from each site but they all came from features having well-defined chronology and cultural affiliation. The number and kinds of plant remains acquired from the separate sites or chronology units are not equal. The majority of Neolithic data come from Funnel Beaker Culture sites. Less frequent are objects of Linear Pottery Culture, Lengyel Culture and Baden Culture.

The remains of cultivated and wild herbaceous plants were preserved in the form of charred seeds, fruits, fragments of spikelets and vegetative organs and imprints in burnt clay.

Linear Pottery and Lengyel Culture sites contained mainly cereals; the dominant species was emmer wheat *Triticum dicoccon*, accompanied by einkorn *T. monococcum* and barley *Hordeum vulgare* occurring in small numbers of grains. The material recovered from Kraków-Mogiła, site 62, indicates that barley belonged to the naked form. In spite of the fact that barley appeared frequently amongst imprints and charred remains, it was never found in large quantities in individual sites. One should think that barley was less significant crop than hulled wheats. Both wheat species were probably sawn together, while barley was cultivated separately.

Plant material from Kraków-Mogiła contained rich assemblage of wild plants representing communities of field weeds, meadows and xerothermic grassland. The occurrence of considerable number of perennial species indicates primitive tillage procedures that did not damage underground plant parts.

Agriculture of the Lengyel Culture people was based on the same cereal species as in the older chronological periods. A store of cereal grain found in a pit from the site Kraków-Prądnik Czerwony contained 90% of dehusked emmer (*Triticum dicoccon*) grain with some

admixture of einkorn *T. monococcum* grain and a small addition of their spikelet forks and glume fragments. The sample contained also small number of seeds and fruits of field weeds, e.g. *Bromus secalinus, Agrostemma githago, Fallopia convolvulus, Rumex crispus, Galium aparine*, and *Phleum pratense*. Particularly interesting is the occurrence of *Phleum pratense*, a species of present-day meadow communities of the *Molinio-Arrhenatheretea* class, which often appears in samples of charred cereals together with typical weed species. We may thus suppose that in the past this species found favourable growth conditions in cereal field.

Other cereal species, rye *Secale cereale*, spelt *Triticum spelta*, and millet *Panicum miliaceum* were found only sporadically and in small numbers. They played probably only an insignificant role in the Neolithic agriculture. Similarly, the cultivation of plants other than cereals, such as lentil *Lens culinaris*, flax *Linum usitatissimum*, pea *Pisum sativum*, and poppy *Papaver somniferum*, was of small significance.

Wild species found in assemblages of macro-remains represent first of all communities, which developed in the zones of settlement and farming activities of humans. Edaphic demands of weeds found in several samples of cereals suggest that fields were located on fairly rich, fresh soils showing acidic to neutral reaction.

The presence of cereals and field weeds confirms the agricultural character of the Neolithic settlement, which developed on the territory of the Loess Uplands of western Lesser Poland. The land was cleared from forest with the use of fire or by grubbing and fields used for cereal cultivation were certainly of small size.

Bronze and Early Iron Ages (*Anna Gawlik*)

The Bronze Age and Early Iron Age in Polish territories are dated between 2400/2300 and 450/400 BC. Three main archaeological units are present in loess uplands of western Lesser Poland in these periods: Mierzanowice Culture, Trzciniec Culture, and Lusatian Culture.

The genesis of the Mierzanowice culture is connected with transformations that took place in Late Neolithic Corded Ware cultural complex and with influences of Bell Beakers. There are few sites belonging to earlier phases of this culture (Proto-Mierzanowice: ca 2400–2200 BC, and Early Mierzanowice: ca 2200–2050 BC). These are single graves (e.g. Kraków-Nowa Huta, site Kopiec Wandy), and settlements (e.g. Iwanowice village, site Babia Góra II). Both social structure and economy of these early stages remained very close to the Neolithic patterns; we may characterize this stage as Initial Bronze Age. Such a situation tends to continue in the classic phase (ca 2050 – 1950/1900 BC). More developed social and economic structures appeared only in the late phase (1950/1900 – 1600 BC), when significant stabilization of settlement pattern and distinguishing of regional units, like Szarbia, Pleszów, and Giebułtów Groups, can be observed. In Mierzanowice culture inhumation predominated as regards burial rite. Deaths were laid in crouched position (women on left side, men on right side). Grave goods consist mainly of single vessels (ornamented with cord impressions in the earliest and latest phases), weapon (stone axes, flint arrowheads, flint axes), and ornaments (necklaces made of bone and shell beads, pendants of animal teeth, bone pins). Bronze artefacts (e.g. small axes) occur very sporadically; they are almost exclusively imports. On the other hand, small pendants in the shape of willow leaf, made of copper, were produced locally. Altogether, over 150 sites of 'Mierzanowice Culture' have been discovered in the area under consideration (Fig. 19). They concentrate first and foremost along river valleys. One of the best-researched sites is Iwanowice, Babia Góra II, that was utilized during all phases of Mierzanowice culture. The village consisted of several houses (families) and a cemetery. Two or three villages of the kind constituted local group (settlement microregion), numbered ca 200 people.

The disappearance of Mierzanowice Culture in western Lesser Poland can be synchronized with the appearance of new populations at about 1600 BC (break of I and II

Bronze Age Period, *sensu* Montelius). The archaeological reflection of these new populations is Trzciniec Culture. Origins of this culture are connected with Polish Lowland (i.e. territories located north of western Lesser Poland), where crucial cultural transformations took place at the end of I Bronze Age Period.

Materials that have been found at settlements are the most important source for the recognition of the Trzciniec culture in loess uplands. When comparing to Mierzanowice culture, a distinct increase of the number of sites should be emphasized (ca. 260) not to mention greater settlement stability. Villages and hamlets were erected mostly in narrow belt at the edges of lower terraces. In the eastern part of the discussed area (Nida valley) the density of the settlement is extremely high, whereas it drops significantly westward (in the Dłubnia river valley). Cartographical analyses made it possible to distinguish settlement clusters consisting of 2–3 villages. The distance between such clusters can be estimated at 3 km at the average. Archaeological remains from settlements at Jakuszowice and Kraków-Mogiła, site 55 (Kopiec Wandy) became the basis for internal division of the Trzciniec culture into three stages: Early, Middle, and Late; in the lump they cover the period ca. 1600 – 1200 BC. One of the most interesting features of this unit is the presence of elements of southern origin (middle Danube basin). They should be linked with Otomani and Madziarovce cultures as well as with so called Barrow Complex. Burial rite of the Trzciniec culture is highly diversified. Both inhumation and incineration were identified as well as flat graves and barrows. The latter ones make the most intriguing phenomenon whereas their genesis is not clear. Metallurgy of this unit has not been well examined. One of a few sites with remnants of bronze production is possibly settlement at Słonowice village.

Disappearance of the Trzciniec culture has been frequently talked over in the archaeological literature due to its connection with the question of origins of 'Lusatian Culture', which is extremely important for the prehistory of Poland. Present state of research suggests that the earliest sites of Lusatian culture, dated at the middle of the III Bronze Age Period in the Kraków area, appeared as a result of migration from Upper Silesia. Specific sets of vessels ornamented with flat knobs (of the so called Silesian type) and specific bronze pins prove aforementioned hypothesis. New settlements were located mainly along the Vistula valley. There are no traces of mixing of Trzciniec and Lusatian populations, although they were undoubtedly contemporaneous for some time.

Settlement of the Lusatian culture in loess uplands of western Lesser Poland covers Middle and Late Bronze Age (ca 1200 – 800 BC) and Early Iron Age (800 – 450/400 BC). The global number of Lusatian sites amounts almost 450 (Fig. 20). In the earlier developmental stages of this unit its material culture is very similar to the Silesian group of the culture. It was only during V Bronze Age Period that Kraków area became a part of so called 'Upper Silesian – Lesser Poland group', i.e. grouping independent on Silesian group. The highest number of Lusatian sites should be connected with this stage. On the basis of detailed settlement studies we can discern roughly 40 micro-regional clusters, consisting of 2–3 villages (with population up to 50 persons each) and a cemetery. Bi-ritual burial rite is typical feature of the 'Upper Silesian – Lesser Poland group', i.e. both cremation and inhumation were applied in the same necropolis. Grave goods consisted of mostly ceramic vessels and personal adornments (bracelets, diadems, necklaces); there are no graves with weapons.

The only site, where remains of fortifications (rampart of the mixed, earth-wooden construction) have been discovered is Witów, located at the mouth of the Szreniawa river, on the high promontory. It is dated at V Bronze Age Period and Hallstatt Period C, although there existed also earlier 'Lusatian' settlement there. From this site two hoards of Bronze items (axes, bracelets, sickles) are known as well. Altogether 14 hoards of the kind were recorded in Loess Uplands.

In Hallstatt D Period (600–450/400 BC) the number of Lusatian sites became smaller (that fits well to global tendencies in southern Poland), although economy was still thriving. For instance, traces of salt production were found on sites dated at that period. The very end of the Lusatian culture in western Lesser Poland is possibly connected with La Tène A period and the appearance of the new population, belonging to the Pomeranian culture.

Archaeobotany of the Bronze and Early Iron Ages (*Maria Lityńska-Zając*)

Plant materials from the Early and Older Bronze Age Periods in Loess Uplands of western Lesser Poland, connected with the settlement of Mierzanowice and Trzciniec Cultures, are poorly examined. The only exception is the site at Słonowice, from which many cultivated and wild plants were recovered (see chapter Słonowice). In the face of the very scanty evidence it may be suggested that the set of cultivated species resembled that known from the Neolithic. Emmer *Triticum dicoccon,* einkorn *T. monococcum*, and barley *Hordeum vulgare* were presumably most frequently cultivated cereals, but the role of einkorn probably decreased compared to the Neolithic. The significance of the other cereals cannot be unequivocally estimated. Possibly the more frequent occurrence of remains of bread wheat *Triticum aestivum*, spelt *T. spelta*, and millet *Panicum miliaceum* may indicate their greater economic importance.

In addition to cereals there are a few records of lentil *Lens culinaris* and pea *Pisum sativum* from the sites of the Older Bronze Age. At Słonowice charred pea seeds were relatively abundant in Trzciniec Culture layers (see chapter Słonowice).

Weeds were described only from 4 sites of the Mierzanowice Culture. They belong to 12 species most frequently recorded also in other archaeological sites, such as *Agrostemma githago, Bromus secalinus*, *Chenopodium album*, and *Fallopia convolvulus*. Due to their wide ecological amplitude they could grow in various cultivated fields. Wild plants recovered from the Trzciniec Culture site at Słonowice are described in a separate chapter dedicated to Słonowice.

Not many puhlications in Polish literature concern plant remains recovered from Lusatian Culture sites dated to the Bronze Age. A few sites that were discovered in Loess Uplands of western Lesser Poland provided scanty plant material that contained a small number of taxa. Nevertheless, in Lesser Poland (similarly as in the other regions of Poland) the remains of millet *Panicum miliaceum* occur more often and in larger numbers than in older times. Besides, there appear barley *Hordeum vulgare*, emmer *Triticum dicoccon*, and rarely bread wheat *Triticum aestivum*. It seems very likely that Lusatian Culture people cultivated, as monocultures, millet, barley and emmer wheat.

The list of wild herbs includes only few species that nowadays grow on field and ruderal habitats, such as *Bromus secalinus*, *Echinochloa crus-galli, Chenopodium album, Galium spurium, Polygonum aviculare, P. minus, Setaria viridis* vel *S. verticillata*, and *Fallopia convolvulus*.

In the Lusatian Culture materials, the most numerous group of remains is made of trees and shrubs. In addition to frequently occurring pine *Pinus sylvestris* and oak *Quercus* sp., anthracological spectra include charcoal of birch *Betula* sp., ash *Fraxinus excelsior*, hornbeam *Carpinus betulus*, and beech *Fagus sylvatica*, which attains relatively high frequency. Particularly interesting are hornbeam charcoals, which provide evidence for its early presence in the forests. Hornbeam appeared relatively late in forest communities of Poland. According to pollen analysis the time of its greatest expansion corresponds to the Iron Age.

Some General Remarks on the Neolithic and Old Bronze Age Site in Słonowice Village, Southern Poland (*Maria Lityńska-Zając & Krzysztof Tunia*)

One of the most spectacular archaeological discoveries on the territory of Poland in recent years was the uncovering and exploration of a large cult-and-sepulchral complex in Słonowice, Kazimierza Wielka district, in southern Poland. The discovered construction belongs to the Central European Neolithic Funnel Beaker culture. Moreover, at the same site the remains of the Old Bronze Age Trzciniec culture settlements were unearthed.

The village of Słonowice is situated on the loess upland of western Lesser Poland (western Małopolska), on the left side of the Małoszówka river, a small right-bank tributary of the Nidzica river (which itself flows into the Vistula river) (see Fig. 11). The site is located in the middle and lower part of a slope inclining towards the Małoszówka.

After a number of years of the conventional archaeological research supplemented with geophysical prospections, the form, function and chronology of the Neolithic construction in Słonowice was explained. It may be described as a *temenos* – a separated sacred area, adjacent to a cemetery The flattened central area of the slopes, which incline towards the Małoszówka river, was occupied by a big quadrangular area, surrounded to the east, west and (most probably) to the north by an earthen embankment, with trenches running on both of its sides, from which the earth for the construction of the embankment was taken. The whole construction was planned on a quadrangle, with one of its sides being more than a hundred meters long. It was oriented in accordance with the points of the compass. The southern boundary of the quadrangle was formed by an immense tomb, oriented on the E–W axis. Near the eastern part of the tomb, the entrance to the quadrangle was situated – in its southeastern corner (Fig. 21).

The tomb was a massive timber-and-earth construction, laid out as a trapezium – its wider base (10 m long) was in the east, the narrower one (3 m long) – in the west; while the whole construction was 110 m in length. The walls were built like "palisades", from timber logs, which were about 30 cm in diameter and were dug into 50–cm wide grooves. On the outside, in parallel with the sidewalls of the tomb, there were trenches. They were deeper on the eastern side. It was from them that the earth for filling in the inside of the tomb was taken. To the south of the above-described construction, five (or six?) similar tombs were situated. They were similar – but not identical. All of the tombs that have been discovered thus far are situated in parallel (one to another), "descending" towards the river. The highest located is the one that forms the southern boundary of the quadrangle. All of the tombs that have been discovered thus far share some characteristics, but there are no two identical ones. The basic construction principles are analogous: for example, the system of wall construction; otherwise, there are considerable differences between them. Only two of the tombs are surrounded by the trenches from which the earth to fill in their interiors was taken. The remaining ones were probably hollow inside, as they have no trenches. The tombs also differ in size. The ones with the trenches and with the filled-in interiors are the biggest. The remaining ones are a little smaller in size – they are shorter and narrower. Basically, in each of the tombs there was one grave. Exceptionally, in one case – three burials were found. All of the tombs are more or less trapezoidal in outline, with the wider side in the east. It was also there that the grave was located, a few metres away from the eastern wall, where the entrance was. The entrance was simply an opening in the "palisade", very often with a post in the middle. Also the principles of the construction of graves differed. The only characteristic that they shared was the orientation on the E–W axis. The characteristics of the Słonowice tombs resemble those of megalithic *Kuyavian* tombs, laid out in the form of a trapezium, with the walls built of massive boulders. Many constructions like those have been discovered on the territory of central and northern Poland. The main difference is the use of a different material for the construction of walls – it may be explained by the fact that on the territories of northern and central Poland there was an abundance of postglacial boulders, while on the southern loess uplands that building material did not occur. Therefore the tomb-builders had

to make do with a different kind of material. Attached to that particular form of tomb, they were forced to use local, widely available material – timber. According to preliminary results of the C14 analysis we can date the immense "timber megaliths" – or better "megaksylos" to the IV millennium BC.

As a result of the investigations conducted in Słonowice, not only an exceptionally spectacular and important complex of constructions was discovered, but also (what is undoubtedly more important) – a great amount of information was gathered that broadens our knowledge about the social, technological and intellectual development of the then society. The inhabitants of the southern loess uplands in Lesser Poland in the Middle Neolithic were able to concentrate considerable human resources and to organize them in such a way that would allow them to carry out very complicated engineering project with such modest means that they had at their disposal. These informations have an impact not only on the assemblage in Słonowice, but also provide us with very important data for determining the cultural situation in central Europe during the time period under discussion.

The second phase of the occupation of the area of Słonowice site were the Old Bronze Age Trzciniec culture settlements. Within excavation units at Słonowice numerous remains proof of uninterrupted development of the settlement during all, typologically distinguished, chronological phases of the Trzciniec culture. Artefacts appear almost exclusively in various kinds of pits dug out in loess ground. Most of them must have been used to store provisions. No traces of dwelling houses have been found. The buildings might have had only over-ground construction, and their remains might have been destroyed by erosion. Some traces of them are numerous lumps of daub found together with potsherds, bone and stone artefacts, bone garbage and charcoal in the pits mentioned above.

Studies on the botanical materials from Słonowice are being carried out for several years parallel to archaeological field explorations. They include Neolithic materials of the Funnel Beaker culture and Old Bronze Age Trzciniec culture. Botanical samples containing fruits, seeds, charcoals, and daub with plant impressions were collected only from places of unequivocal chronology. Funnel Beaker culture materials originated from graves and constructions connected with the graves. Materials of Trzciniec culture were collected from utility pits.

In the Neolithic samples only charred wood of oak *Quercus* sp. and small fragments of grass straw (Poaceae indet.) was found.

Much abundant material, which included over 100 taxa, was recovered from the features of the Trzciniec culture. Predominately were cultivated plants, mainly cereals, but wild herbaceous and woody plants were also numerous. Among cereals most frequent were emmer wheat *Triticum dicoccon* and einkorn wheat *T. monococcum*; fairly frequent was also barley *Hordeum vulgare*. Remains of other cultivated plants belonged to millet *Panicum miliaceum* rare were grains of spelt *Triticum spelta*, as well as seeds of pea *Pisum sativum* and lentil *Lens culinaris*.

Besides cultivated species mentioned above, a significant number of diaspores of wild plants was found at Słonowice. An interesting species is *Melandrium noctiflorum*, which originated from the Pontic-Pannonian Province, and grows today in cereal fields, on soils rich in calcium carbonate. In this material, the oldest in Poland macroscopic remains of *Plantago lanceolata* were found. This is our native species, pollen grains of which appear in pollen spectra correlated with various chronological phases and are interpreted as indicators of the presence of pastures or mown meadows.

Among the interesting species the fairly abundant occurrence of *Echinochloa crus-galli* and *Setaria pumila* are worth mentioning. Both species are connected today with root crops. At Słonowice they occur in several pits together with millet, though often also in the

samples of other cereals. Their presence at Słonowice is probably connected with millet cultivations, which increased in significance during this chronological period.

Samples from the Trzciniec culture features at Słonowice are characterized by the relatively great number of species connected today with ruderal communities. Here belong e.g. *Sambucus ebulus*, *Melandrium album*, *Artemisia vulgaris*, and several *Chenopodium* species. Their presence, and particularly the occurrence of perennial species, suggests the existence of habitats considerably and permanently changed by humans due to their long-lasting interference with the environment surrounding settlements.

Remnants of trees are dominated by oak *Quercus* sp. (over 2000 fragments) and pine *Pinus sylvestris* (ca. 800 fragments). Fairly abundant are also alder *Alnus* sp., elm *Ulmus* sp., birch *Betula* sp., and linden *Tilia* sp. Taxonomic diversity of wood fragments suggests that in various habitats different deciduous forest communities developed near Słonowice. On leached loess soils oak and pine could form mixed oak-pine forests of *Pino-Quercetum* type. The most interesting data were obtained from the feature no. 28, in which the remnants of hulled barley *Hordeum vulgare* occurred in great numbers (over 1800 hulled grains). Grains of emmer *T. dicoccon* and einkorn *T. monococcum* and pieces of straw of undetermined cereals were an insignificant admixture, while pea *Pisum sativum* was represented by 115 seeds. All cultivated species were found in each of the 6 samples collected from different parts and at different depths of this feature. This kind of distribution of various species in one feature may suggest either the sawing of pea and barley in mixture or secondary mixing of crops originally kept in separate (e.g. wooden) containers. In the feature 28, in addition to cultivated plants, several field weed species occurred: *Agrostemma githago* (1 seed), *Bromus secalinus* (8 kernels), *Chenopodium album* (9 seeds), *Chenopodium ficifolium* (1 seed), *Chenopodium hybridum* (1 seed), *Fallopia convolvulus* (6 fruits), *Galium spurium* (2 fruits), *Melandrium album* (2 seeds) and *Stellaria media* (1 seed). Habitat requirements of these species, expressed by ecological numbers, indicate that barley was sawn on fresh, fairly rich and neutral soil.

Loess uplands of western Lesser Poland in Pre-Roman, Roman, and Early Migration Periods (*Judyta Rodzińska-Nowak*)

Loess uplands of western Lesser Poland were also important centre of human settlement in Pre-Roman, Roman, and Early Migration Periods, i. e. between late 3rd century BC and mid-5th century AD.

In the second half of the first millennium BC Celtic tribes were of significant importance in Central Europe. Celtic settlement extended also to the parts of Polish territory, including the Upper Vistula river Basin (from the Kraków area to the Nida river). This is not a surprise because Celts used to settle areas with fertile soils, due to strictly agricultural pattern of their economy.

The oldest, stray finds connected with Celtic cultural milieu in western Lesser Poland should be dated at the beginning of 3rd century AD (i. e. period La Tène B2). Rich graves of Celtic warriors discovered at Iwanowice are slightly later (La Tène C). Mixing of the elements characteristic for Celtic culture and for local, so called Przeworsk culture is typical for next phases of pre-Roman development. Therefore, specific terms like 'Celtic-Przeworsk Cultural Group' or alternatively 'Tyniec Group' were introduced. It should be emphasised that these stages of cultural development are represented by archaeological remains discovered only on settlements, as in most other territories of Celtic cultural circle. That was caused by specific burial rite practiced in period La Tene D that virtually left no archaeological traces. Those customs were seemingly accepted also by most of the Przeworsk Culture population in the area under discussion.

Within the development of Tyniec Group three phases can be distinguished. Presence of only Celtic elements is characteristic for the first one. It is represented in settlements at Kraków-Wyciąże, Kraków-Pleszów, Dalewice and Pełczyska villages, and recently excavated Zagórzyce. In the second phase, which begins at early 2nd century BC, Celtic artefacts (i.a. wheel-made pottery, both of so called graphite and grey types) have been found in concomitance with hand-made pottery of Przeworsk Culture. In the third phase (ca. 1st century BC), a shrinking of territorial extent can be seen, especially in its northern part, due to new wave of Przeworsk Culture migration. Thin-walled, wheel-made pottery, produced and ornamented with painting in workshops located in Kraków region, was typical for that phase. It is very similar to the Celtic pottery identified in the territory of present-day Slovakia. Findings of coins minted in 'our' area (staters of Kraków type) bear witness to highly developed social and economic structures of local Celtic populations.

At the break of the 3rd and 2nd centuries BC, essential cultural transformations took place in the present-day Polish territory. One of the consequences of these transformations was the emergence of aforementioned Przeworsk culture. This phenomenon appeared due to influences of Celtic cultural complex and of Jastorf culture (located in the Elbe river basin). Relation of the Przeworsk culture to the earlier cultural background, i.e. Pomeranian culture remains to be solved. Archaeological materials of early Przeworsk chronology were found i.a. in settlements at Pełczyska and Kraków-Wyciąże. More intensive settlement of this unit should be dated at the phase A2 (in pre-Roman chronological schedule, i.e. ca. 120 – 60 BC). A cemetery at Stradów village, single grave at Miernów village and the first stage of Przeworsk town settlement at Jakuszowice village are the most valuable examples of this phase.

Further development of the Przeworsk culture settlement in Loess Uplands of western Lesser Poland took place in pre-Roman phase A3 (ca. 60 BC – 20 AD) and in Roman period (called also Period of Roman Influences), dated traditionally to AD 375. It should be also mentioned that the presence of Puchov culture (derived from northern, mountainous part of Slovakia and identified with Celtic tribe *Kotinae*) was confirmed in left bank territory of the Upper Vistula river.

Przeworsk culture sites dated to Roman period are first and foremost open settlements (Fig. 22). They contain usually traces of semi-dugout buildings as well as indistinct configurations of post-holes, pits, workshop features like pottery kilns and fireplaces. A row of settlements localized along the left bank terrace of the Vistula river, east of Kraków (e.g. in Igołomia village, Zofipole village, Kraków-Nowa Huta, Kraków-Branice) are worth special noticing due to a great number of wheel-made pottery workshops and kilns as well as traces of iron and other metals metallurgy and processing.

A multi-layer settlement at Jakuszowice village deserves exceptional attention because of an extremely complicated stratigraphy and unusual richness of archaeological remains, including a lot of Roman imports (i.a. 110 Roman coins) and remnants of production activity (pottery, amber, bone, horn, metals). The latest stage of that settlement can be dated at the Early Migration Period (first half of the 5th millennium) and is contemporary with 'prince' grave, containing artefacts typical for nomadic Hunn culture, that was discovered in close proximity (Fig. 23).

As it was already mentioned, sepulchral sites are relatively rare in area, which was within boundary of Tyniec group before. Only several, small cemeteries are known to date. Some of them (in Górka Stogniewska and Michałowice villages) contain features deriving from earlier, Celtic tradition.

Beside 'prince' grave from Jakuszowice, there are also a few other interesting findings, like inhumation grave at Przemęczany village with golden earring of the Hunn style and treasure of golden solids at Witów village. All these elements suggest that western Lesser

Poland remained under political influences of Hunn state, the centre of which was located in the Carpathian Basin.

Przeworsk culture in the Loess Uplands of western Lesser Poland, similarly to other territories of that culture, disappeared at about AD 450. Analyses of ancient written sources suggest that in Early Roman Period (ca. 0/50–150 AD) 'Przeworsk Culture' should be identified with tribe(s) called *Lugiae* (*Lugiorum Nomen*), whereas after ca. AD 150 that unit should be treated as an archaeological reflection of Vandals.

ARCHAEOBOTANY OF IRON AGE (*Maria Lityńska-Zając*)

Plant remains from Pre-Roman and Roman periods were examined from 9 archaeological sites situated on Loess Uplands of western Lesser Poland. Most of them are located in Kraków-Nowa Huta quarter. The majority of remains belonged to cereals and other cultivated plants, which were recognized on the basis of charred fruits and seeds as well as imprints in daub. Among cereal cultivations, rye *Secale cereale*, barley *Hordeum vulgare*, and bread wheat *Triticum aestivum* took dominant position along with significant role of millet *Panicum miliaceum*, emmer wheat *Triticum dicoccon* and oat *Avena sativa*.

One of the most important archaeological sites of Roman age in this area, representing Przeworsk culture, is the settlement at Jakuszowice village, site 2, and Kazimierza Wielka commune. At this site, cultivated plants were represented by 10 species preserved as charred kernels, spikelet fragments, fruits and seeds dispersed in various archaeological objects. Qualitative and quantitative analyses indicate the dominant role of cereals, and among them of common barley *Hordeum vulgare* and oat *Avena sativa*. Other cultivated plants, represented by lentil *Lens culinaris*, flax *Linum usitatissimum*, pea *Pisum sativum*, and broad bean *Vicia faba* var. *minor*, were of lesser importance.

Wild herbaceous plants belonged to 61 species and 5 taxa identified only to the generic level. Their quantitative representation was generally low, most abundant were remnants of *Chenopodium album*, *Fallopia convolvulus*, and *C. polyspermum*. Phytosociological analysis has shown that several species were connected with communities of field weeds growing in cereals and root crops. Weed species differed in their edaphic requirements. For instance *Melandrium noctiflorum, Neslia paniculata, Stachys annua, Valerianella dentata*, and *Fumaria officinalis* required fertile soils, while *Bromus secalinus, Spergula arvensis, Digitaria ischaemum, Echinochloa crus-galli*, and *Setaria pumila* could grow on poorer soils. The differentiation of edaphic demands of field weeds suggests that both, fertile and poor soils were used for farming.

Considerable number of species belonged to ruderal weeds, meadow and grassland plants. Particularly interesting is the presence of meadow plants, which distinctly increase in number in archaeological materials from Roman sites in the whole Poland. *Plantago lanceolata, Vicia cracca, Lychnis flos-cuculi*, and *Prunella vulgaris* grew in various meadow communities. The occurrence of these light-demanding plants indicates that meadows must have been maintained intentionally by people.

Trees and shrubs were represented by 12 taxa, including 4 species and 8 generic identifications. Most abundant were charcoals of oak *Quercus* sp. and pine *Pinus sylvestris*, smaller numbers belonged to lime *Tilia* sp., alder *Alnus* sp., poplar or willow *Populus* sp. vel *Salix* sp., ash *Fraxinus excelsior*, hornbeam *Carpinus betulus* and beech *Fagus sylvatica*.

A very interesting finding, worth mentioning in this short description, is a set of taxa recovered from object 174, in Kraków-Nowa Huta-Mogiła site 1. It included kernels of rye *Secale cereale*, bread wheat *Triticum aestivum* s.l., and common barley *Hordeum vulgare*, as well as numerous (over 600) seeds of poppy *Papaver somniferum* and *Hyoscyamus niger*, and other weed species. At present, *H. niger* grows first of all in ruderal habitats, but rarely occurs also in root crop, vegetable, and poppy cultivations. It is particularly noxious as poppy weed

because its poisonous seeds are difficult to separate from poppy seeds. It seems likely that *H. niger* grew as poppy weed already in the Roman Period.

THE NIECKA NIDZIAŃSKA BASIN IN THE EARLY MIDDLE AGES (*Aneta Gołębiowska-Tobiasz & Zbigniew Robak*)

The beginnings of the settlement of Lesser Poland in the early Middle Ages are linked with the period of expansion of the Slavic peoples, from their dwellings in the east towards the new territories, e.g.: the neighbouring lands of the basin of the Upper Vistula river to the west. This process did not start until the 2nd half of the 5th century and it was linked with the cultural province of Prague.

The distinctive features of that culture were e.g.: square earth houses, with a clay or stone-heating appliance in one of the corners. In most cases, the small, open settlements of loose built-up were located on the edges of the terraces, always near to the water. The southern slopes were always preferable. The earliest Slavic settlements were not frequently developed over 300 metres of elevation, so the territory of the Nida river valley was a very attractive place to settle. Very fertile, loess based soil was yet another advantage of the region.

The agriculture was the base of the economy. Wheat and millet were cultivated. Breeding of cattle has also been developed. It is probable that the natural richness of these lands was used through fishing, hunting and gathering (fishing hooks were found). Home workshops were providing the households with unadorned, oval, slender vessels, with barely marked, short brims (pottery of Prague type). Weaving was also practised, which is proved by numerous weaving weights and other accessories, found in the region. The richness of the handicraft of the early Slavic peoples was doubtlessly connected with processing of wood. There is also some evidence of smelting iron in primitive hearths, and founding it in stone moulds.

A low quantity of imported goods proves contact with other cultures, though it is difficult to estimate if there was a regular trade between the Slavs and their neighbours.

The finds connected with the Early Slavic Period, from the turn of the 5th and the 6th century to the 7th century show a rather insignificant social stratification and low economic level of the people. The main unit of the society was probably a family containing a dozen of individuals, inhabiting a defined territory in a settlement with related families, creating a larger group of kinsmen. In the period of increased mobility, these groups were combining with one another, creating territorial communities and so-called "small tribes" consisted of a few of such communities. War democracy was the political system. The decisions were taken by a rally of adult, free members of the society.

Nothing connected to the funeral rite has been found in the Niecka Nidziańska basin so far. The region belongs though to the zone, where, at that time pit graves or flat ashtrays were the dominant forms of the funeral rite, which included also cremation. It is not impossible, that a form of burial, which was in use, is undetectable by means of excavations (e.g.: cremation of bodies).

In the territory of the Niecka Nidziańska basin, the archaeological sites linked with the early settlements of Slavs are those found in Stradów, Szarbia, Bizoręda and Żerniki Dolne villages.

The tribal period, form the late 7th and the early 8th to the end of the 10th century is known to be the time of fast social transformations, adoption of some foreign cultural influences and modification of the own model of culture. The war democracy was gradually transformed, in consequence of the concentration of power in hands of a narrow group of tribal leaders, overtaken later by the elites (the dynasties) that were shaping. In the middle of the 8th century, the Slavic tribes were expanding and fighting one another. The "great tribes" were created.

The Niecka Nidziańska basin was then the northern line of the Vistulans tribal territory. The emergence of tribal elites and consolidation of local communities within the tribe led to a new model of settling structures, characterized by defensive features. They were the centres of the society and were meant to represent power. They were also where the tribal veches gathered and where trade was proceeded. In the periods of conflict, they have also been the centres of resistance. In Lesser Poland, the first gords, wooden fortified settlements, were founded in the middle of the 8th century, but their construction was particularly intense in the 9th century. It was a consequence of a rising threat from the part of Great Moravia. The gords were built with use of the natural terrain features (such locations, in the highlands, were the culminations of hills, or any landforms, extending significantly above the surrounding terrains, that could be artificially fortified, while in the lowlands they were the locations defended naturally by moors and water streams). The constructed gords had different forms; some had regular shapes, as the wooden and earthwork fortifications were adjusted to the natural form of the terrain. It was characteristic for Lesser Poland to build large gords, with complicated systems of embankments and irregular forms. Stradów, of which the total surface was about 25 ha, is a good example. Szczaworyż, with its 5 ha was significantly smaller, but compared to the tribal gords of other regions of Poland, it was indeed a big object. What is interesting, the tribal gords were not fixed seats of the local elites and a part of them was not at all inhabited. Nevertheless, their concentration in the zones, in which the monuments connected with the presence of the elites, especially equestrian equipment and armaments, were more numerous is significant.

There were three gords in the Niecka Nidziańska basin in the tribal period (Fig. 24): in Stradów village, in Szczaworyż village and in Wiślica town. Szczaworyż and Stradów belonged to the defensive system with the gords in Zagórowa and Damice villages and an implicit gord in Siedliska village, of which the objective was to protect the left bank of Vistula river, encircling Kraków city from the north and north-west. The gord in Wiślica, founded at the estuary of Nida river to Vistula river, was meant to protect the communication routes, which these two rivers were.

In the early 7th century, the vessels shaped on potter's wheels appeared. It was a new phenomenon in the Slavic world, but it was quickly spread in the south and east parts of Poland. The skill of producing vessels on a potter's wheel was acquired from the Danubian territories. The brims of the vessels were shaped and at the imprints of the potter's wheel were visible on the bottom. The vessel was also adorned by straight and wavy lines, or curves, made with a brush. In Poland, so-called Prague type vessels, in form of bathtubs, were spread. Their function is unknown (perhaps that they were used to roast seeds). In the 7th and in the beginning of the 8th century, pottery made on wheel was more widely spread than hand built dishes.

It became relatively frequent to find hook, low or high bow spurs, which was an emulation of the similar specimens of the Merowings. The occurrence of those items is an evidence of the adaptation of equestrian equipment in Lesser Poland and of a change in combat tactics. In the 8th and the 9th century, other types of spurs appeared as well (Carolingian and Great Moravian influences – items found in Stradów and Szczaworyż). The treasuries of iron items, including tools, and more rarely, armaments, were specific for Lesser Poland. Another category of the finds are the ornaments, including beads, ear rings and belt fitting, that were mostly imported, and armaments, including axes, arrowheads and spearheads.

In the 2nd half of the 7th century, besides the square semi-dugouts, new types of buildings began to be constructed in the open settlements. Their remains, found at the archaeological site, are, lengthened to be rectangular, less or more regular pits. Such buildings

were used as houses or household objects. In the 8th and the 9th century, they became the single form of buildings used.

From the half or the end of the 7th century, to the end of the 10th century, a kurgan, cremation funeral rite was practised. In the end of the 10th century, under the Christian influence, a kurgan skeletal ritual has been introduced in cemeteries not placed near the churches (Strzemieszyce, Stradów and Złota Pińczowska villages) and those in proximity of the churches (Wiślica town, Kije village and Gorysławice village).

In the Niecka Nidziańska basin, the archaeological sites, connected with the tribal period, except those enumerated hitherto, are located in Jakuszowice village, Pełczyska village, Żurawiki village, Złota Pińczowska village, Skalbmierz town, Jaksice village, Pałecznica village, Busko Zdrój town (early medieval cemeteries of an imprecise type).

The 2nd half of the 10th century brought very important changes. Lesser Poland fallen under the influences of Czech rule for a short period of time and about 989, it has been connected to the State of Gniezno, which has been shaped at that time and which was the root of what later became Poland. The mentioned north line of the tribal territory of the Vistulans has lost its strategic meaning and its existence has even become undesirable for the new rulers, coming from Greater Poland. In the end of the 10th and in the 11th century, most of the gords ceased to function, as they have been abandoned by the people or even voluntarily destroyed by the members of the Piast dynasty. A system of gords and serving settlements assigned to them has been developed in the country. From now on, the castellan was a prince's clerk, who supervised the land, assigned to him by the prince. It could be said, that the destruction of the old, tribal gords was a symbolic end to the old social structures. The former gords, existing in the consciousness of the population as centres were undesirable for the Piast dynasty, as they could favour the entryist tendencies. Wiślica was an exception, due to its strategic location, a castellan's seat was established there. Another castellan's seat gord was Czechów village, of which the remnants are the remains of a gord in Stawy village. In the end of the 11th or in the 12th century, a gord Chroberz village, which became a residence of the prince's Court, has been founded.

The gords of the castellans were not similar to the tribal gords. They were mostly minor strongholds with a narrow built-up and, which is important, inhabited by a fellowship of warriors and the clerks. A model house was a unicameral bungalow of 15–25 m^2. Such house was usually accompanied hy, in most cases, lesser household buildings. The important places of a gord were the church and the central square, which was a meeting spot and a marketplace.

The archaeological sources do not allow to describe of the appearance of the early medieval villages, e.g. because most of them still exist in their original locations.

The gords of the castellans, with their supporting organization, became the basis of a great economic progress of the young State. Their decline in the 13th century had its reasons in the political system, as it supported town and village location on German Law and that process grew in intensiveness.

With the coming of the Piast dynasty, the Christian influences were also becoming more and more significant, which resulted in an obligatory change from the kurgan funeral rite to the pit skeletal funeral rite. In the beginning, the cremation was still tolerated, especially among the State's elite.

With the passing of time, a network of parishes embraced the country; churches and monasteries have been spread. In 1155, the Knights Hospitaller were invited to Stara Zagość and in 1180, the Norbertines came to Busko. It was also the period, when the Romanesque art was developing, of which a beautiful example is the "plate of Wiślica" (ca. 1170). All these changes shaped the social structure and the organization of the State of the Piast dynasty in a manner, which made it similar to the conditions in the Western Europe.

MEDIEVAL STRONGHOLD AT STRADÓW (*Anna Tyniec-Kępińska, Bartłomiej Sz. Szmoniewski & Maria Lityńska-Zając*)

I. Archaeological data

Early Middle Ages settlements on the Loess Uplands of western Lesser Poland are rather well studied. There are six early medieval hillforts, numerous inhumation cemetery and open settlements, a few cremation burial grave-mounds and hoards and several hundred sites where field survey has been conducted. In the reconstruction of the settlement network written materials have begun to play a significant role (especially to younger phases – there are only few records earlier than the 12th century). It was a territory of the Vistulans (Wiślanie) tribe. They had been linked with the Great Moravian State (9th century), later with the Czech and in the 2nd part of 10th century became part of early Polish state – united under the rule of Mieszko, duke of Polanie tribe from Greater Poland.

Scale and character of finds from the Early Middle Ages allows us to do determine preferred environmental conditions. The location of the settlements is converging with the later one. In he younger phases of the Early Middle Ages is observed a considerable influence of political and *stricte* economical factor on the location of settlements.

Traces of the oldest medieval settlements have been found on the higher elevated pieces of land and slopes of rivers' valleys (often at the mouths of the minor flows) and some of them in the area of the present fluvial terraces. In the 9th and 10th century the penetration had widened towards the Upland areas. There are settlements where the cultural layers and archaeological objects have been found below the present ground water table. It is undoubtedly connected to the contemporary climatic conditions – lower ground water table and the levels of superficial water flows.

Hillfort at Stradów village (Malopolskie province) is the biggest (25 hectares) Early Medieval complex in Poland. It consisted of a borough ("Zamczysko", that occupied the area of approx. 1.5 hectares and was surrounded by an embankment approx. 500 m long) and a moat (Fig. 25). Contrary to the *suburbia* ("Barzyńskie", "Mieścisko", "Waliki"), which were gradually destroyed by ploughing and farming, the reinforcements of the borough are preserved well and the state of their preservation in the last one hundred years was subject only to minor changes (fortification is approx. 20 m wide at the base; its height from the interior ranges from 2 m in western section to 6 m in eastern section, whereas from the bottom of the moat it amounts to 12 m). The moat, 5 m deep, surrounded the borough from the north, south and east. The varied height of the embankment and the fact that it was surrounded by the moat only partially result from making use of the natural shape of the area. There are a few settlements and cemetery in the vicinity. Hillfort in Stradów is one of the so-called tribe hillforts (9th–10th century) but all the settlements in this area became from 8th to 12th century.

II. Archaeobotanical data

Early Medieval plant remains from the Loess Uplands of western Lesser Poland are relatively well studied. Several sites contained rich assemblages of cultivated and wild herbaceous plants, as well as trees and shrubs. These materials provided information about cultivated species and about vegetation that spontaneously developed in cultivated fields, meadows and pastures, in the near surroundings of settlements or in neighbouring forests. Most extensive data were obtained for the flora and vegetation of Kraków, due to the systematic investigations carried out since the 1950s.

During the Early Middle Ages changes took place in the significance of individual species constituting the set of cultivated plants. Bread wheat *Triticum aestivum*, rye *Secale*

cereale, and millet *Panicum miliaceum* became the dominant cereals. Barley *Hordeum vulgare* was probably cultivated on a smaller scale, cultivation of oat *Avena sativa* was of small importance. Hulled wheats, emmer *Triticum dicoccon* and spelt *T. spelta* (2 sites each), had no economic significance. It is possible that they were not cultivated on purpose, but appeared spontaneously in fields of other cereals.

Fairly important was the cultivation of pea *Pisum sativum*, lentil *Lens culinaris*, flax *Linum usitatissimum*, and hemp *Cannabis sativa*. Poppy *Papaver somniferum* and gold-of-pleasure *Camelina sativa* were also cultivated. In the Early Medieval time there appeared several new vegetables (e.g. cucumber *Cucumis sativus*) and spices (e.g. *Anethum graveolens*). *Amaranthus lividus* subsp. *lividus* was probably sowed, as is suggested by the finds from Kraków-Wawel. This was also the time of strongly developed fruit growing.

The castle at Stradów has a special significance in providing the information about flora and vegetation of the early middle Ages. For several years the studies of plant material were carried out on this site, including charred seeds and fruits, imprints preserved in daub and roasters, and charcoals from wooden rampart construction or dispersed in archaeological objects of different kinds (Fig. 26).

Among cereals found at Stradów the grains of rye *Secale cereale* were most abundant, the next one was millet *Panicum miliaceum*, and bread wheat *Triticum aestivum* was also frequent. Single seeds of pea *Pisum sativum* and lentil *Lens culinaris* were present.

Cereals were accompanied by several species of plants growing in cultivated fields. These were first of all cereal weeds, such as *Agrostemma githago*, *Papaver rhoeas*, *Bromus secalinus*, *Lithospermum arvense*, *Galeopsis tetrahit*, and possibly *Rumex acetosella*, but the last mentioned species could also grow in dry, acidic sandy grasslands. *Setaria pumila* could grow in root-crop cultivations or millet fields. *Chenopodium album* and *Bromus arvensis* developed in fields or in ruderal habitats. *Rumex acetosa* represented meadow plants; *R. crispus* could originate from natural nitrophilous communities. The presence of relatively large number of *Solanum dulcamara* seeds is interesting, because seeds of this plant, which commonly occurs in moist forests and thickets may be consumed and used for medicinal purposes. From wet habitats comes *Ranunculus flammula*, a poisonous plant. Large number of diaspores of both last mentioned species might suggest that they were gathered, possibly as medicinal plants.

The main timber used for the construction of ramparts at Stradów originated from oak *Quercus* sp. This tree has a very resistant wood, which is used as excellent building material. Oak dominated also in charcoals found in pits and half-dugouts. Slightly less abundant was pine *Pinus sylvestris*, relatively numerous were charcoals of beech *Fagus sylvatica*, birch *Betula* sp., poplar *Populus* sp., and willow *Salix* sp. Qualitative and quantitative composition of charcoal found in ovens indicates that mostly oak wood was burnt, but wood of other trees was also used, e.g. hornbeam *Carpinus betulus*, beech, birch, poplar, and willow. Taxonomic composition of samples suggests that wood was collected in many-species deciduous forests, which were probably present in the neighbourhood of the settlement.

VEGETATION DIVERSITY OF THE STRONGHOLD IN STRADÓW (*Krystyna Towpasz & Małgarzata Kotańska*)

Stradów, one of the biggest and best-preserved Early Middle Age (8^{th}–11^{th} century) strongholds in Poland, is situated in southern Poland in the Wyżyna Małopolska upland (see Fig. 25). The silhouette of this stronghold rises distinctively over its surroundings. Its vegetation cover is more differentiated than that the surrounding hills covered with fields. In the area of about 4 km^2 the natural communities meet the anthropogenic ones.

At present the ramparts are overgrown by xerothermic grassland (*Festuco-Brometea* class). The most frequent plant association is *Thalictro-Salvietum pratensis*. The xerothermic

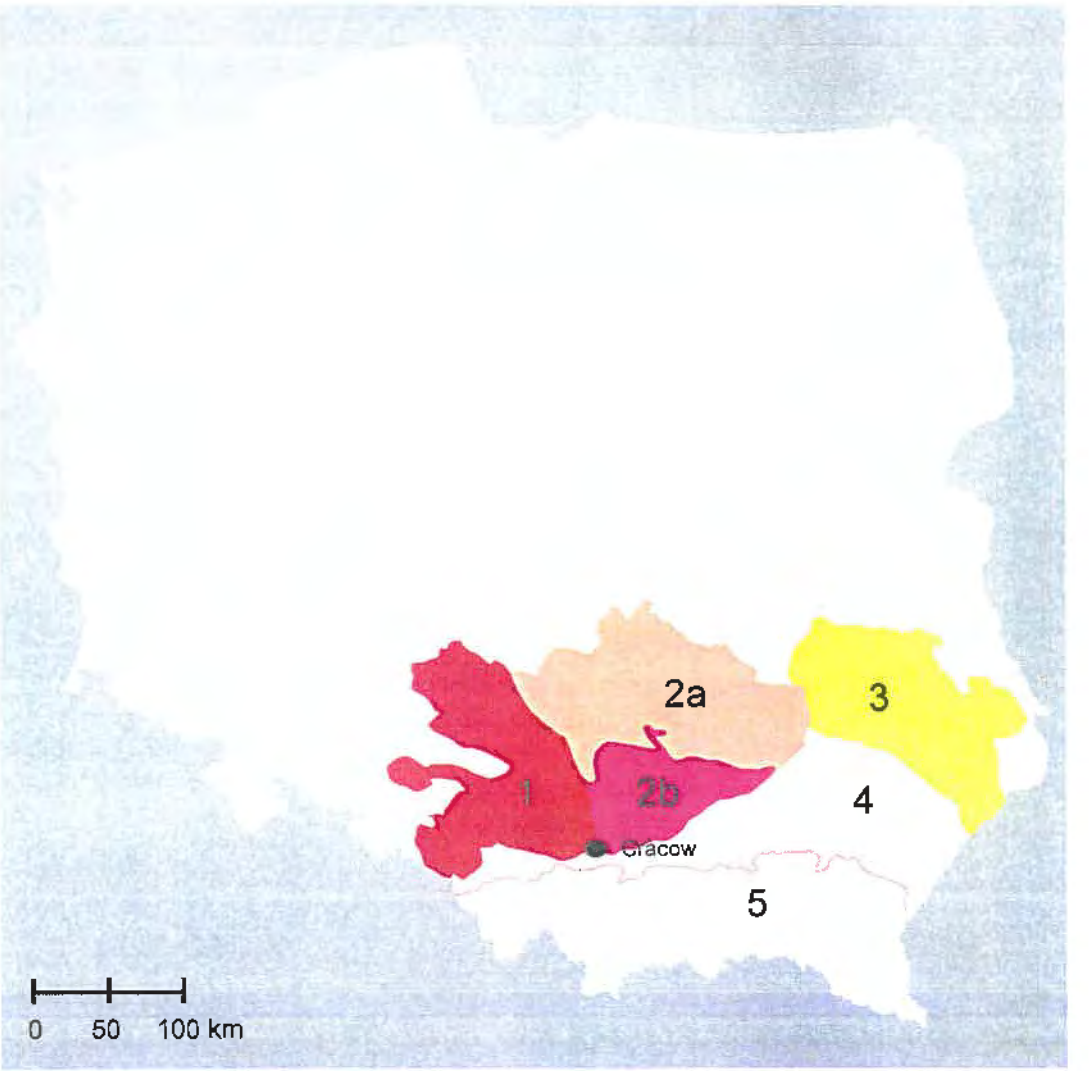
grasslands are often being burnt in early spring. In the sites, which are grazed, is *Koelerio-Festucetum macranthae* – a very frequent association. The ramparts, on which burning and grazing have been stopped, are overgrown with shrubs of *Prunus spinosa* or *Lycium barbarum*. In the depression between ramparts, in streams and ravines, which are remains of a moat, the meadows of *Molinio-Arrhenatheretea* class (in this also pasture community – *Lolio-Cynosuretum*) developed. The most of the area of the borough is occupied by fields (*Stellarietea mediae* class). In the cereal fields *Vicietum tetraspermae* and in the root crops *Echinochloo-Setarietum* communities are mostly found. Rarely, on more acid soils, thermophilous associations form: *Lathyro-Melandrietum* in the cereal fields and *Lamio-Veronicetum politae* in the root crops.

In one place only on the slopes of the ravine there grows an isolated stand of deciduous forest with *Tilia cordata* and *Ulmus montana* (*Tilio-Carpinetum*) and a riverside forest (of *Alno-Ulmion* alliance). Below the earthwork near a spring and near two ponds swamps of *Phragmitetea* class and wet and fresh meadows of *Molinio-Arrhenatheretea* class occur.

The list of plant species contains 272 taxa. In this, 205 are native and 67 are alien species. In native species the main socio-ecological groups are meadow and xerothermic species. Among them there are rare, endangered and protected taxa: *Campanula bononiensis, C. sibirica, Centaurium erythraea, Cirsium canum, Elymus hispidus, Ficaria nudicaulis, Salvia nemorosa, Thymus kosteleckyanus* and *Vicia tenuifolia* (Table 8).

Among the alien species 54 are archaeophytes and 13 kenophytes (12 holoagriophytes and 1 hemiagriophyte). The archaeophytes are the most frequent. To this group belong segetal species from *Caucalidion* alliance: *Euphorbia exigua, Sherardia arvensis, Neslia paniculata* and *Consolida regalis*. On ruderal sites grow: *Ballota nigra, Leonurus cardiaca* and *Onopordum acanthium*. Kenophytes are few. In cereal crop epoecophytes grow: *Galinsoga parviflora, G. ciliata* and *Veronica persica*. In forests hemi- or holoagriophytes occur, e.g. *Echinocystis lobata, Impatiens glandulifera* and *Robinia pseudacacia*.

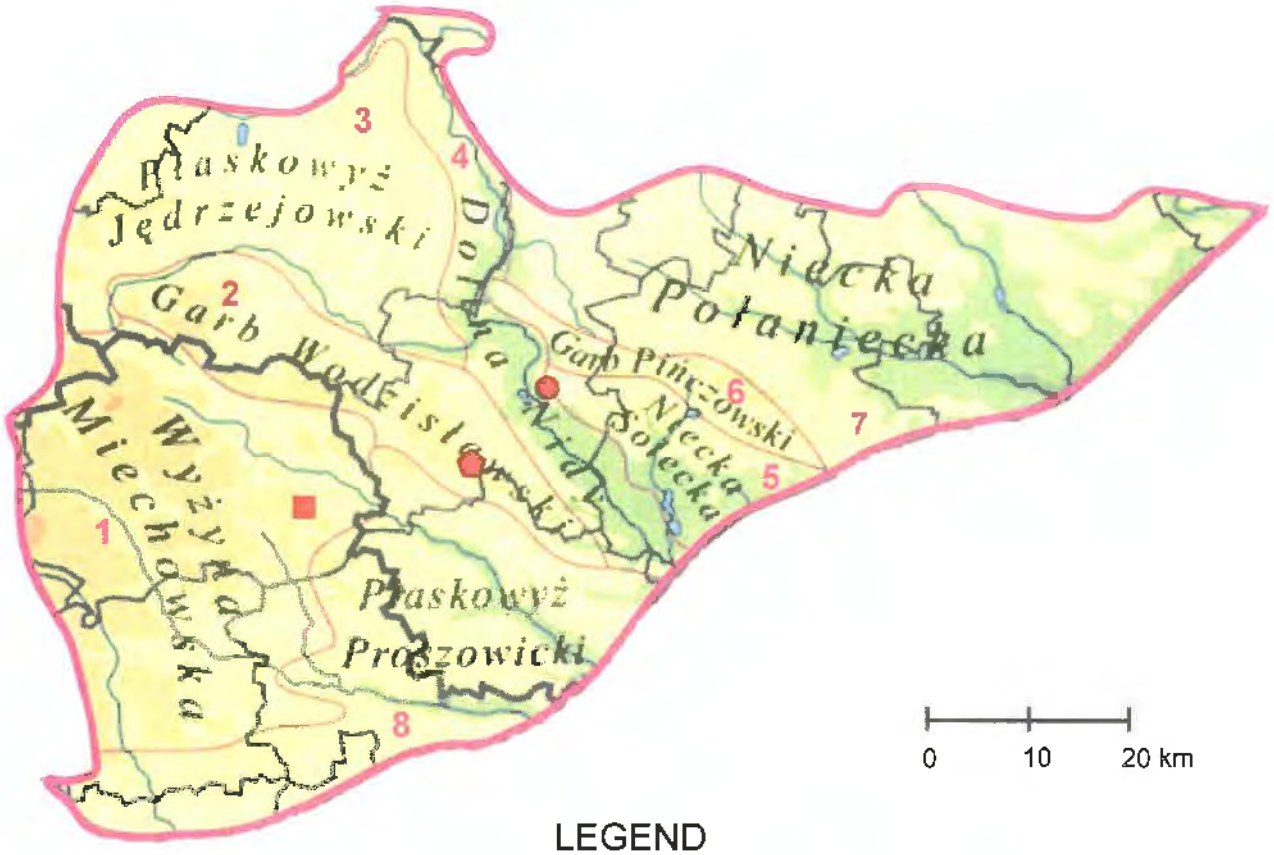
Lavatera thuringiaca represents a relic of old time cultivation, as do single specimens of *Linum usitatissimum* and (on the balks) old breeding variety of plum e.g. *Prunus insititia*.



Geographical units (macroregions):

1 – Wyżyna Śląsko-Krakowska upland
2 – Wyżyna Małopolska upland:
    2a – northern part (Wyżyna Kielecka
        and Wyżyna Przedborska uplands)
    2b – southern part (Niecka Nidziańska basin)
3 – Wyżyna Lubelska and Roztocze uplands
4 – Kotlina Oświęcimska and Kotlina Sandomierska basins
5 – Carpathians

Fig. 1. The Niecka Nidziańska basin and its surroundings.



LEGEND

Outlines

- borders of the Niecka Nidziańska basin
- borders of the voivodships
- borders of the counties
- borders of the secondary geographical units (1 to 8)

Visited places

- "Krzyżanowice" steppe reserve
- "Wały" steppe reserve
- Stradów – archaeological site

Hypsometry

- 100-150 m a.s.l.
- 150-200 m a.s.l.
- 200-300 m. a.s.l.
- 300-400 m a.s.l.
- 400-500 m a.s.l.

Secondary geographical units (mesoregions)

1 – Wyżyna Miechowska plateau
2 – Garb Wodzisławski hummock
3 – Płaskowyż Jędrzejowski plateau
4 – Dolina Nidy valley
5 – Niecka Solecka basin
6 – Garb Pińczowski hummock
7 – Niecka Połaniecka basin
8 – Płaskowyż Proszowicki plateau (northern part)

Fig. 2. The Niecka Nidziańska basin – geographical division, hypsometry and location of sites visited during the excursion.

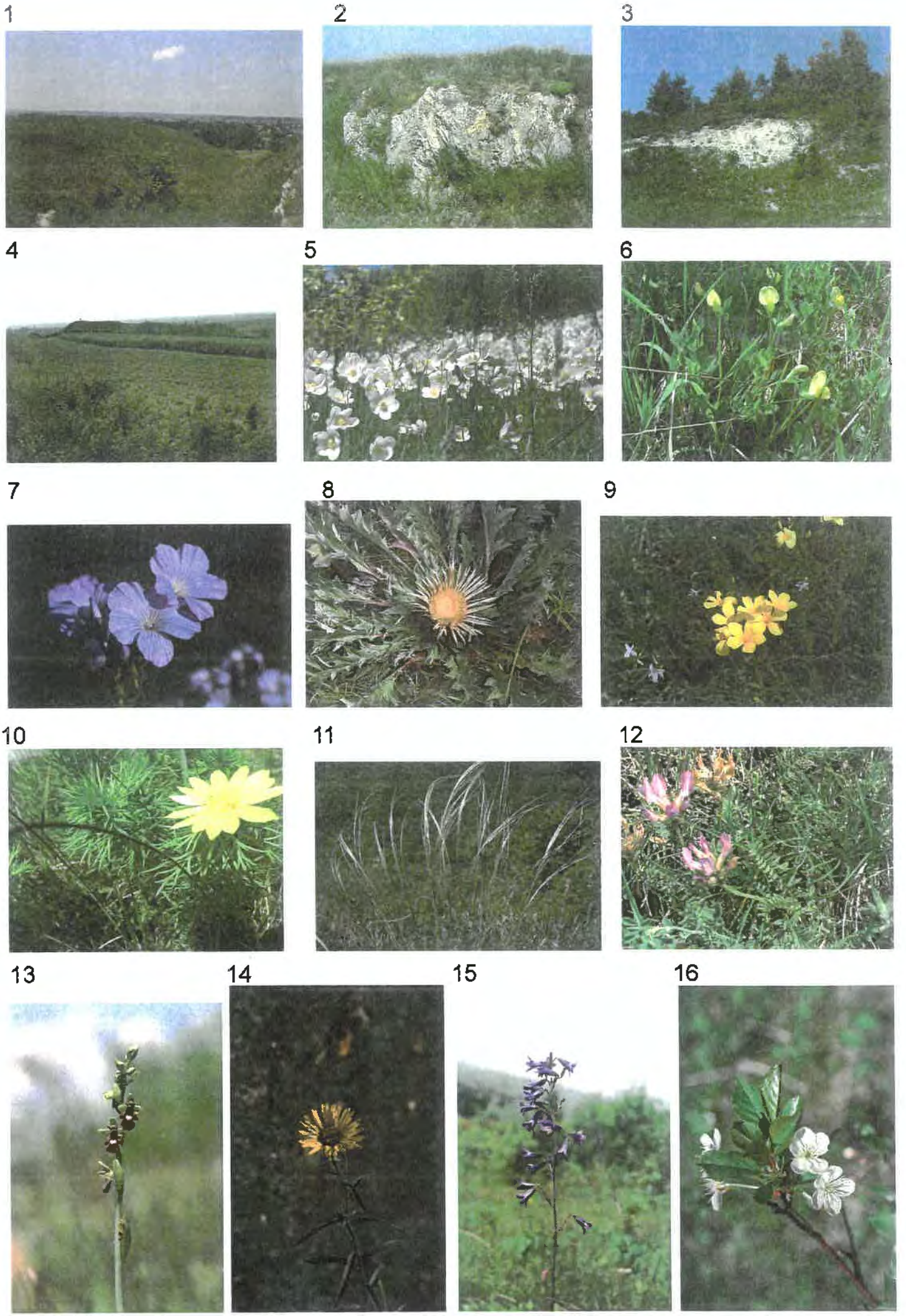


Fig. 3. Views of visited places and photos of chosen thermophilous plant species (captions - see overleaf).

Fig. 3. – picture captions:

1. View of the „Krzyżanowice" steppe reserve (photo A. Bieniek)
2. Gypsum outcrop in the "Krzyżanowice" reserve (photo A. Nikel)
3. View of the „Wały" steppe reserve with chalk outcrop (photo A. Nikel)
4. View of an old rampart (8^{th}–12^{th} century) in Stradów – one of the biggest hillforts in Poland (photo W. Paul)
5. *Anemone sylvestris* L. (photo Ł. Wilk)
6. *Tetragonolobus maritimus* (L.) Roth subsp. *siliquosus* (L.) Murb. (photo A. Nikel)
7. *Linum hirsutum* L. (photo Ł. Wilk)
8. *Carlina onopordifolia* Besser (photo K. Romeyko-Hurko)
9. *Linum flavum* L. (photo Ł. Wilk)
10. *Adonis vernalis* L. (photo W. Paul)
11. *Stipa pulcherrima* K. Koch (photo A. Bieniek)
12. *Astragalus danicus* Retz. (photo A. Nikel)
13. *Ophrys insectifera* L. (photo Ł. Wilk)
14. *Inula ensifolia* L. (photo Ł. Wilk)
15. *Campanula sibirica* L. (photo Ł. Wilk)
16. *Cerasus fruticosa* Pall. (photo Ł. Wilk)

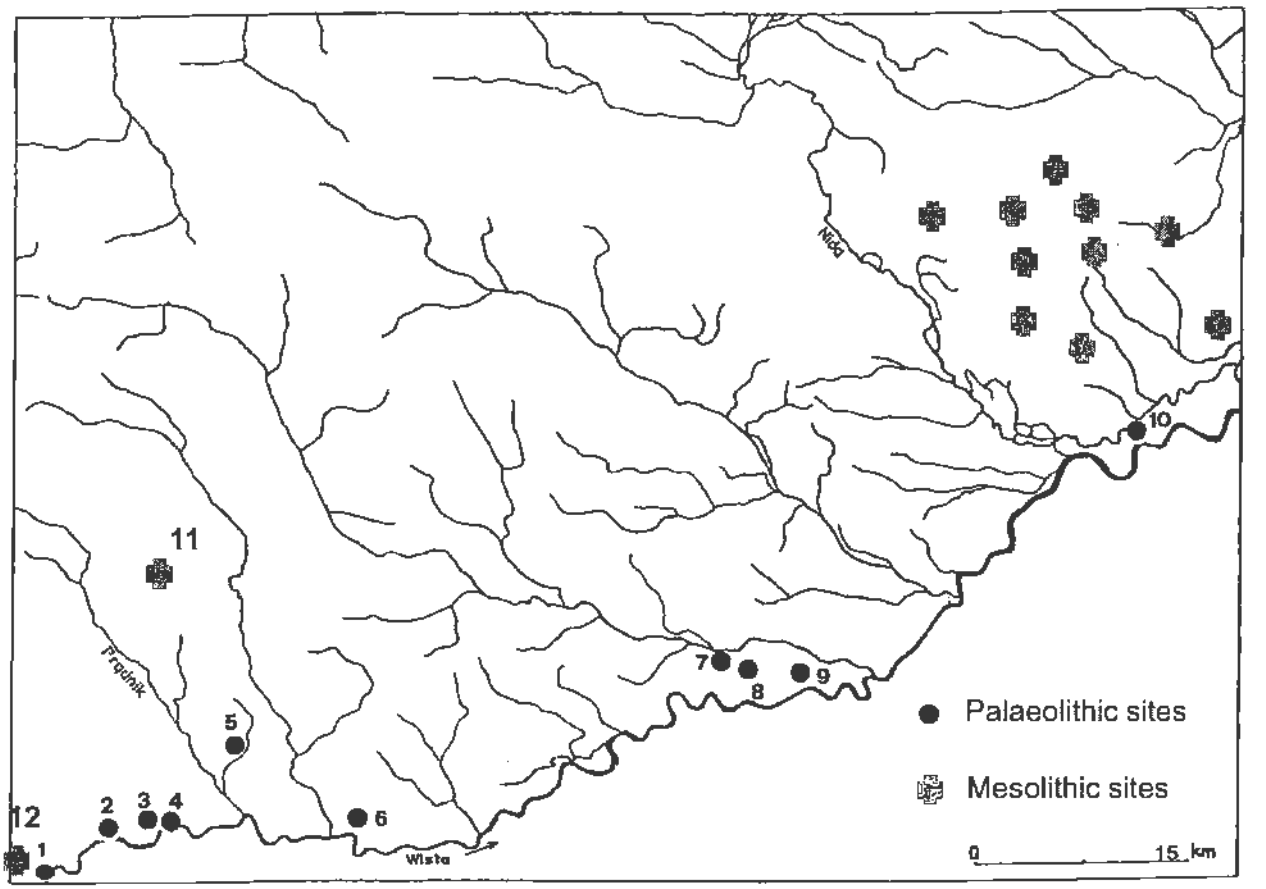


Fig. 4. Palaeolithic and Mesolithic sites (after Sobczyk 1997, supplemented by the author).
1 – Piekary, 2 – Kraków-Przegorzały, 3 – Kraków-ul. Spadzista, 4 – Kraków-Zwierzyniec, 5 – Kraków-Prądnik Czerwony, 6 – Kraków-Nowa Huta, 7 – Poborowice, 8 – Zębocin, 9 - Jaksice, 10 – Nowy Korczyn, 11 – Glanów, 12 – Ściejowice.

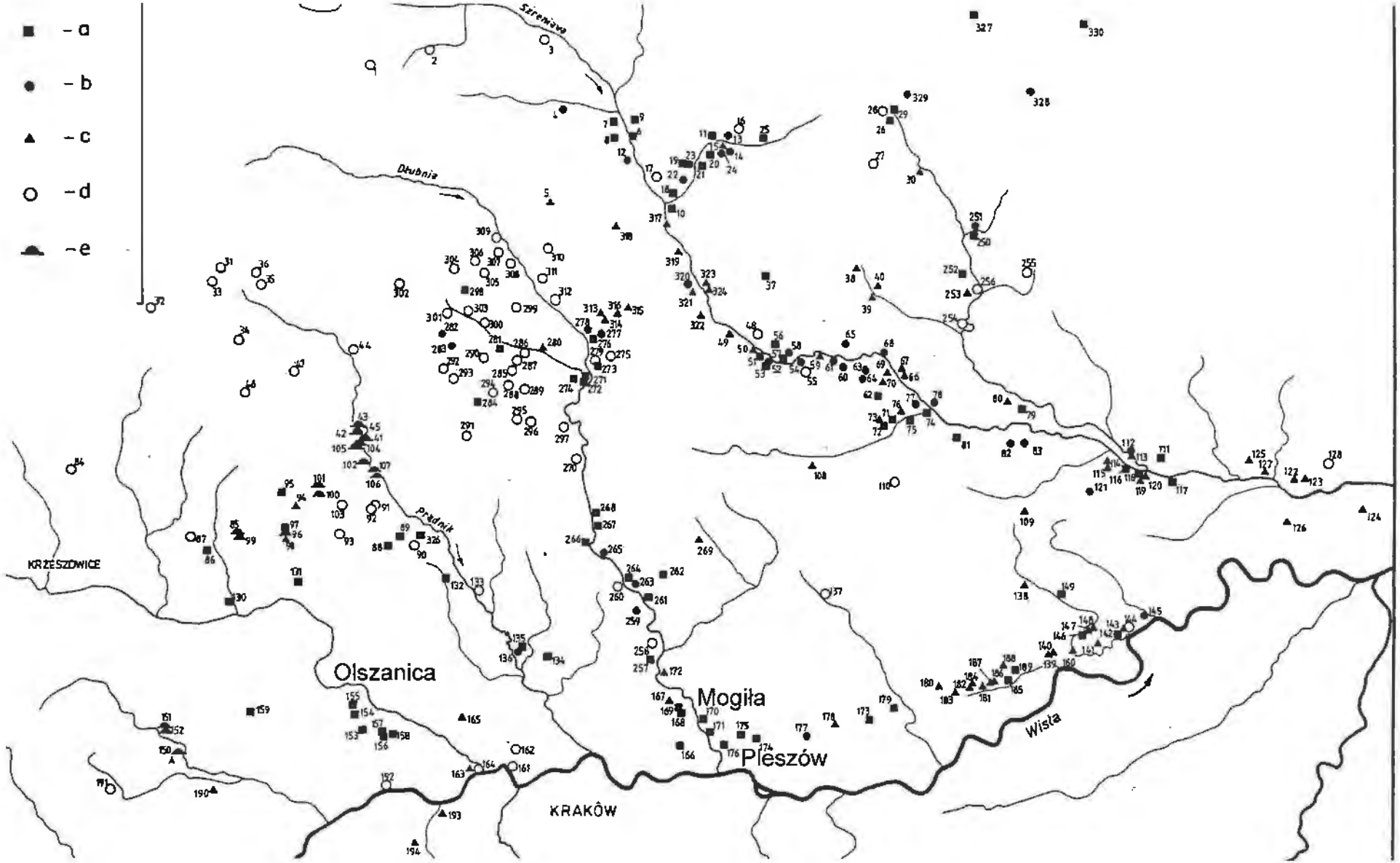


Fig. 5. LBK sites (after Czekaj-Zastawny 2000).
a – settlement sites, b – camp sites, c - stray finds, d – sites possibly affiliated to the LBK, e – cave sites
Some other Neolithic sites, mentioned in the text, were included by the author.

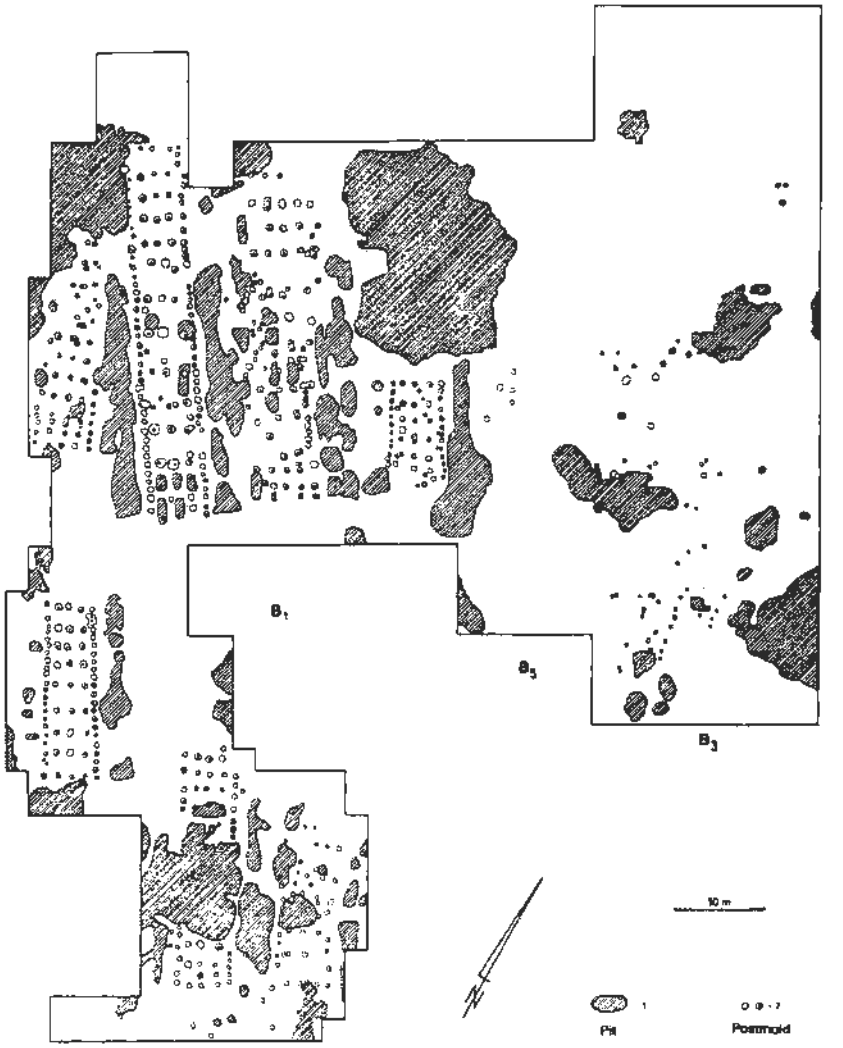


Figure 54. Excavation units B1, B5, and B3 at Olszanica.

Fig. 6. A section of the LBK settlement at Olszanica (after Milisauskas 1986).

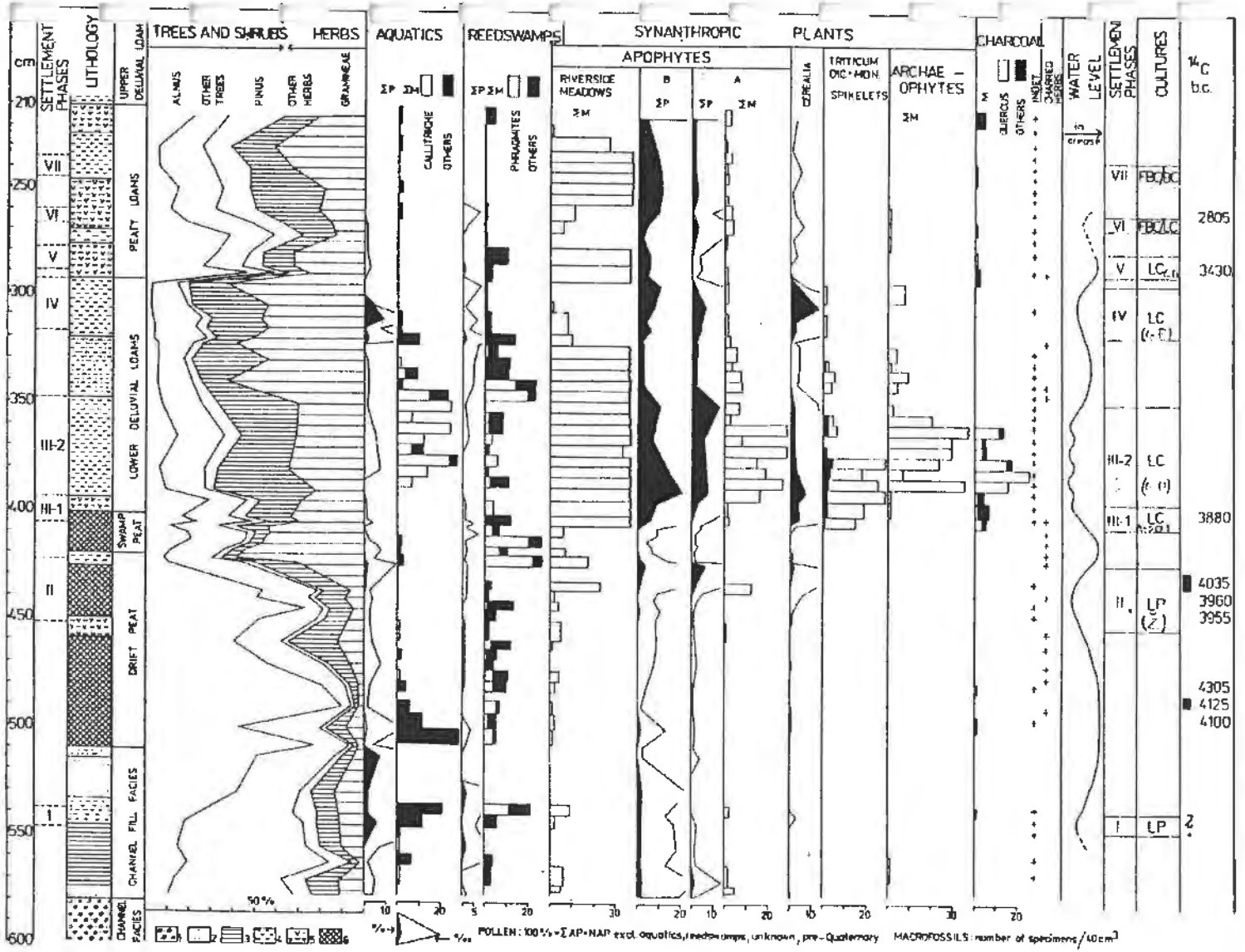


Fig. 7. Simplified pollen and macrofossil diagram from Pleszów I, showing vegetation changes and fluctuations in moisture of the valley foor habitats (after Wasylikowa).

Curves represent pollen, bars – macrofossils. Synanthropic plants include cereals. Apophytes A – synanthropic taxa, which expand in the settlement phases in profile PL or occur in Pit 416 at Mogiła 62 (see also Wasylikowa 1986): *Centaurea jacea, C. scabiosa, Chenopodium album, Chenopodiaceae, Cruciferae, Lotus* type, *Melampyrum* sp., *Papillionaeceae, Plantago lanceolata, P. major, Polygonum aviculare, P. convolvulus/dumetorum, Sambucus ebulus, Symphytum/Cerinthe* type, *Trifolium* type, *Vicia* type. Apophytes B – taxa, whose synanthropic status at Pleszów is probable but not certain: *Boraginaceae, Compositae Liguliforae, Compositae Tubuliflorae, Mentha* type, *Prunella* type, *Ranunculus acer, Ranunculus* type, *Rubiaceae, Umbelliferae*. Plants numbered in the remaining groups are listed in tables 1-9. ? P – sum of pollen, Σ M – sum of macrofossils. *Triticum* spikelets – black bars indicate charred specimens, white – uncharred ones. LPC – Linear Pottery culture. LC – Lengyel culture. FBC – Funnel Beaker culture. BC – Baden culture: 1 – gravel with sand, 2 – sand, 3 – clayey silt, 4 – sandy silt, 5 – organic silt, 6 – peat and strongly organic silt.

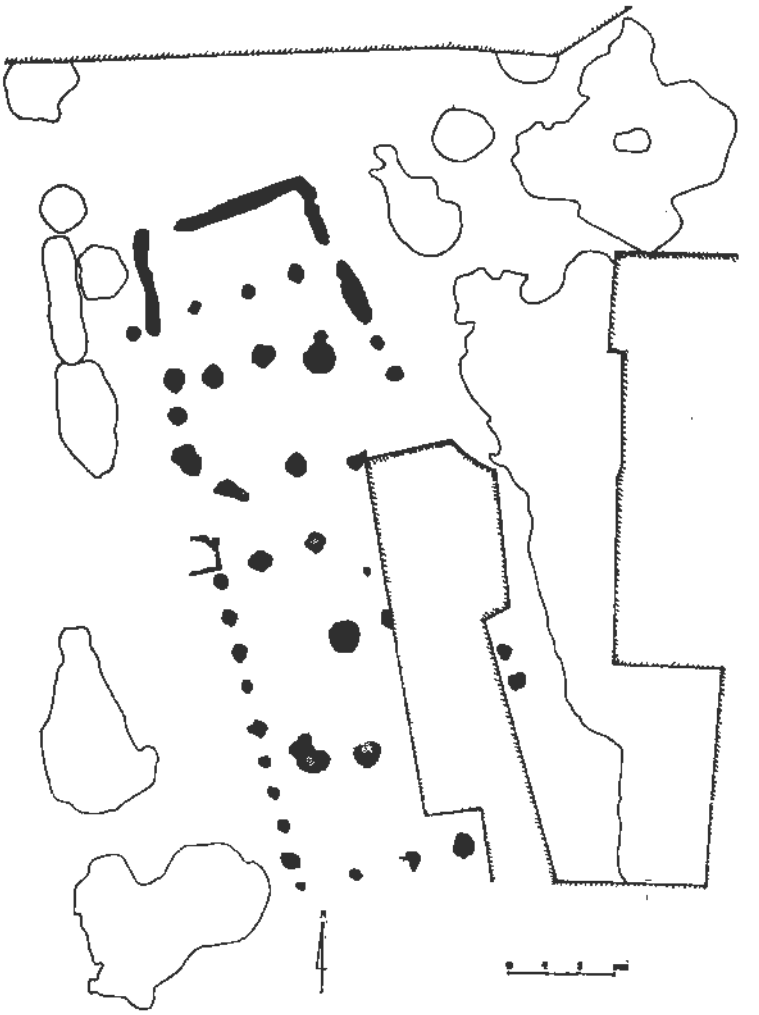


Fig. 8. Kraków-Mogiła site 62, House 316. An example of Early Lengyel-Polgar house (after Godłowska 1968).

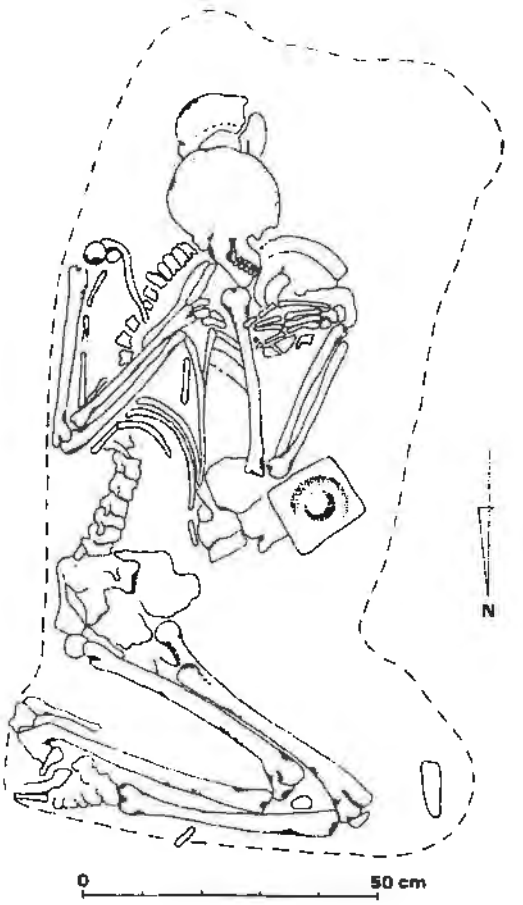


Fig. 9. Kraków-Pleszów, site 17. Grave 1325, of the middle phase of Lengyel-Polgar Complex (after Godłowska 1978).

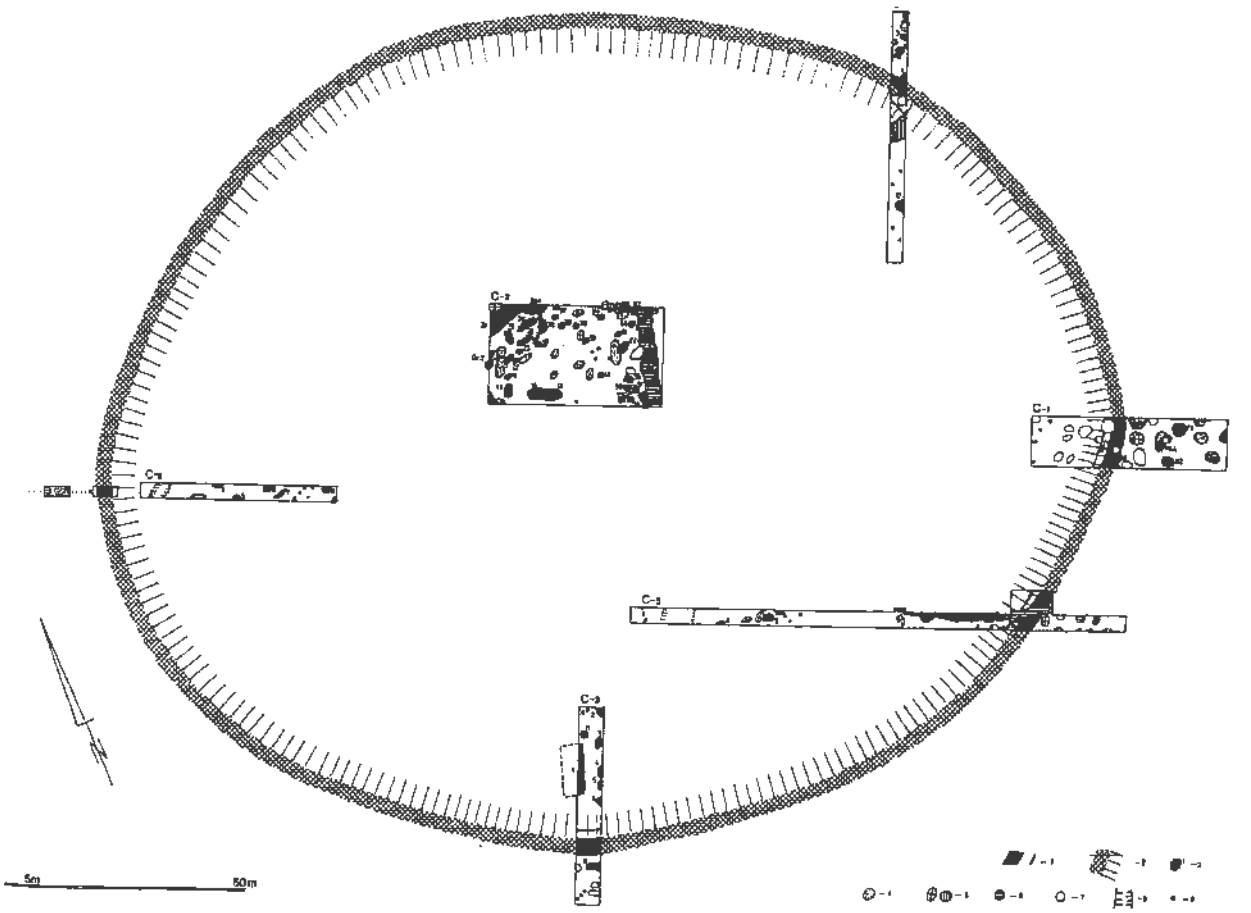


Fig. 10. Settlement of the latest Lengyel-Polgar Complex at Bronocice (after Kruk & Milisauskas 1985).
1 – researched sections of the ditch and palisade, 2 – reconstructed outline of the "fortification" system,
3 – features of the Lublin-Volhynia Culture (the latest Lengyel-Polgar Complex),
4-6 – features of Funnel Beaker Culture, 7 – features of Early Bronze Age, 8 – natural ditches,
9 – post-holes

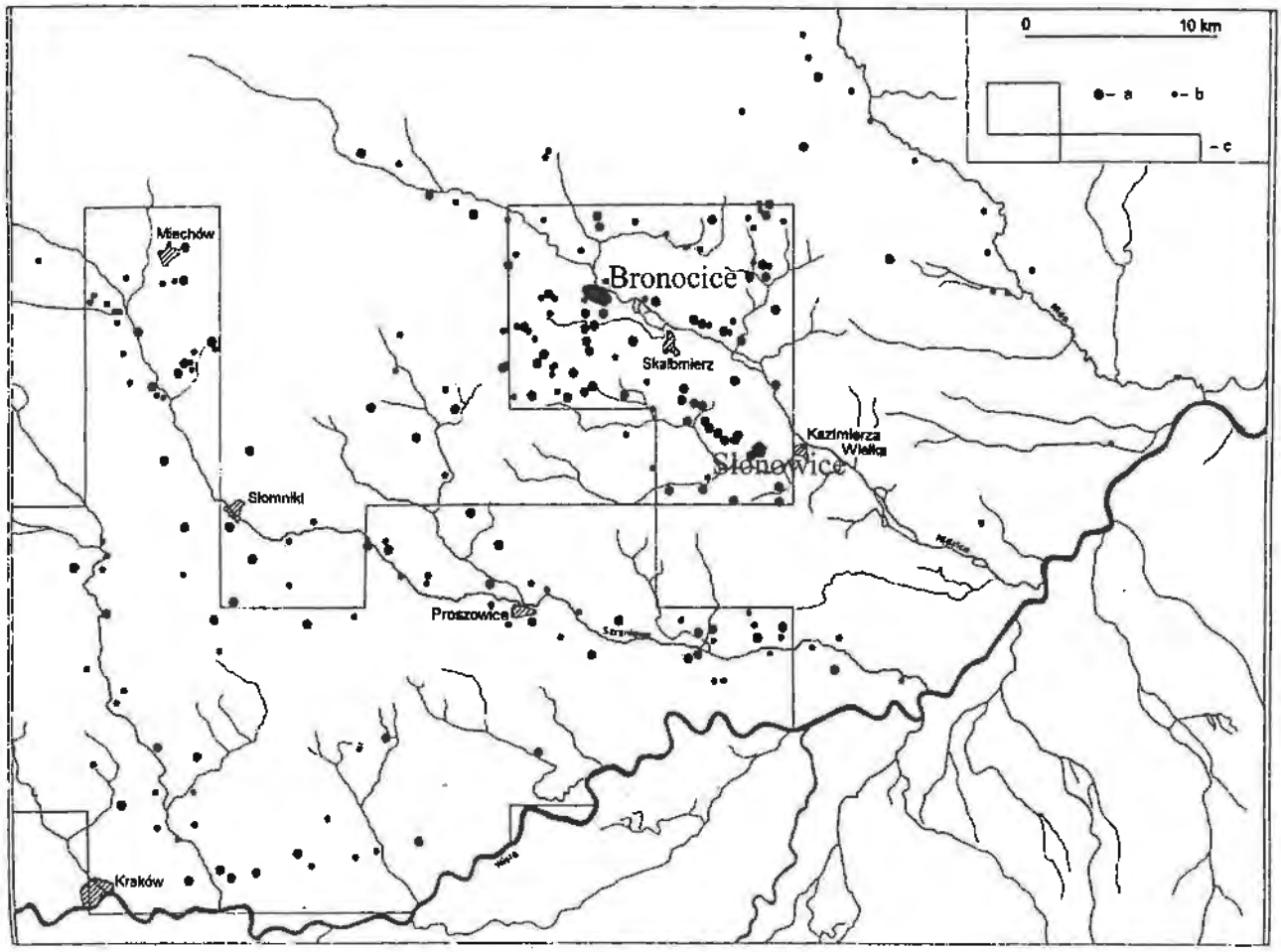


Fig. 11. Selected sites of Funnel Beaker Culture (after Burchard 1997).
a - excavated sites or sites where more material was found during AZP field survey, b - stray finds, c - borders of AZP squares.

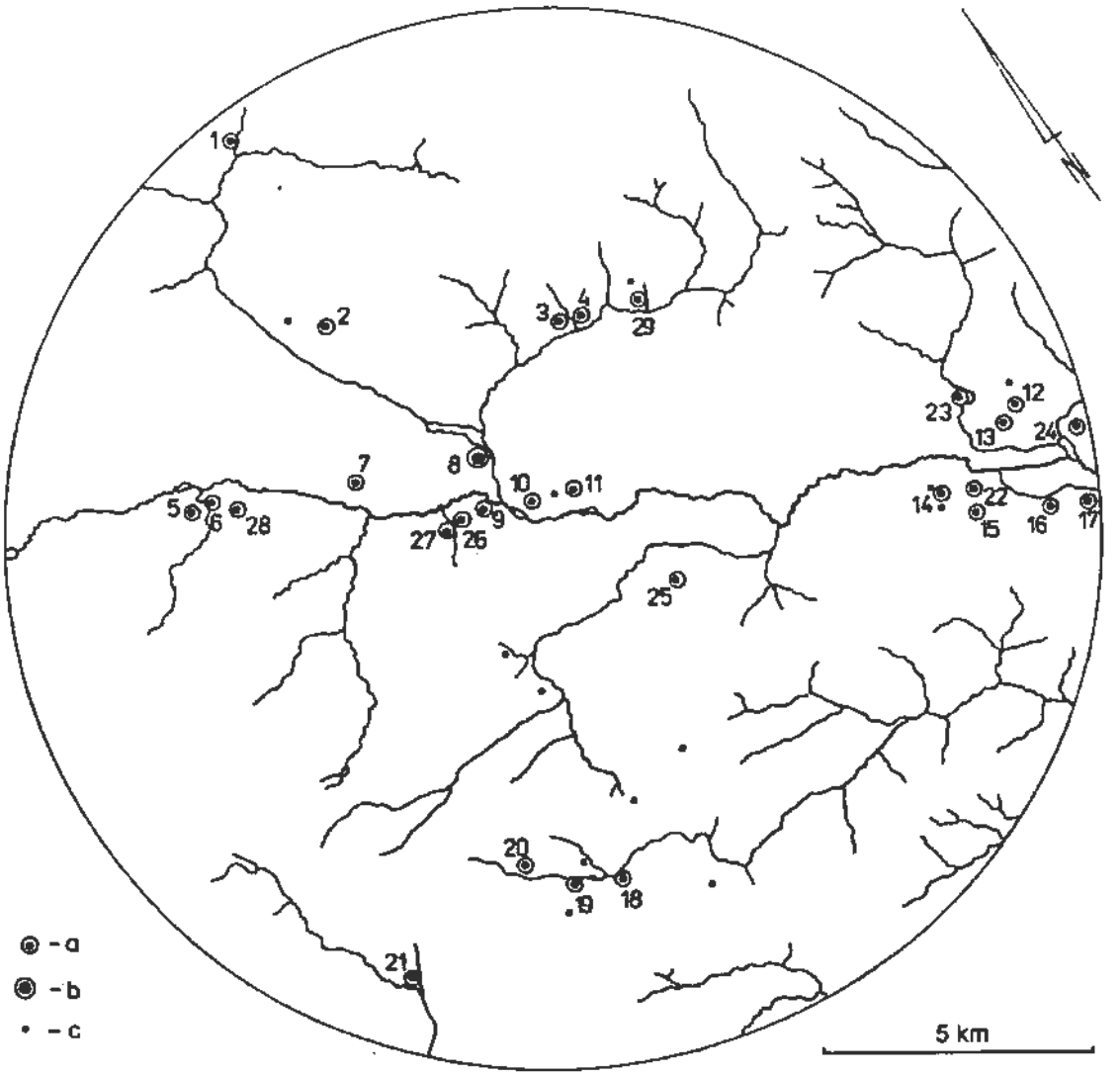


Fig. 12. Middle Nidzica Basin; LBK settlement pattern (after Kruk et al. 1996).
a – settlements and short occupation sites, 0.5 – 3.0 ha, b – 5 ha settlement, c – stray finds.

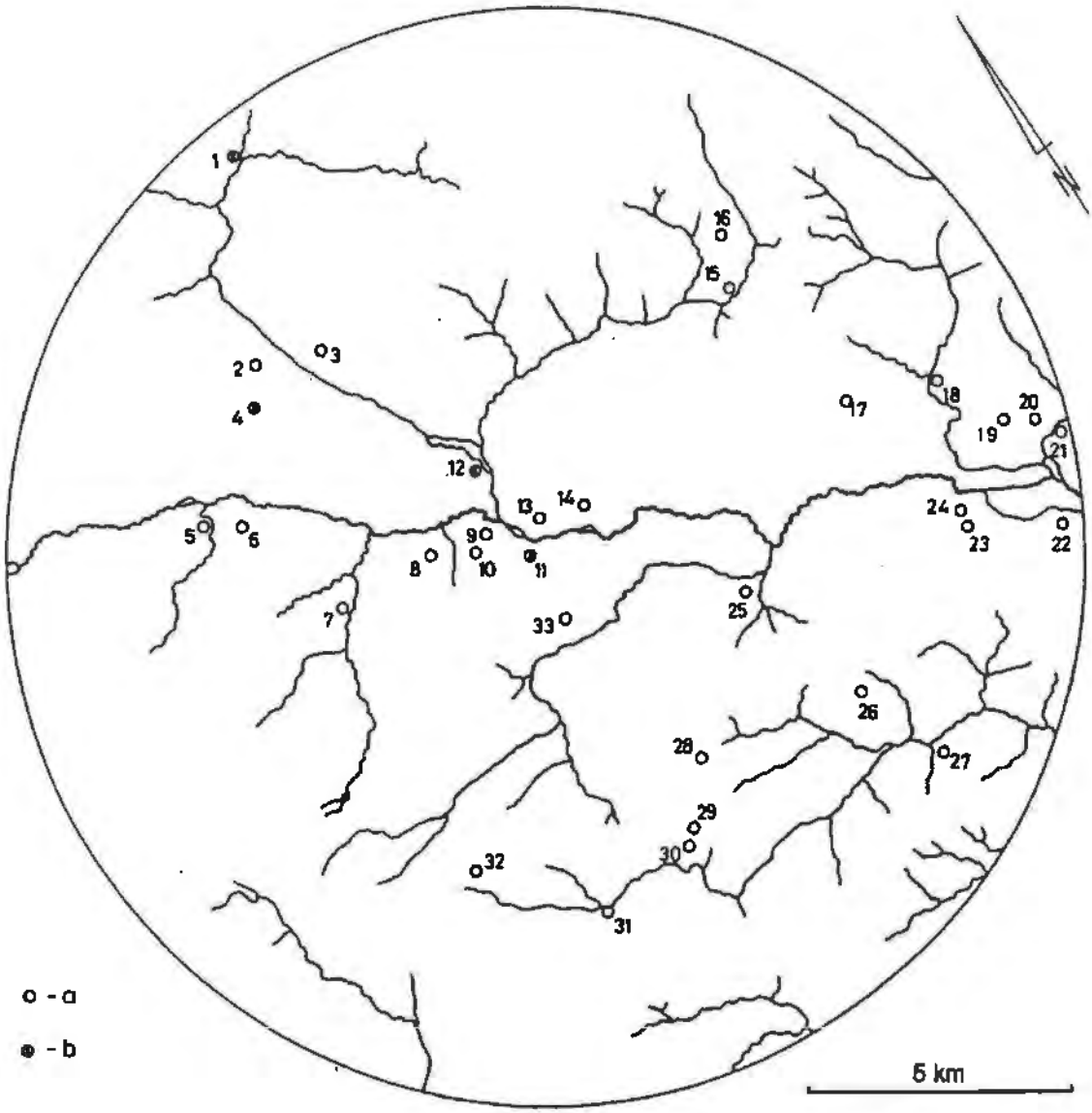


Fig. 13. Middle Nidzica Basin; Lengyel-Polgar settlement pattern (after Kruk et al. 1996). a – settlement and short occupation sites, 0.5 – 3.0 ha, b – settlements, 4.5 – 5.5 ha (no. 11 – fortified settlement at the site of Bronocice).

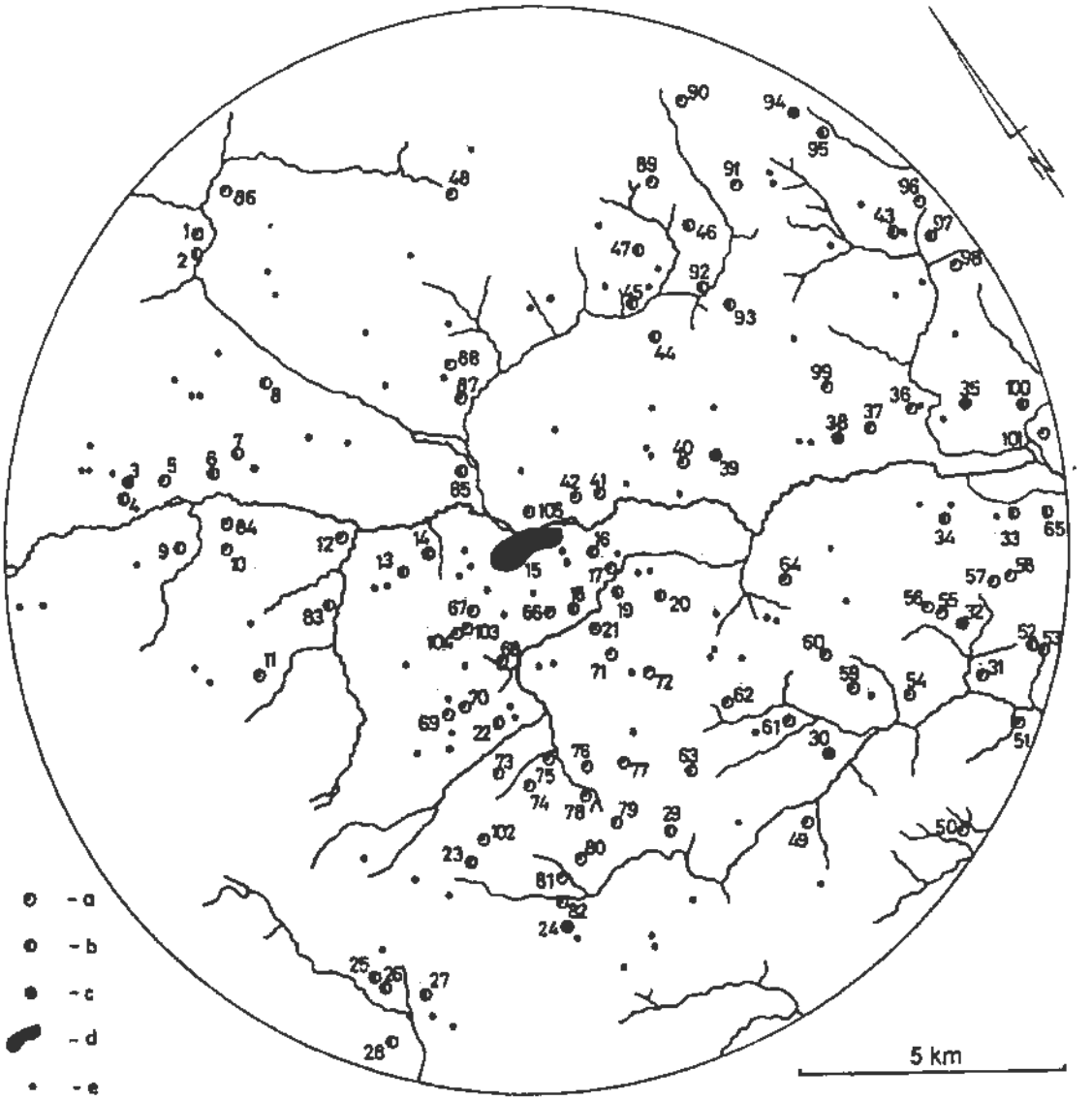


Fig. 14. Middle Nidzica Basin; Funnel Beaker Culture settlement pattern (after Kruk et al. 1996).
a – settlements and short occupation sites up to 2.0 ha, b – settlements 2.1-4.9 ha,
c – settlements 5.0 – 10 ha, d – settlements of phases: BR I (2 ha), BR II (8 ha), BR III (21 ha),
at the Bronocice site, e – stray finds.

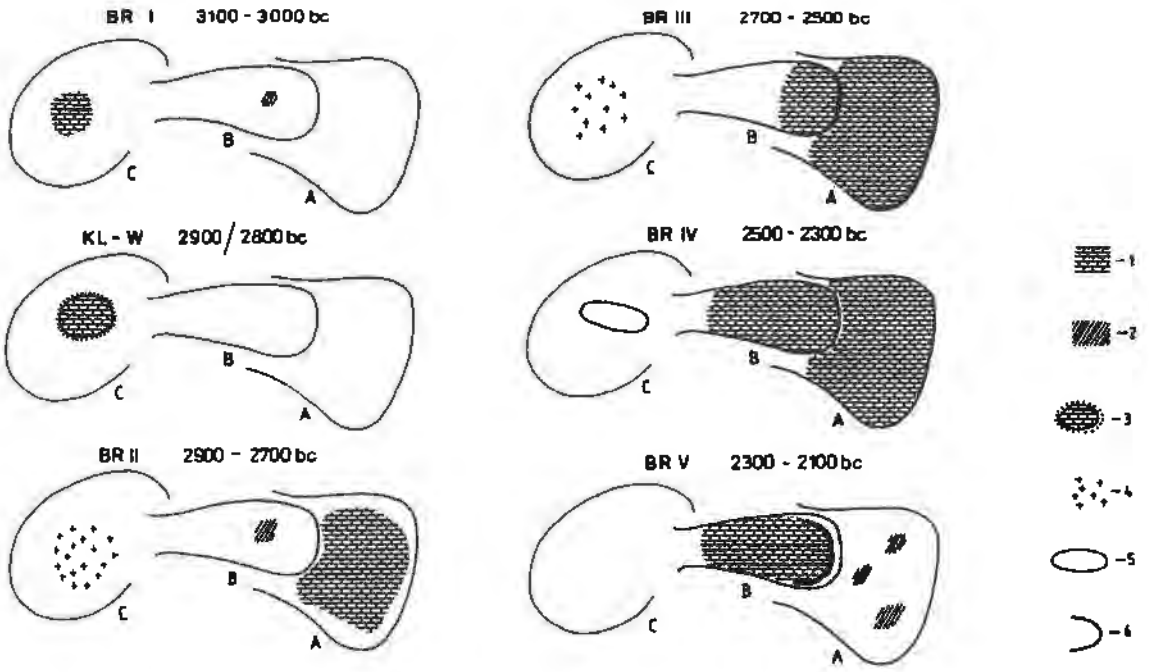


Fig. 15. Development of the site at Bronocice (after Kruk et al. 1996).
A, B, C – areas of the site; BR I, II, III – Funnel Beaker Culture occupation phases; BR IV, V – Funnel Beaker/Baden occupation phases; KL-W – Lublin-Volhynian occupation phase of the Lengyel-Polgar cycle; 1 – area of the site, 2 – distribution of utilized land beyond the close proximity to the site, 3 – Lublin-Volhynian Culture (the latest Legyel-Polgar) "fortifications", 4 – cemetery of BR II-III phase, 5 – enclosure of BR IV phase, 6 – fortification of BR V phase settlement.

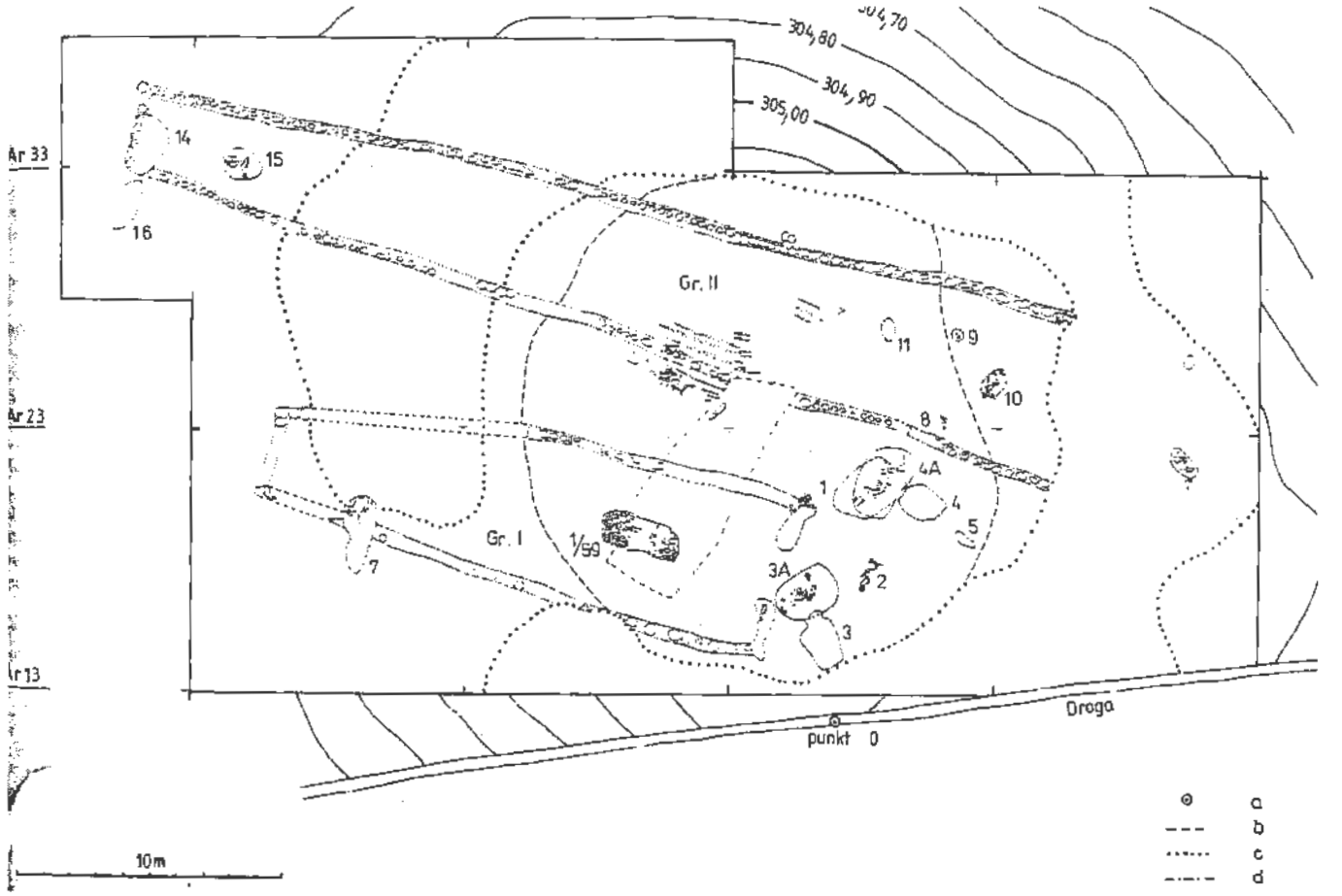


Fig. 16. Zagaje Stradowskie, "Megalithic" tombs of Funnel Beaker Culture (after Burchard 1998).
a – bench mark, b – outline of the Corded Ware Culture mound, c – outline of the Corded Ware Culture near-mound pit, d – modern pit

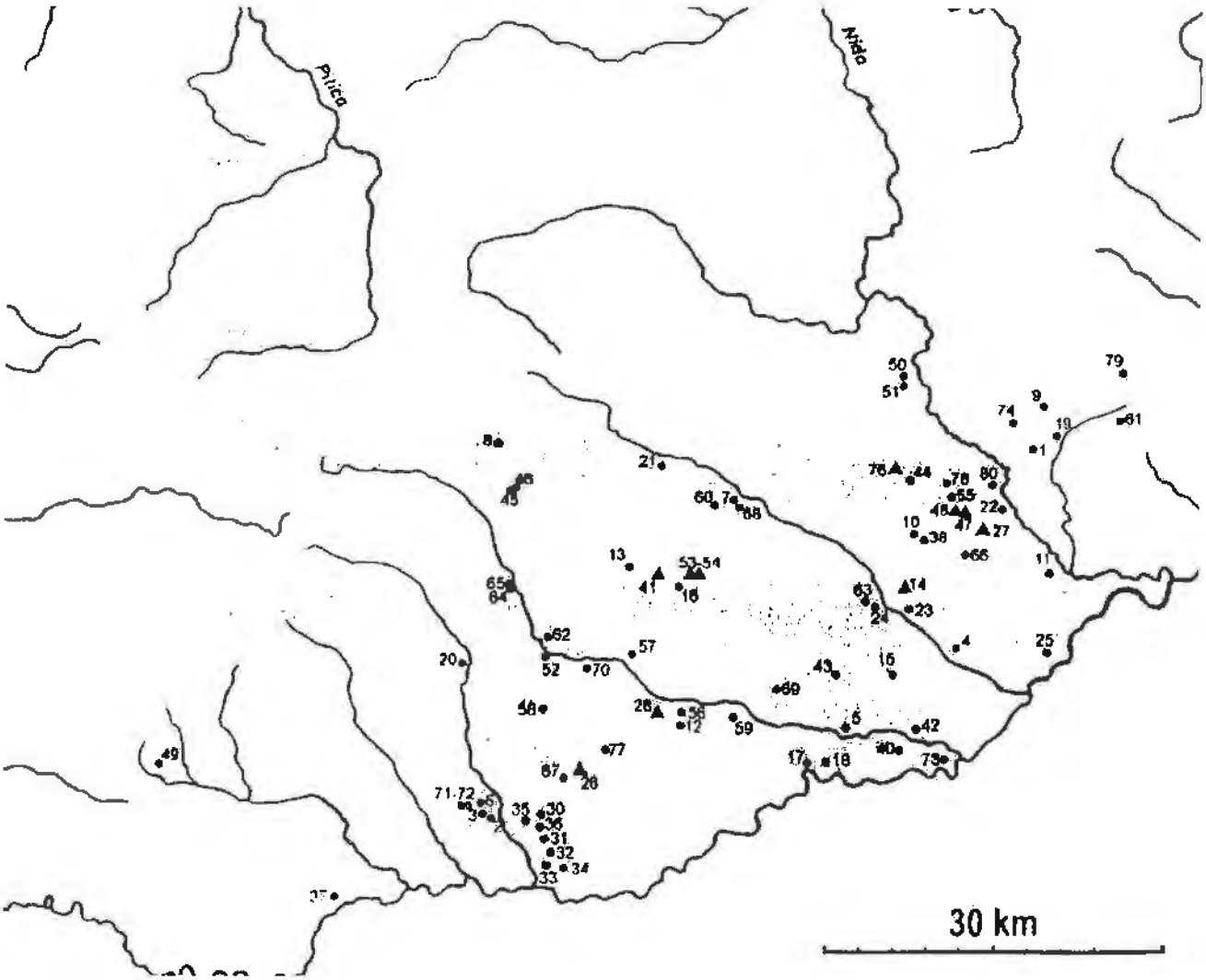


Fig. 17. Grave sites of Corded Ware Culture in Loess Uplands of western Lesser Poland (after Włodarczak 2006). Triangles – barrows; dots – single flat graves and cemeteries; 27 - Kolosy site.

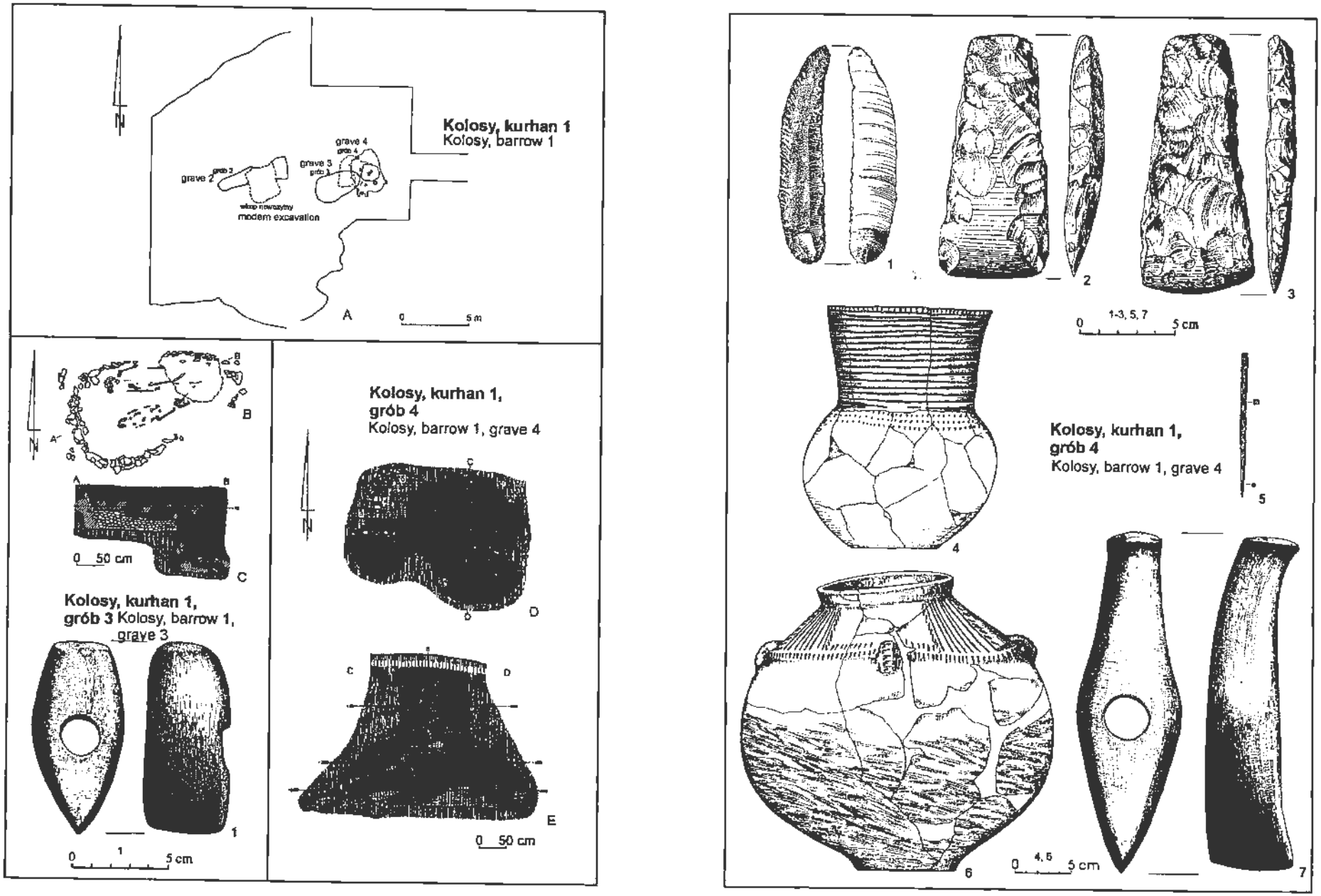


Fig. 18. Kolosy – Corded Ware Culture barrow and graves (after Włodarczak 2006).

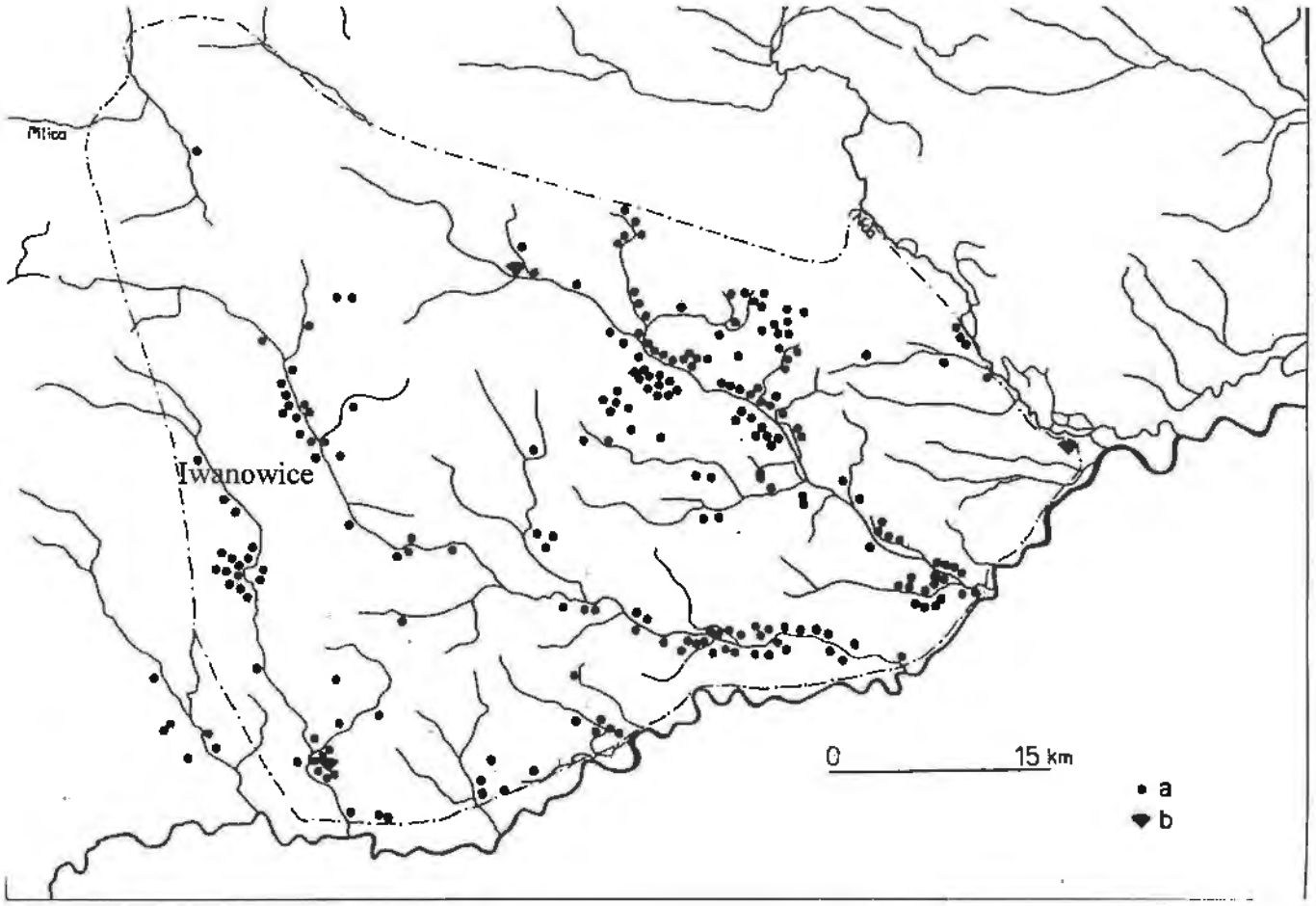


Fig. 19. Mierzanowice Culture (a) and Bell Beaker Culture sites (b); after Kadrow 1997.

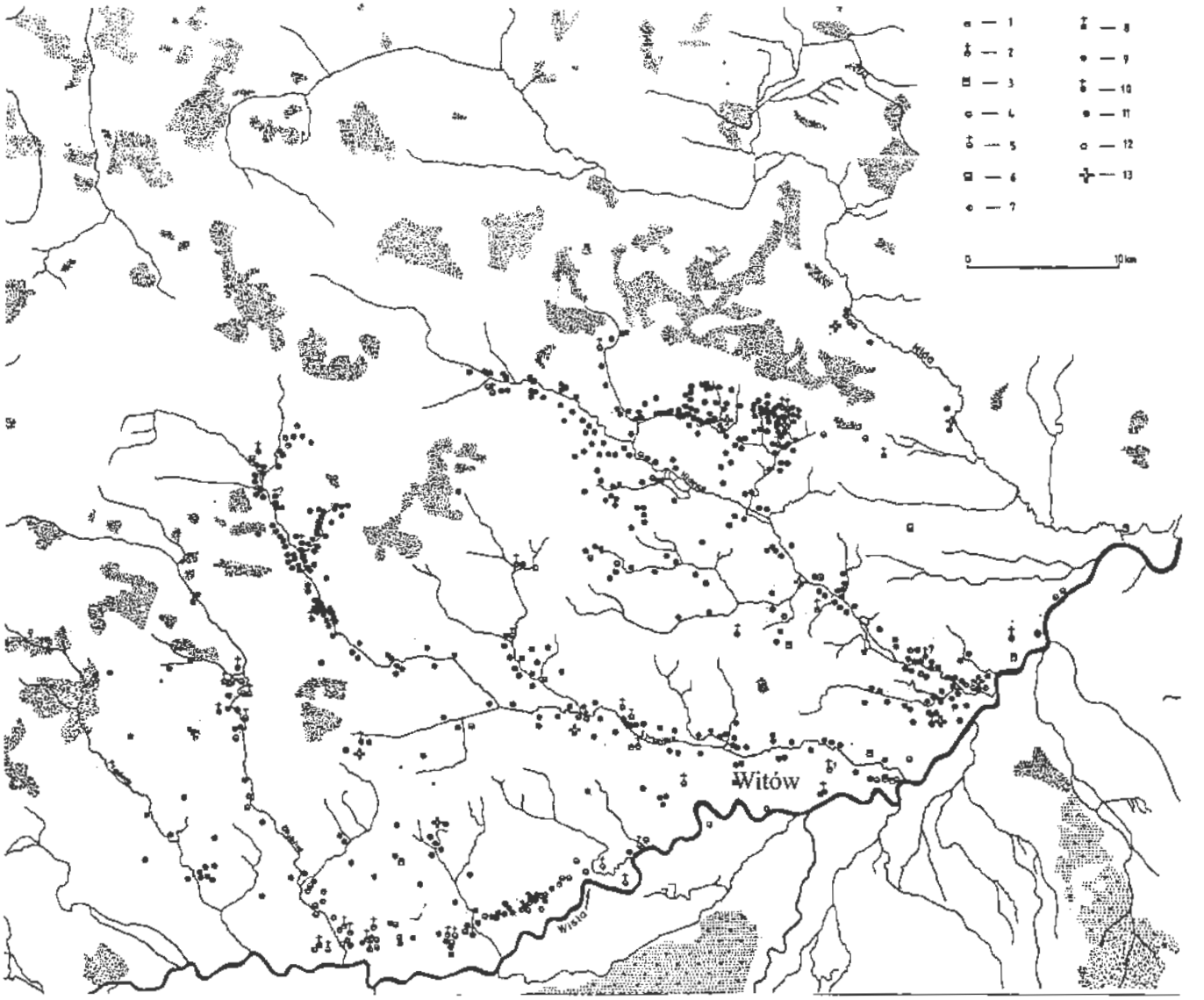


Fig. 20. Lusatian culture sites (after Rydzewski 1997).
1 - a settlement from the III and/or IV EB, 2 - a cemetery or a single grave from III and/or IV EB, 3 - a hoard from III and/or IV EB, 4 - a settlement from V EB and/or HaC, 5 - a cemetery or a single grave from V EB and/or HaC, a hoard from V EB and/or HaC, 7 - a settlement from HaC-HaD, 8 - a cemetery or a single grave from HaC-HaD, 9 - settlements dated to the Lusatian culture and materials from field surveys, 10 - a cemetery of a single grave dated to the Lusatian culture in general or known from field survey, 11 - Tarnobrzeg group elements, 12 - a Pomeranian culture settlement, 13 - a cemetery or a single grave of the Pomeranian culture.

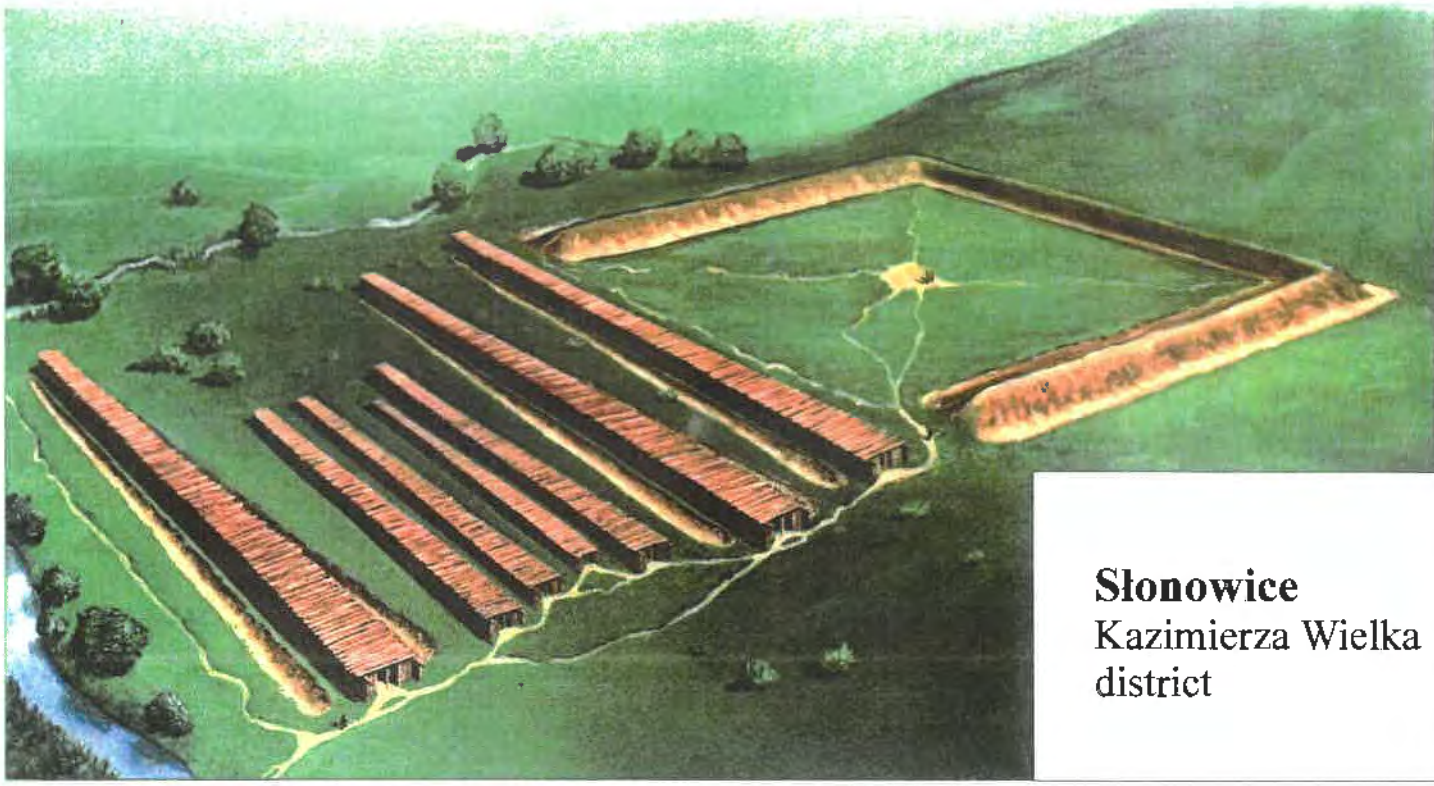


Fig. 21. Słonowice. Reconstruction of the ceremonial area and the tombs of earth-and-timber construction from the Neolithic - IV millennium BC (Funnel Beaker culture).
Made by W. Święcicki, on the basis of K. Tunia's investigations

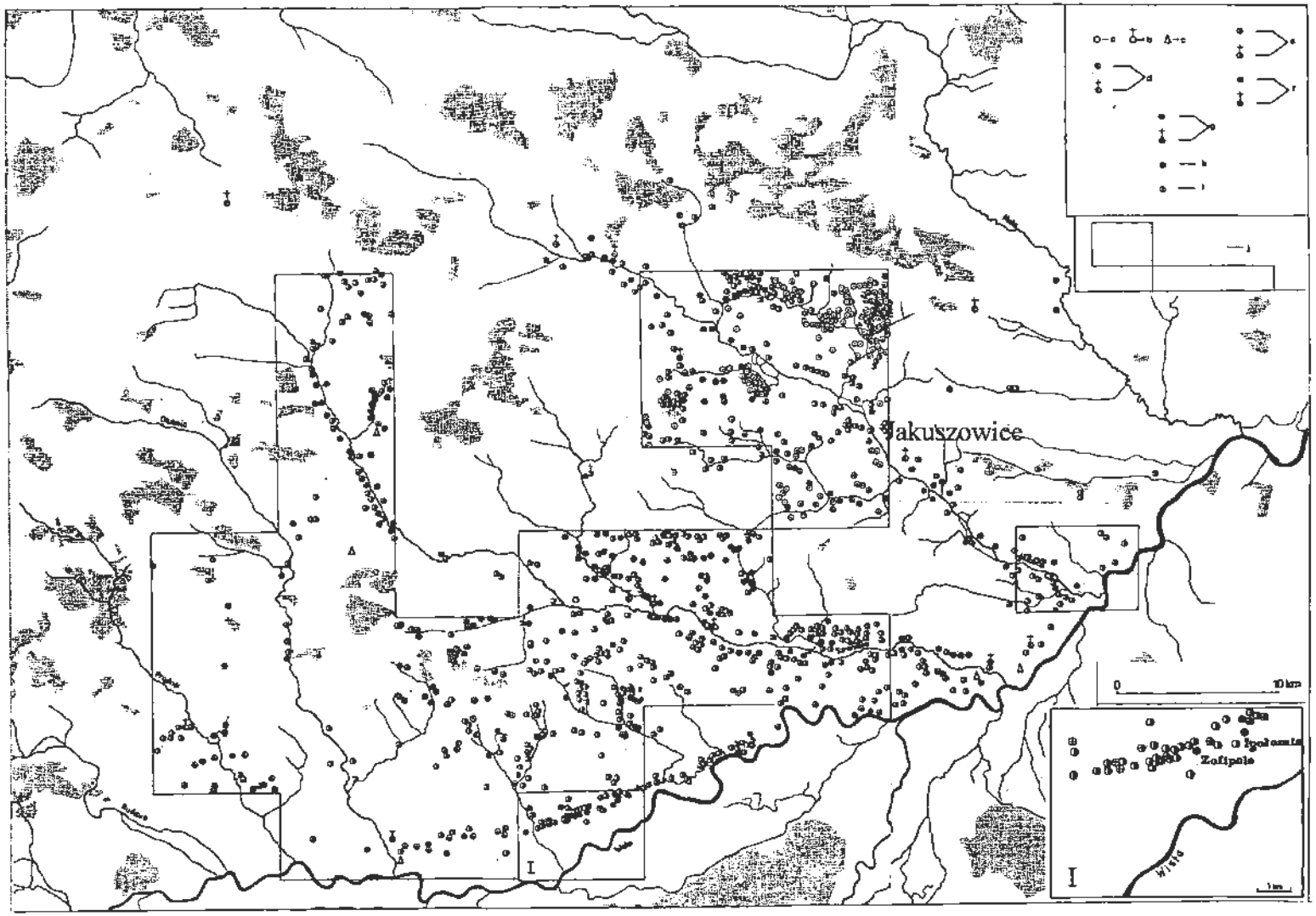


Fig. 22. Roman period (after Dobrzańska 1997): a – settlement and stray finds, b – cemeteries and single burials, c – hoards, d – Early Roman period, e – Late Roman period, f – Early and Late Roman periods, Roman period, h – Roman period with distinguished late phase, i – Przeworsk culture in general.

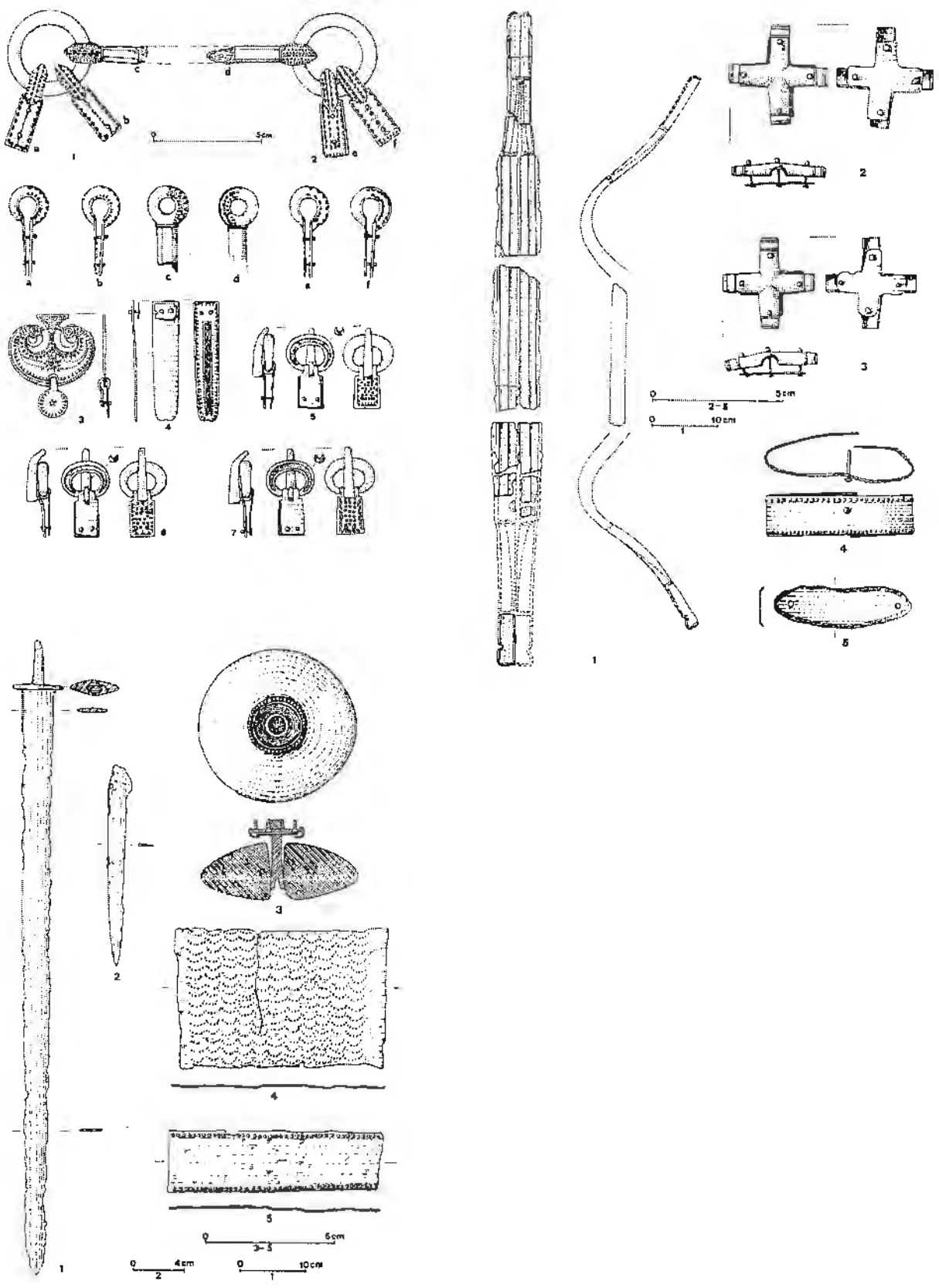


Fig. 23. Jakuszowice; artefacts from 'prince' grave belonging to the Hunn cultural complex.

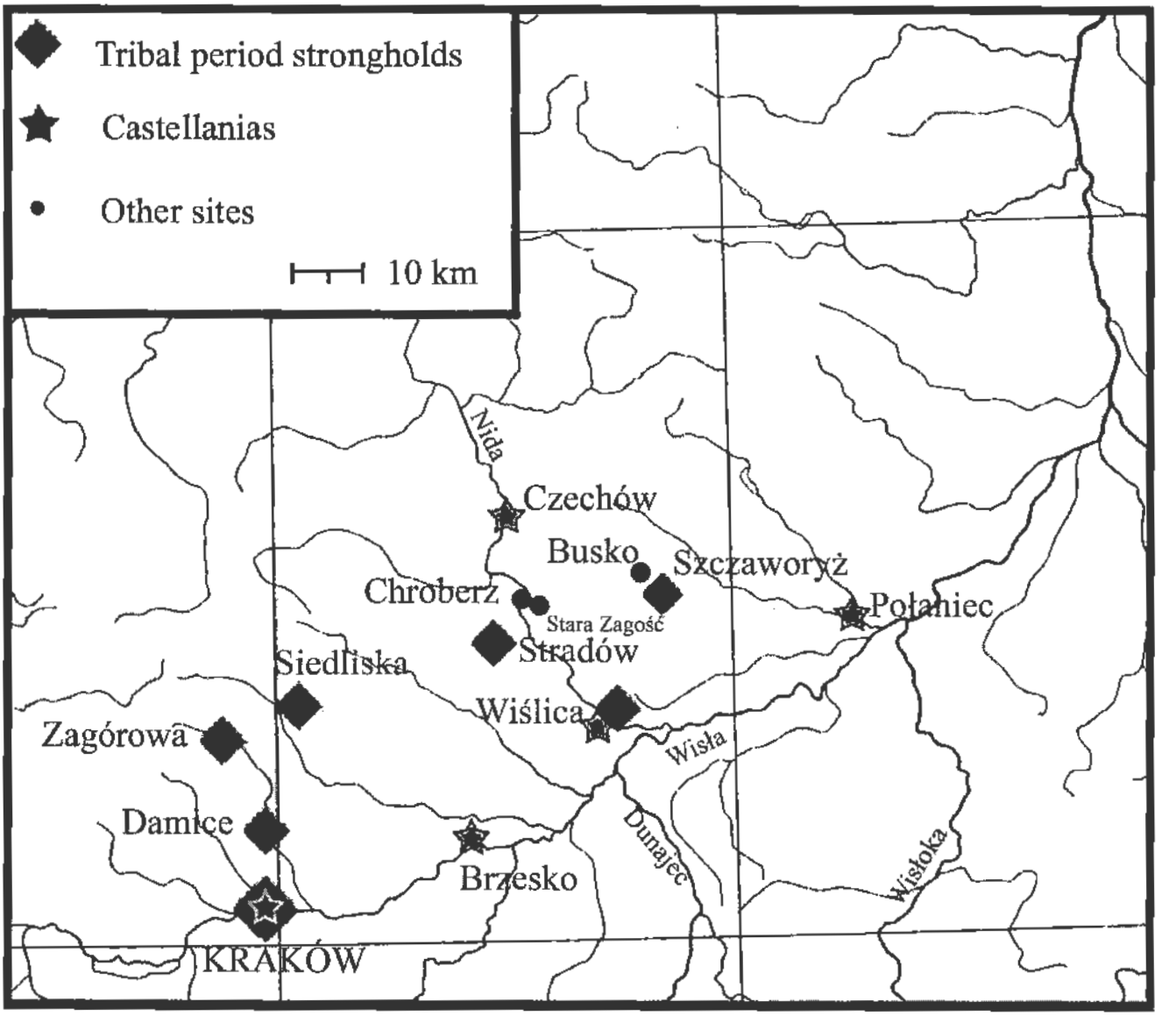


Fig. 24. The most important early medieval archaeological sites in the Niecka Nidziańska basin and a part of its surroundings.

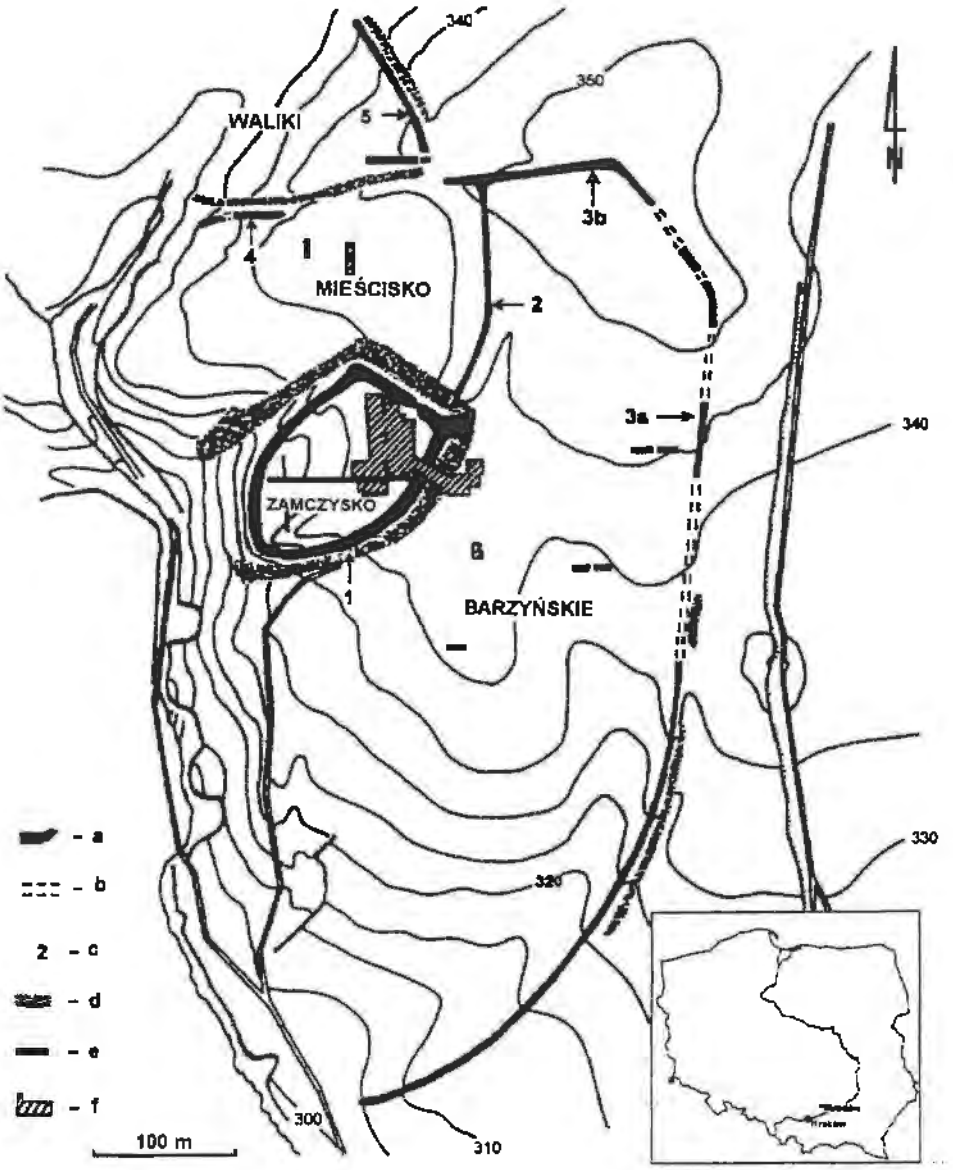


Fig. 25. Stradów. Plan of the hillfort (hillfort proper - "Zamczysko", outer settlements: "Barzyńskie", "Mieścisko", "Waliki"); after Tyniec-Kępińska 1996.
a - existing ramparts, b - destroyed ramparts, c - rampart number, d - moats, e - soundings from 1956, f - excavation trenches from 1957-1963

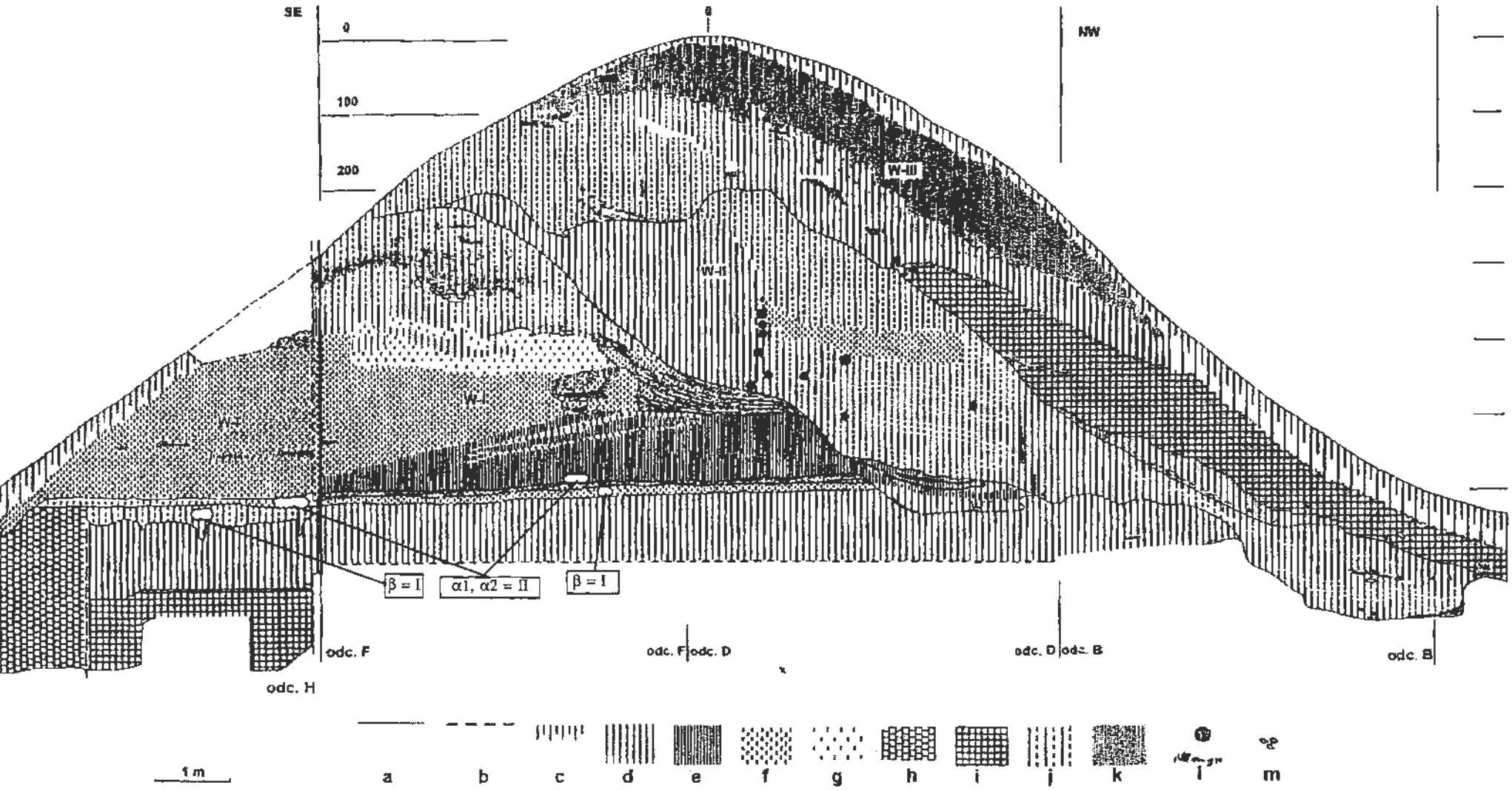


Fig. 26. Stradów. Rampart of the hillfort proper - "southern" cross-section (after Tyniec-Kępińska 1996).
a - feature borders, b - borders of the exploration level, c - soil, d - light gray or light brown clay, e - clay with black tint, f - yellow clay with admixture of dark clay, g - light yellow clay, h - mixed clay of gray and light gray color, i - gray and light gray clay, j = d+f, k - burnt clay, l- charcoal, burnt timber, m - stones.

Table 1. Associations of thermophilous grasslands in Poland – detailed description. Associations occurring within the Niecka Nidziańska basin are given **in bold**

Association	Habitat	Soils/substratum	Characteristic species	Occurrence in Poland	Remarks
Festucetum pallentis – pioneer grassland of scattered structure with *Festuca pallens* as a predominant	steep, warm rocks	shallow, initial rendzinas on limestone	*Allium montanum, Dianthus gratianopolitanus, Hieracium bifidum, Libanotis pyrenaica, Sempervivum soboliferum, Melica transsilvanica* and *Thymus praecox*	Pieniny Klippen Belt, and the southern part of Wyżyna Śląsko-Krakowska upland	Communities of natural, relict origin in Poland, practically stable.
Sisymbrio-Stipetum capillatae – pioneer association of scattered structure (between tufts of *Festuca valesiaca, Carex supina* and *Stipa capillata* there are patches of bare ground with spring therophytes like *Arabis auriculeta, Erophila verna*, etc.)	the warmest and driest sunny habitats on steep, south facing slopes	a) shallow, alkaline and rich in sulphate rendzinas on gypsum; b) shallow initial rendzinas on limestone; c) brown soils on loess	Three subassociations depending on the substratum: 1. ***S.-S. poëtosum bulbosae*** (on gypsum) with characteristic species like: *Arabis recta, A. auriculata, Festuca valesiaca, Poa bulbosa* var. *vivipara, Veronica praecox, Sisymbrium polymorphum*; 2. ***S.-S. achilleetosum pannonicae*** (only on loess, with extensive grazing) with the presence of *Achillea pannonica;* 3. ***S.-S botriochloëtosum*** (only on loess, with intensive grazing, the poorest in species subass.) with the presence of *Achillea setacea* and *Botriochloa ischaemum*	**Niecka Nidziańska basin**, Wyżyna Kielecko-Sandomierska upland, Wyżyna Lubelska upland	On the habitats of the most extreme conditions, the community is stable, on the other – it changes slowly into more mesotrophic grasslands (on gypsum) or into *Cerasus fruticosa* shrubs (on loess).
Potentillo-Stipetum capillatae – Pomeranian ***Stipa*** steppe, referring to *Sisymbrio-Stipetum capillatae* but poorer in species	in extremely topoclimatic conditions on steep, south facing moraine slopes	mainly brown soils on marl sometimes clay sediments	*Alyssum montanum, Stipa capillata, S. joannis*, (only on the Lower Odra river), *S. pulcherrima, Carex supina, Oxytropis pilosa*. Accompanying species: *Anthericum liliago*	Pomerania, Wielkopolska [Greater Poland], Kujawy regions (Lower Odra and Lower Vistula valleys, Toruń-Eberswalde spillway)	Community poorer in species than *Sisymbrio-Stipetum capillatae* – lack of *Festuca valesiaca, Sisymbrium polymorphum*, etc. On the most extreme habitats, the community is stable.
Koelerio-Festucetum rupicolae – low grassland with rather scattered structure without *Stipa* species and with *Festuca rupicola* and *Koeleria macrantha* predominating	dry and sunny slopes	soils formed on loess layer overlying limestone substratum	*Festuca rupicola, Koeleria macrantha, Myosotis ramosissima, Phleum phleoides, Thymus eustriacus, Th. glabrescens*	Wyżyna Śląsko-Krakowska [Silesian-Cracovian] upland and **Niecka Nidziańska basin**	Secondary community forming as a result of intensive grazing on other thermophilous grassland associations and on habitats of destroyed thermophilous shrubs or forest, requiring continuous grazing to persist. In case of occurrence of sand layer instead of loess, on analogical places communities from *Koelerio-Corynephoretea* class (grasslands on sandy substratum) form there.
Inuletum ensifoliae – floristically rich, low flowery grasslands with dense structure, consisting of highly calciphilous and thermophilous species	warm and dry slopes, hilltops, on small areas, mainly as a narrow belt on thermophilous shrubs' margins	shallow rendzinas on chalk, marl	*Aster amellus, Cirsium pannonicum, Inula ensifolia, Iris aphylla, Linum flavum, L. hirsutum*, locally *Carlina onopordifolia, Dorycnium sericeum*	**Niecka Nidziańska basin**, Wyżyna Lubelska and Wyżyna Zachodniowołyńska uplands	Community of origin related to grazing. As a result of grazing abandonment it changes relatively quickly into thermophilous brushwood (*Peucedano-Coryletum*).

Thalictro-Salvietum pratensis – tall flowery grasslands with dense structure, with quantity share of *Salvia pratensis*, resembling so-called "flowery meadow steppe"	gentle, mostly east/west facing slopes, less dry and less warm than in case of communities mentioned above; extensive grazed places; embankments' slopes	deep, chernozem type (pheozem) soils and rendzinas on gypsum, chalk, marl or limestone	*Agropyron intermedium, Campanula bononiensis, Carex praecox, Eryngium campestre, Ranuculus illyricus.* Accompanying species: *Adonis vernalis, Falcaria vulgaris, Thalictrum minus,* etc.	typical form – steppe ("halawy"): Wyżyna Małopolska [Lesser Poland] upland (incl. **Niecka Nidziańska basin**) and Wyżyna Wołyńsko-Podolska upland; poorer forms – in whole upland belt and in foothills	Community of origin related to grazing. As a result of grazing abandonment it changes, but relatively slowly, into thermophilous brushwood (*Peucedano-Coryletum*). On the gypsum substrate adjoins with *Sisymbrio-Stipetum capillatae* and often replaces this community as a result of succession process.
Adonido-Brachypodietum pinnati – tall flowery grasslands with dense structure and predomination of *Brachypodium pinnatum* and high share of *Fragaria viridis, Filipendula hexapetala, Medicago falceta*, etc.	Slopes similar to the ones occupied by *Potentillo-Stipetum* but less dry and more gentle	deep, clayey brown soils or chernozem type (phaeozems) on gypsum, loess or marl	*Adonis vernalis, Campanula sibirica, Gentiana cruciata, Melampyrum arvense, Seseli annuum.* Accompanying species: *Frageria viridis, Filipendule hexapetala, Medicago falcata*, etc.	Wyżyna Małopolska [Lesser Poland] upland (incl. **Niecka Nidziańska basin**) and Wyżyna Wołyńsko-Podolska upland, Wielkopolska [Greater Poland] and Pomorze [Pomerania] regions	Secondary community of anthropogenic origin (formed on habitats of destroyed thermophilous shrubs or forest as a result of continuous grazing, mowing, burning. Needs these forms of use to persist. In case of abandonment it quickly changes into thermophilous: brushwood (*Peucedano-Coryletum*) and then oak forest (*Potentillo albae-Quercetum*).
Seslerio-Scorzonerietum purpureae – specific grassland with the predominance of *Sesleria uliginosa*	shadow and moist, north facing steep slopes	middle deep rendzinas on gypsum	*Asperula tinctoria, Scorzonera purpurea, Thelictrum simplex, Viola rupestris.* Accompanying species: *Sesleria uliginosa*	only in **Niecka Nidziańska basin**	Lack of detail information about the ecology; it may be an endemic community to the Niecka Nidziańska basin.
Origano-Brachypodietum pinnati – community of tall-herb/meadow character forming in contact zone between *Festucetum pallentis* and *Peucedano-Coryletum*	warm, dry slopes	rendzinas on limestone	*Stachys germanica.* Accompanying species: *Agrimonia eupatoria, Clinopodium vulgare, Inula conyza, Origanum vulgare*	southern part of Wyżyna Śląsko-Krakowska [Silesian-Cracovian] upland and Pieniny Klippen Belt	Systematic position not clear (probably should be counted into thermophilous margins' communities from *Trifolio-Geranietea* class).
***Carex glauca-Tetragonolobus maritimus* community** – community of intermediate syntaxonomical character, forming in contact zone between *Thalictro-Salvietum* and fresh meadow of *Arrhenatherion* order	on calcareous substrate of variable humidity	different soils on substratum containing calcium carbonate and sulphates or chlorides	*Carex flacca, Tetragonolobus maritimus* ssp. *siliquosus* (facultative halophyte)	only in **Niecka Nidziańska basin**	

Table 2

(after: Medwecka-Kornaś 1959)

Stadium inicjalne zespołu (initial stage of the association) *Sisymbrio-Stipetum capillatae*

Zdj. 14. Skorocice, prawe zbocze wąwozu, na stromej skałce. Pokrycie przez roślinność 25% (w tym rośliny kwiatowe 20%, kryptogamy 5%). Naga gleba zajmuje 50% płatu, odsłonięte podłoże skalne 25%. Powierzchnia zdjęcia 3 m². 7. VI. 1954.

(Relevé 14. Skorocice, the right slope of the ravine, on steep rock outcrop. Total plant cover: 25% (coverage of the flowering plants: 20%, of cryptogams: 5%), bare soil: 50%, bare rock: 25%. Relevé area: 3 m². 7 June 1954)

Gatunki charakterystyczne zespołu (Species characteristic for the association):

1.2 *Gypsophila fastigiata*
\+ *Stipa capillata*
\+ *Poa bulbosa vivipara*

Gatunki charakterystyczne związku, rzędu i klasy *Festucion valesiacae, Festucetalia valesiacae, Festuco-Brometea* (Species characteristic for the *Festucion valesiacae alliance, Festucetalia valesiacea* order and *Festuco-Brometea* class):

\+ *Artemisia campestris*
\+ *Stachys recta*
+.2 *Thymus glabrescens*

Gatunki towarzyszące (Accompanying species):

3.2 *Sedum acre*
\+ *Arenaria serpyllifolia*
\+ *Camelina microcarpa*
\+ *Erophila verna*
\+ *Holosteum umbellatum*
1.1 *Bryum argenteum*
\+ *Barbula gracilis*
\+ *Ceratodon purpureus*
+.2 *Syntrichia ruralis*
\+ *Cladonia pyxidata*
\+ *Cladonia* sp.

Table 3

(after: Medwecka-Kornaś 1959)

Sisymbrio-Stipetum capillatae

Numer kolejny (Number)	1	2	3	4	5	6	7	8	9	10	
Numer zdjęcia (No. of relevé)	36	10	15	19	11	34	37	40	7	8	
Miejscowość (Locality)	Skotocice										
Data (Date)	5. 6. 1953	6. 6. 1954	8. 6. 1954	22.8. 1954	6. 6. 1954	5. 6. 1953	5. 6. 1953	6. 6. 1953	6. 6. 1954	6. 6. 1954	
Ekspozycja (Aspect)	SE	SE	E	S	SE	ESE	SE	S	SE	ESE	
Nachylenie (Slope inclination)	70°	70°	28°	18°	30°	12°	12°	25°	25°	21°	
Pokrycie łączne (Total cover – in %)	30	40	50	60	70	70	75	75	75	95	
Pokrycie roślin kwiatowych (Flowering plants' cover – in %)	25	35	45	60	70	65	75	...	60	90	
Pokrycie roślin zarodnikowych (Cryptogams' cover – in %)	10	5	5	<5	<5	20	<5	...	40	20	
Powierzchnia (Relevé area – in m²)	7	6	12	12	10	15	10	60	15	8	Stałość (Constancy)
I. Gatunki charakterystyczne zespołu (Species characteristic for the association):											
Festuca valesiaca	+	2.2	.	2.2	3.2	3.2	3.3	1.2	2.2	1.2	V
Poa bulbosa vivipara	+.2	1.2	+	+	2.2	+	2.2	3.2	+	+	V
Stipa capillata	+.2	1.2	3.2	2.2	3.2	1.1	3.2	2.2	3.2	4.3	V
Veronica praecox	+	+	.	+	1.1	.	+	+	+	.	IV
Euphrasia tatarica	.	.	1.1	+	.	.	1.1	+	+	.	III
Gypsophila fastigiata (char. lok.)	2.3	.	+.2	1.2	.	.	+.2	+.2	1.2	.	III
Hieracium echioides	+.2	+	+	.	.	.	+	.	2.2	+	III
Arabis auriculata	+	.	.	.	.	1.1	+	+	.	.	II
Medicago minima (char. lok.)	.	+	.	.	+	1.2	+.2	.	.	.	II
Sisymbrium polymorphum	+	.	.	+	.	1.1	1.1	.	.	.	II
II. Gatunki charakterystyczne związku i rzędu *Festucion valesiacae* i *Festucetalia valesiacae* (Species characteristic for *Festucion valesiacae* alliance and *Festucetalia valesiacae* order):											
Potentilla arenaria	+	+	+	2.2	.	1.2	+	2.3	2.2	+	V
Agropyron intermedium (incl. *A. trichophorum*)	.	.	.	+	1.2	+	+	+	.	+	III
Ornithogalum Guzzonei	.	.	+	+	.	.	.	.	.	.	
Thymus glabrescens	.	+.2	+.2	1.2	.	.	.	+	+	.	III
Astragalus danicus	.	.	+.2	+	.	.	.	.	+	3.3	II
Carex supina	.	.	.	+	.	.	+	+	.	+	II
Thymus Marschallianus	+.2	.	.	.	.	2.2	+.2	+.2	.	.	II
III. Gatunki charakterystyczne klasy (Species characteristic for the *Festuco-Brometea* class):											
Artemisia campestris	1.2	1.2	1.2	1.2	2.2	1.2	+	+	2.2	+	V
Euphorbia cyparissias	+	+	1.1	+	+	+	+	+	1.1	+	V
Medicago falcata	+	.	2.2	2.1	1.2	+	+	+.2	+.2	1.2	V
Calamintha acinos	+	.	+	.	+	+	+	+	+	+	IV
Koeleria gracilis	.	.	+.2	+	.	+.2	.	+	2.2	+	III
Stachys recta	+	+	.	.	2.2	+.2	+	+	.	.	III
Asperula cynanchica	.	.	+	.	.	.	.	.	+	+	II
Centaurea rhenana	+	.	.	.	.	.	+	+	.	.	II
Festuca cfr sulcata	.	.	2.2	2.2	.	.	.	2.2	1.2	.	II
Thlaspi perfoliatum	+	.	.	.	.	+.2	.	+	.	.	II
IV. Gatunki towarzyszące (Accompanying species):											
Alyssum calycinum	+	+.2	+	+	+	2.2	2.2	1.2	+	+	V
Arenaria serpyllifolia	+	+	+	+	+	3.2	3.2	1.2	+	+	V
Galium verum	+	.	+	1.1	2.2	+	+	+	1.1	2.2	V
Erophila verna	+	+	1.1	+	1.1	+	.	+	1.1	.	IV
Sedum acre	2.2	3.2	+	.	+	1.2	.	+	2.2	+	IV
Carex humilis	.	.	+.2	+.2	.	1.2	.	1.2	1.2	2.2	III
Camelina microcarpa	+	.	.	+	+	.	.	+	.	.	II
Falcaria vulgaris	.	.	.	.	+	+	.	.	.	+	II
Holosteum umbellatum	+	.	.	+	1.1	.	+	.	.	.	II
V. Mchy i porosty (Mosses and lichens):											
Gatunek charakterystyczny rzędu (The species characteristic for the order):											
Fimbriaria saccata	1.2	+.2	.		.	.		+	.	.	II
Gatunki charakterystyczne klasy (Species characteristic for the class):											
Abietinella abietina	.	.	+	+	.	1.2	.	+	+	+	III
Astomum crispum	.	.	+	.	.	+	.	.	.	+	II
Pterygoneurum pusillum	.	+	.	.	+.2	.	+	.	.	.	II
Gatunki towarzyszące (Accompanying species):											
Syntrichia ruralis	1.2	1.2	1.1	+.2	+	+	+	1.2	2.2	+	V
Rhytidium rugosum	.	.	+	+	+	.	.	+	1.1	+.2	III
Bryum argenteum	.	+	.	.	.	.	+	+	.	.	II
Cladonia foliacea alcicornis	.	.	+	+	.	.	.	.	1.1	2.2	II
Cladonia furcata	.	.	+	+	.	+	.	.	2.1	.	II
Collema sp.	.	.	.	.	+	+.2	.	.	+	.	II
Liczba gatunków roślin naczyniowych (No. of vascular plant species)	28	15	23	31	22	31	33	46	27	27	

Gatunki sporadyczne (Sporadic species):

II. *Adonis vernalis* 7, 8; *Campanula sibirica* 36; *Carex praecox* 37; *Erysimum pannonicum* 40; *Odontites lutea* 40, 8; *Oxytropis pilosa* 15, 40; *Scabiosa canescens* 15, 8; *Thymus austriacus* 40; *T. pannonicus* 40.

III. *Anthyllis vulneraria* var. *polyphylla* 15, 19; *Centaurea scabiosa* 37, 40?; *Dianthus carthusianorum* 19, 34; *Eryngium campestre* 11; *Pimpinella saxifraga* 40, 8; *Polygala comosa* 15; *Silene otites* 19, 40; *Taraxacum* cfr *laevigatum* 37; *Verbascum lychnitis* 36, 37; *Veronica spicata* 8.

IV. *Adonis aestivalis* 37; *Agrostemma githago* 11; *Avena* sp. 7; *Berteroa incana* 37; *Bromus mollis* 34; *Convolvulus arvensis* 40; *Crepis tectorum* 34; *Echium vulgare* 19, 40; *Erodium cicutarium* 34, 40; *Gypsophila muralis* 8; *Lamium amplexicaule* 37; *Lappula myosotis* 34, 37; *Lotus corniculatus* 40; *Medicago lupulina* 11, 40; *Melampyrum arvense* 19; *Papaver rhoeas* 34, 37; *Trifolium arvense* 36, 37; *Triticum sativum* 40, 7; *Viola arvensis* 37, 40.

V. *Barbula fallax* 15; *B. Hornschuchiana* 36; *Camptothecium lutescens* 7, 34; *Ceratodon purpureus* 10; *Hypnum cupressiforme* var. *lacunosum* 34, 7; *Cladonia furcata* f. *foliacea* 8, 34; *Cladonia* sp. 40; *Cornicularia aculeata* 19, 7; *Lecanora lentigera* 10, 15; *Peltigera rufescens* 34.

Table 4

(after: Medwecka-Kornaś 1959)

Zbiorowisko (community) *Festuca sulcata-Koeleria gracilis*

Numer kolejny (Number)	1	2	3
Numer zdjęcia (No. of relevés)	1	2	16
Miejscowość (Locality)	Skorocice		
Data (Date)	6. 6. 1954	6. 6 1954	8. 6. 1954
Ekspozycja (Aspect)	W	SWS	WNW
Nachylenie (Slope inclination)	6°	3°	0—15°
Pokrycie łączne (Total cover – in %)	75	95	100
Pokrycie roślin kwiatowych (Flowering plants' cover – in %)	50	80	90
Pokrycie roślin zarodnikowych (Cryptogamms' cover – in %)	30	20	30
Powierzchnia (Relevé area – in m²)	12	25	16
Gatunki charakterystyczne zespołu (Species characteristic for the association):			
Euphrasia tatarica	1.1	+	+
Hieracium echioides	+	+	+
Festuca valesiaca	.	1.2	+
Poa bulbosa vivipara	+	+.2	.
Gypsophila fastigiata (lok.)	1.2	.	.
Stipa capillata	.	+.2	.
Gatunki charakterystyczne związku *Festucion valesiacae* i rzędu *Festucetalia valesiacae* (Species characteristic for the *Festucion valesiacae* alliance and the *Festucetalia valesiacae* order)			
Ornithogalum Gussonei	1.1	+	+
Potentilla arenaria	2.2	1.2	3.2
Thymus glabrescens	+	2.2	+
Astragalus danicus	.	2.2	+
Scabiosa ochroleuca	.	+	+
Thymus austriacus	.	+.2	1.2
Adonis vernalis	.	.	+
Campanula sibirica			
Gatunki charakterystyczne klasy *Festuco-Brometea* (Species characteristic for the *Festuco-Brometea* class):			
Anthyllis vulneraria polyphylla	+	+	1.1
Calamintha acinos	+	+	+
Euphorbia cyparissias	1.1	+	1.1
Festuca sulcata	2.2	3.2	2.2
Koeleria gracilis	2.2	2.2	1.2
Artemisia campestris	1.2	1.2	.
Asperula cynanchica	.	+.2	+
Avenastrum pratense	.	+.2	1.1
Dianthus carthusianorum	.	+.2	+
Medicago falcata	+	+.2	.
Pimpinella saxifraga	.	+	+
Polygala comosa mieranthа	.	1.1	+
Scabiosa canescens	.	1.2	+
Trifolium montanum	.	1.2	2.2
Veronica spicata	.	+	1.1
Arabis hirsuta	.	+	.
Carex caryophyllea	.	.	1.1
Phleum Boehmeri	.	+.2	.
Plantago media	.	+	.
Ranunculus bulbosus	.	+	.
Sesali annuum	.	.	+
Thalictrum minus	.	.	+
Viola rupestris	.	.	+
Gatunki towarzyszące (Accompanying species):			
Sedum acre	2.2	2.2	+.2
Alyssum calycinum	+	+	.
Arenaria serpyllifolia	+	+	.
Cerastium arvense	.	+.2	+
Hieracium pilosella	.	+.2	+
Agrostis vulgaris	.	+.2	.
Carex humilis	.	.	3.2
Cerastium semidecandrum	+	.	.
Erophila verna	+	.	.
Gallium verum	.	.	1.1
Peucedanum oreoselinum	.	.	+
Plantago lanceolata	.	+	.
Senecio sp.	.	.	+
Trifolium arvense	1.1	.	.
Trifolium pratense	.	r	.
Mchy i porosty (Mosses and lichens):			
Gatunki charakterystyczne klasy (Species characteristic for the class):			
Hypnum cupressiforme lacunosum	+	.	+
Abietinella abietina	1.1	.	.
Gatunki towarzyszące (Accompanying species):			
Rhytidium rugosum	2.2	2.2	3.3
Syntrichia ruralis	+	+	.
Bryum argenteum	+	.	.
Ceratodon purpureus	+	.	.
Cladonia foliacea alcicornis	1.1	1.1	+
Cladonia furcata	.	+	+
Cladonia silvatica	1.1	.	+
Cetraria islandica	.	+	.
Cladonia pyxidata pocillum	.	+	.
Cornicularia aculeata	2.2	.	.
Peltigera rufescens	r	.	.
Liczba gatunków roślin naczyniowych (No. of vascular plant species):	20	39	34

Table 5

(after: Medwecka-Kornaś 1959)

Thalictro-Salvietum pratensis

Numer kolejny (Number)	1	2	3	4	5	6	
Numer zdjęcia (No. of relevé)	27	9	38	23	35	22	
Miejscowość (Locality)	Skorocice						
Data (Date)	1. 7. 1954	7. 6. 1954	6. 6. 1953	8. 6. 1954	5. 6. 1953	8. 6. 1954	
Ekspozycja (Aspect)	E	ESE	E	E	E	SE	
Nachylenie (Slope inclination)	30°	25°	25°	25°	20°	35°	
Pokrycie roślin kwiatowych (Flowering plants' cover – in %)	100	100	100	100	100	100	
Powierzchnia (Relevé area – in m²)	40	50	250	50	36	100	Stałość (Constancy):
I. Gatunki charakterystyczne zespołu (*) i wyróżniające (Species characteristic and distinguishing * for the association)							
**Agropyron intermedium* (incl. *A. trichophorum*)	3.2	2.1	2.2	3.2	+	3.2	V
**Carex praecox*	1.2	1.3	2.2	2.1	2.1	3.2	V
Falcaria vulgaris	+	+	.	1.1	1.1	+	V
**Eryngium campestre*	+	1.1	+	+	+	+	V
Fragaria viridis	2.1	2.1	1.2	2.2	2.2	1.1	V
Medicago falcata	2.2	3.2	2.2	3.2	2.2	3.3	V
Salvia pratensis	1.1	3.2	3.3	3.1	3.2	3.2	V
Thalictrum minus	2.2	2.1	+.2	2.1	2.2	1.2	V
**Campanula bononiensis*	.	+	.	.	.	+.2	II
**Ranunculus illyricus*	.	.	.	(+)	.	.	I
II. Gatunki charakterystyczne związku *Festucion valesiacae* i rzędu *Festucetalia valesiacae* (Species characteristic for the *Festucion valesiacae* alliance and the *Festucetalia valesiacae* order):							
Achillea millefolium pannonica	1.1	1.1	1.1	1.1	1.1	2.1	V
Adonis vernalis	+	2.1	1.2	1.1	1.1	2.2	V
Scabiosa ochroleuca	1.1	+	+	.	+	+	V
Festuca valesiaca	.	.	+.2	+°	+°	+°	IV
Potentilla arenaria	.	.	+	.	+	+	III
Thymus austriacus	.	+	.	+	+.2	.	III
Thymus Marschallianus	+	.	.	.	+	+	III
Thymus pannonicus	+	.	.	+	+	.	III
Astragalus danicus	.	+	.	.	.	+.2	II
Bromus inermis	.	.	.	+	+	.	II
Thymus glabrescens	+	.	.	.	.	+	II
III. Gatunki charakterystyczne klasy *Festuco-Brometea* (Species characteristic for the *Festuco-Brometea* class)							
Asperula cynanchica	+.2	+	.	+	1.1	+	V
Dianthus carthusianorum	+	+	+	1.1	+	1.1	V
Euphorbia cyparissias	(+)	1.1	+	+	+	+	V
Plantago media	.	+	+	+	+.2	+	V
Stachys recta	(+)	.	+	1.2	+	+.2	V
Agrimonia eupatoria	.	.	+	+	+.2	+	IV
Phleum Boehmeri	+	+	+	.	+	.	IV
Pimpinella saxifraga	+	.	2.2	.	+.2	+	IV
Poa pratensis angustifolia	.	.	3.2	+	2.1	1.1	IV
Potentilla argentea	.	.	+	+	+.2	+	IV
Ranunculus bulbosus	.	+	+	.	+	+	IV
Thlaspi perfoliatum	.	+	+	+	.	1.1	IV
Trifolium montanum	+.2	+	.	+	+	.	IV
Arabis hirsuta	.	1.1	.	.	+	+	III
Verbascum lychnitis	.	.	.	+	+	+	III
Artemisia campestris	.	.	+	.	+	.	II
Brachypodium pinnatum	.	+	.	.	3.2	.	II
Calamintha acinos	.	.	+	.	+	.	II
Filipendula hexapetala	.	2.1	.	+.2	.	.	II
Potentilla cfr recta	.	.	+.2	.	+.2	.	II
Sanguisorba minor	.	.	+	.	+	.	II
Scabiosa cfr canescens	.	.	.	.	+	+.2	II
Seseli annuum	.	+	.	+	.	.	II
IV. Gatunki towarzyszące (Accompanying species):							
Carex contigua	1.2	+	+	1.1	1.2	+.2	V
Cerastium arvense	+	+	+	1.1	1.1	1.1	V
Coronilla varia	2.2	+	2.2	2.1	.	+	V
Galium verum	2.1	2.2	2.2	1.1	+	2.1	V
Berteroa incana	+	.	+	.	+	+	IV
Dactylis glomerata	+	+	.	+	+	.	IV
Hypericum perforatum	.	+	+.2	+	.	+	IV
Convolvulus arvensis	.	.	+	1.1	.	+	III
Festuca pratensis	.	+	.	+	1.1	.	III
Plantago lanceolata	.	+	+	.	.	+	III
Alyssum calycinum	+	.	.	+	.	.	II
Arenaria serpyllifolia	.	.	+	.	+	.	II
Consolida regalis	+	.	.	.	.	r	II
Hieracium pilosella	.	.	+	.	.	+	II
V. Mchy (Mosses):							
Gatunek charakterystyczny klasy (The species characteristic for the class):							
Abietinella abietina	.	2.1	.	+	.	.	II
Gatunek towarzyszący (Accompanying species):							
Camptothecium lutescens	.	1.1	.	+	.	.	II
Liczba gatunków roślin naczyniowych (No. of vascular plant species)	32	37	41	42	48	49	

Gatunki sporadyczne (Sporadic species):

II. *Carex supina* 35; *Salvia verticillata* 23; *Sisymbrium polymorphum* 38; *Stipa capillata* 22; *Veronica austriaca* 23.

III. *Draba nemorosa* 38; *Festuca sulcata* 22; *Koeleria gracilis* 35; *Ornithogalum Gussonei* 23; *Polygala comosa* 23; *Veronica spicata* 9.

IV. *Avenastrum pubescens* 22; *Carlinus acanthoides* 22; *Carex humilis* 9; *Crepis rectorum* 35; *Cuscuta* sp. 27; *Erophila verna* 35; *Eryngium planum* 38; *Euphorbia esula* 9; *Glechoma hederacea* 22; *Medicago lupulina* 22; *Papaver rhoeas* 35; *Selinum carvifolium* 27; *Senecio vernalis* 38; *Vicia angustifolia* 22.

V. *Syntrichia ruralis* 9; *Thuidium Philiberti* 23.

Table 6

(after: Medwecka-Kornaś 1959)

Zbiorowisko (Community) *Carex glauca-Lotus siliquosus*

Zdj. 6. Skorocice — dolna część prawego zbocza wąwozu poniżej Wielkiego Stawu. Płat 2 m szeroki, ciągnący się tuż ponad ścieżką i przechodzący wyżej w *Thalictro-Salvietum*. Ekspozycja SE, nachylenie 20°, pokrycie przez roślinność 90%, mchów brak. Wysokość darni 20 cm, kwiatostany *Carex glauca* do 50 cm. Powierzchnia zdjęcia 12 m². 6. VI. 1954.

(Relevé 6. Skorocice, the bottom part of right slope of the ravine. 2 m wide patch, situated just over the path and transiting upwards into *Thalictro-Salvietum*. Slope aspect: SE, slope inclination: 20°, total plant cover: 90%, no moss layer. Sward height: 20 cm, height of flowering individuals of *Carex glauca* up to 50 cm. Relevé area: 12 m². 6 June 1954)

Gatunki wyróżniające (Species distinguishing the community):

3.2 *Carex glauca*

2.2 *Lotus siliquosus*

Gatunki charakterystyczne związku *Festucion valesiacae* i rzędu *Festucetalia valesiacae* (Species characteristic for the *Festucion valesiacae* alliance and the *Festucetalia valesiacae* order):

\+ *Agropyron intermedium*
\+ *Bromus inermis*
\+ *Campanula sibirica*
\+ *Scabiosa canescens*
\+ *Scabiosa ochroleuca*
\+° *Thymus austriacus*

Gatunki charakterystyczne klasy *Festuco-Brometea*: (Species characteristic for *Festuco-Brometea* class):

1.2 *Brachypodium pinnatum*
1.2 *Plantago media*
\+ *Anthyllis vulneraria polyphylla*
\+ *Asperula cynanchica*
\+ *Euphorbia cyparissias*
+.2° *Festuca sulcata*
\+ *Medicago falcata*
\+ *Polygala comosa*
\+ *Ranunculus bulbosus*
\+ *Salvia pratensis*
\+ *Sanguisorba minor*

Gatunki towarzyszące (Accompanying species):

2.2 *Leontodon hispidus*
1.1 *Achillea millefolium*
1.1 *Ononis spinosa*
1.1 *Ranunculus acer*
+. *Cichorium intybus*
\+ *Cirsium lanceolatum*
\+ *Convolvulus arvensis*
\+ *Coronilla varia*
\+ *Dactylis glomerata*
r° *Daucus carota*
\+ *Festuca pratensis*
\+ *Galium verum*
\+ *Lotus corniculatus*
\+ *Melilotus altissimus*
\+ *Potentilla reptans*
\+ *Prunella vulgaris*
+.2 *Sesleria uliginosa*
\+ *Sonchus arvensis*
\+ *Taraxacum officinale*
\+ *Cladonia* sp.

Table 7

(after: Medwecka-Kornaś 1959)

Festerio-Scorzoneretum purpureae

Numer kolejny (Number)	1	2	3	4	5	6	7	Stałość w zdjęciach 1–7 (Constancy in relevés 1–7)	Stałość w 5 zdjęciach — Kozłowska 1928 (Constancy in 5 relevés – Kozłowska 1928)
Numer zdjęcia (No. of relevé)	39	41	12	20	24	5	18		
Miejscowość (Locality)	Winiary	Chotel Czerwony	Skorocice						
Data (Date)	6. 6. 1953	22. 6. 1957	5. 6. 1954	8. 6. 1954	8. 6. 1954	6. 6. 1954	8. 6. 1954		
Ekspozycja (Aspect)	NWN	NW	WNW	N	N	N	NEN		
Nachylenie (Slope inclination)	25°	20°	70°	25°	45°	30°	30°		
Pokrycie łączne (Total cover – in %)	90	100	95	95	95	98	100		
Pokrycie roślin kwiatowych (Flowering plants' cover – in %)	90	90	95	90	85	90	80		
Pokrycie roślin zarodnikowych (Cryptogams' cover – in %)	5	50	5	60	40	40	70		
Powierzchnia (Relevé area – in m^2)	300	100	10	8	8	50	16		
I. Gatunki charakterystyczne zespołu (*) i wyróżniające (Species characteristic and distinguishing * for the association)									
**Asperula tinctoria*	3.3	3.2	1.1	2.1	3.3	1.1	3.3	V	.
Galium boreale	+	2.2	+	2.2	1.1	1.1	2.2	V	V
Scaleria altissima	4.4	2.2	1.2	2.2	2.2	4.4	3.2	V	V
**Viola rupestris*	.	.	+	1.1	+	2.1	+	IV	V
**Scorzonera purpurea*	.	+	.	.	1.1	.	1.1	III	III
**Thalictrum simplex*	+	.	.	.	+	+	.	III	I
Valeriana officinalis tenuifolia	.	.	+	.	+	.	1.1	III	.
II. Gatunki charakterystyczne związku *Festucion valesiacae* i rzędu *Festucetalia valesiacae* (Species characteristic for *Festucion valesiacae* alliance and *Festucetalia valesiacae* order)									
Adonis vernalis	1.2	+	+	+	+	+	.	V	.
Astragalus danicus	+	+	+	+	+	+	1.1	V	IV
Thymus austriacus	+.2	.	+	+	+	1.2	+	V	.
Veronica austriaca	.	.	+	+	+	+	1.1	IV	IV
Achillea millefolium pannonica	.	+	+	.	.	+	+	III	.
Agropyron intermedium (incl. *A. trichophorum*)	.	+	1.2	+°	.	.	+°	III	.
Campanula sibirica	+	.	.	+	.	+	+	III	III
Erysimum pannonicum	.	+	.	.	+	.	1.1	III	.
Onobrychis arenaria	+	+.2	.	.	.	1.1	.	III	.
Ornithogalum Gussonei	.	.	.	+	+	1.2	+	III	.
Potentilla arenaria	.	.	+	+	+	.	.	III	V
Scabiosa ochroleuca	.	.	.	+	+	+	.	III	.
Senecio integrifolius	+	.	+	.	.	+	+	III	.
Thesium linophyllon	2.2	+	.	+	.	+	.	III	.
Thymus glabrescens	+.2	.	.	+	.	.	+	III	.
Bromus inermis	.	.	+	.	+	.	.	II	.
Inula ensifolia	.	.	4.3	.	.	.	+	II	.
Salvia verticillata	.	.	.	.	.	+	+	II	.
Stipa Joannis	.	.	+.2	.	+.2	.	.	II	.
III. Gatunki charakterystyczne klasy *Festuco-Brometea* (Species characteristic for *Festuco-Brometea* class):									
Centaurea scabiosa	1.2	.	1.1	1.1	+	+	+	V	IV
Euphorbia cyparissias	+	+	+	+	.	+	+	V	V
Filipendula hexapetala	2.1	+	1.1	2.1	1.1	.	1.1	V	IV
Medicago falcata	1.2	+	1.1	+	+	+	+	V	.
Polygala comosa mixtanthia	.	+	+	+	+	+	+	V	V
Salvia pratensis	2.2	.	+	+	1.1	+	+	V	.
Trifolium montanum	1.1	1.1	+	2.2	+	2.2	2.1	V	V
Anthyllis vulneraria polyphylla	.	+	.	+	+	+	+	IV	V
Avenastrum pratense	.	1.1	.	+	+	1.1	+	IV	II
Brachypodium pinnatum	2.2	1.1	2.2	.	+	.	1.2	IV	.
Dianthus carthusianorum	.	+	+	+	+	.	1.1	IV	IV
Plantago media	.	.	+	1.1	+	+	+	IV	IV
Scabiosa canescens	.	.	+	+	+	+	+	IV	.
Thalictrum tuibus	.	2.1	1.1	1.1	+	.	+	IV	III
Arabis hirsuta	.	.	.	+	.	+	+	III	V
Campanula glomerata	1.2	.	.	.	.	1.1	+	III	.
Festuca sulcata	1.1	.	.	+	.	+.2°	.	III	V
Pimpinella saxifraga	.	.	.	.	+	+	+	III	.
Ranunculus bulbosus	+	.	.	.	.	+	1.1	III	V
Seseli annuum	.	.	.	1.1	+	+	+	III	V
Agrimonia eupatoria	+	.	.	.	.	.	+	II	.
Carex caryophyllea	.	.	.	+	.	+	.	II	II
Phleum Boehmeri	.	+	.	.	+	.	.	II	II
Veronica spicata	.	.	.	+	+	.	.	II	.
IV. Gatunki przechodzące z rzędu *Quercetalia pubescentis* (Species characteristic for *Quercetalia pubescentis* order):									
Fragaria viridis	+.2	+	+	+	+	.	+	V	.
Primula officinalis	2.1	+	+	.	2.1	1.1	+	V	IV
Anemone silvestris	.	2.2	+	.	1.1	2.1	2.1	IV	.
Peucedanum cervaria	.	1.1	2.1	.	.	.	+	III	.
Veronica teucrium	1.1	+	.	.	.	.	.	II	.
Viola hirta	1.2	.	+	.	.	.	.	II	.
V. Gatunki towarzyszące: (Accompanying species):									
Carex humilis	2.2	3.2	2.2	3.2	1.2	2.2	2.2	V	V
Briza media	+	+	.	+.2	.	+	+	IV	III
Dactylis glomerata	+.2	+	+	.	.	+.2	+	IV	.
Galium verum	+	+	.	+	.	+	2.1	IV	I
Cerastium arvense	.	.	.	+	+	+	1.1	III	.
Galium mollugo (incl. *G. arvense*)	.	+	+	.	+	.	+	III	.
Peucedanum oreoselinum	.	2.1	.	+	+	+	.	III	V
Ranunculus acer	+	.	.	+	.	.	+	III	.
Hypericum perforatum	+.2	.	.	.	+	.	.	II	.
Leontodon hispidus	.	.	.	.	+	+	.	II	.
Lotus corniculatus	+	+	.	.	.	.	.	II	II
Rubus caesius	.	.	+	.	.	.	+	II	.
Vicia sp.	.	+	+	.	.	.	.	II	.
VI. Mchy (Mosses):									
Gatunki charakterystyczne klasy (Species characteristic for class):									
Abietinella abietina	+	+	+.2	2.1	2.2	1.1	2.2	V	V
Hypnum cupressiforme lacunosum	.	+	+.2	.	.	.	.	II	V
Gatunki towarzyszące: (Accompanying species):									
Camptothecium lutescens	+	2.2	+.2	3.2	+.2	3.3	+	V	V
Thuidium Philiberti	1.2	3.3	+.2	.	+.2	1.1	3.2	V	.
Rhytidium rugosum	1.1	.	.	2.2	3.3	.	3.2	III	V
Fissidens taxifolius	.	.	1.2	.	+.2	.	.	II	III
Mnium affine	.	+	+.2	.	.	.	.	II	.
Liczba gatunków roślin naczyniowych (No. of vascular plant species)	38	40	43	44	45	53	53		

Table 8. The list of protected, endangered and rare species of the old ramparts in Stradów.

Species name	Protected species	IUCN category of threat
Astragalus cicer		EN
Campanula bononiensis	++	EN
Campanula sibirica	++	VU
Carlina acaulis	++	LR
Centaurium erythraea	+	VU
Cerasus fruticosa	++	VU
Cirsium canum		VU
Crataegus x macrocarpa		VU
Dianthus carthusianorum	+	LR
Elymus hispidus		VU
Ficaria nudicaulis		LR
Helianthemum nummularium		VU
Holosteum umbellatum		EN
Lavatera thuringiaca		LR
Ononis spinosa	+	LR
Salvia nemorosa		VU
Viburnum opulus	+	LR
Vicia tenuifolia		VU
Vincetoxicum hirundinaria		VU

Explanations: EN – endangered, VU – vulnerable, LR – lower risk, ++ strictly protected species, + partially protected species