Acta Palaeobot. 39(1): 137–169, 1999

THE USE OF PLANT RESOURCES IN THE EARLY CENTURIES AD ON THE BASIS OF PLANT MACROREMAINS FROM THE ROMAN IRON AGE SITE AT WĄSOSZ GÓRNY, NEAR KŁOBUCK, CENTRAL POLAND

ALDONA BIENIEK

W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31–512 Kraków, Poland

ABSTRACT. Three pits from the Roman Iron Age site at Wąsosz Górny differed in the composition of their plant remains. Cultivated plants were represented by *Avena sativa*, *Hordeum vulgare*, *Linum usitatissimum*, *Panicum miliaceum*, *Pisum sativum*, *Secale cereale* and *Triticum spelta*. Pit 17 from the Late Roman Period included, in addition to cultivated plants, a great number of weed species, which provide an insight into the kind of arable farming practised at the time. The use of a field rotation system with fallowing was very likely. With the aid of ecological index analysis a picture of the kinds of soil used for the cultivation can be built up. Comparison of the ecological analysis of weeds with the cultivated plant composition in pit 17 showed that spring barley was probably cultivated on rendzinas; pea and oat, probably sown as a mixture, could have been cultivated on light, more acid soils (sandy podsolic soils); rye could have been grown on poor soil, or as a mixture with spelt on fertile, loamy almost neutral soil. Pit 17 contained some species not previously recorded from the Roman Iron Age in Poland, *Chenopodium ficifolium, Dianthus armeria, Fragaria vesca, Verbena officinalis, Centaurea phrygia / C. stoebe* and *Trifolium arvense / T. dubium*.

KEY WORDS: archaeobotany, Roman Iron Age, charred remains, cultivated plants, weeds, Poland

INTRODUCTION

Archaeological research at Wąsosz Górny, near Kłobuck, Częstochowa province, was carried out by Prof. Kazimierz Godłowski from the Archaeological Institute of the Jagiellonian University in 1961. At site 3, located on an elevated terrace of the Warta river, three pits (nos 2, 3 and 17) with large amounts of charred plant remains were discovered. All the contents of the pits were taken for study to the Department of Palaeobotany, Institute of Botany of the Polish Academy of Sciences in Kraków. The contents of pits 2 and 3 have been described by Anna Orlicz (Orlicz 1967). Now the material from pit 17 has been subjected to detailed examination.

Pit 3 dates from the Early Roman Period (I-II cent. AD), while pits 2 and 17 belong to the younger phases of the Late Roman Period (III-IV cent. AD) (Gedl et al. 1971). In the Roman Period the area was inhabitated by peoples of the Przeworsk culture.

RESEARCH AREA

Wąsosz Górny lies on the Warta river in the Wieluń Upland (Fig. 1), east of Działoszyn.

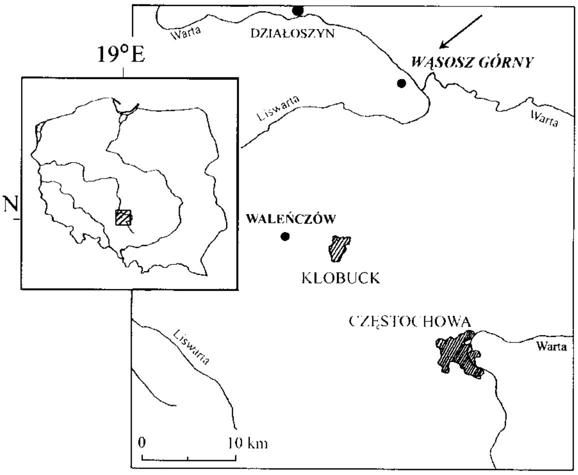


Fig. 1. Location of Wąsosz Górny

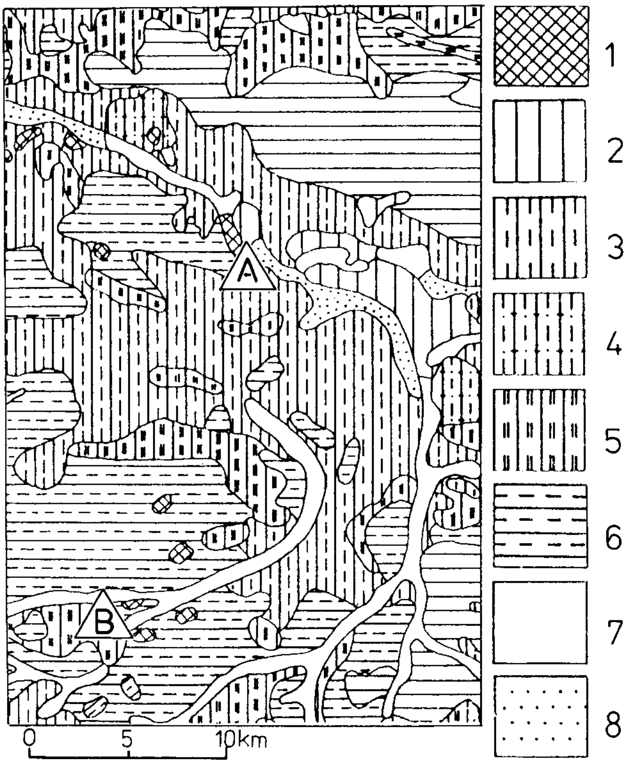


Fig. 2. Soils in the vicinity of Wąsosz Górny (after Hereźniak 1993). **1** – Jurassic carbonate rendzinas, **2** – podzolic loose soils, **3** – podzolic slightly loamy soils, **4** – podzolic slightly loamy soils on limestones, **5** – podzolic loamy soils, **6** – podzolic light and middle, **7** – alluvial muck soils, **8** – sandy soils and river sands, **A** – Wąsosz Górny, **B** – Walenczów

The village is about 200–250 m a.s.l., above the Warta valley which itself has an altitude of about 150–200 m.

A number of different types of soil occur around Wąsosz Górny (Fig. 2). Podsolic sandy and slightly loamy soils are predominant, while podsolic loamy soils and Jurassic rendzinas occupy small areas. In the river valley alluvial muddy soils and river sands occur (Hereźniak 1993). At present, the land in the Wąsosz Górny vicinity is mainly used for agriculture. Small patches of forest surrounding the studied area consist mainly of white cinquefoil-pine-oak mixed wood (Potentillo albae-Quercetum), mixed pine-oak forest (Querco roboris-Pinetum), pine forest (Leucobryo-Pinetum) and dry linden-abundant oak grove (Tilio-Carpinetum mellitetosum). Willow-poplar, ash-elm, oak-elm forests (Salici-Populetum, Ficario-Ulmetum and others) would develop in the Warta valley as potential natural vegetation. On the upland would grow subcontinental mixed oak-pine forests (Querco-Pinetum, Serratulo-Pinetum), dry subcontinental linden-abundant oak grove (Tilio-Carpinetum) and white cinquefoil-pine-oak mixed wood (Potentillo albae-Quercetum) (Hereźniak 1993).

Palynological data for this region are available from the Walenczów site near Kłobuck, lying about 15 km south-west of Wąsosz Górny (Ralska-Jasiewiczowa 1977). In the layers dating back to 1970 ± 140 BP and upwards, human impact is very obvious. At first it is indicated by an increase in the pollen of meadow plants, nitrophilous weeds, and light demanding species growing in open sandy places. This is followed slightly later by an increase in cereal pollen, including *Secale,* and the pollen of field weeds. During the Roman Period the Walenczów area was covered with mixed forest dominated by *Quercus, Tilia, Ulmus, Fraxinus* and *Picea*, with a rich brushwood as is indicated by the high *Corylus* content. In the course of this period a change in the floristic composition of the forest took place, probably caused in part by human activity (deforestation). *Carpinus*, *Fagus* and *Abies* spread and *Corylus* declined.

DESCRIPTION OF PIT 17

The first signs of pit 17 appeared at a depth of about 40 cm. It had an oval outline measuring ca 3.20 × 2.00 m. At a depth of ca 60 cm the pit outline changed to become almost rectangular with measurements of 3.20 × 1.60 m. It was filled with brown soil containing clusters of stones and big pieces of daub that formed something like a concave bottom to the upper part of the pit. Below that, at a depth of about 80 cm a thin layer of dark brown-black soil with charcoals and probably charred grains was found at the pit margin. At the same level, in the eastern part, a large fragment of rotational quernstone was discovered. At a depth of about 90 cm, in the western part of the pit, a large number of charred plant remains were preserved in blackish soil overlain by a thin layer of yellow sand. This blackish soil contained also stones, pieces of daub and strongly fired potsherds, including parts of a storage vessel decorated with a wavy line. In the eastern part, in brown grey soil there were no charred plant remains, stones or daub, only fragments of dishes decorated with meander ornament and one piece of pottery with a swastika. The pit ended at a depth of 100–110 cm (Godłowski 1963).

Plant remains described in this paper originated from the layer at 90–100 cm depth; sample localization: are II, quarter B/D, depth 90–100 cm.

MATERIAL AND METHODS

The investigated material was a mixture of seeds and fruits of cultivated and wild plants (ca 500 cm^3) and charcoals (ca 300 cm^3). Plant remains were separated from sand in the laboratory by wet sieving on sieves with a 0.5 and 0.2 mm mesh. All remains were charred. Identification was made using a binocular microscope, magnification 4–100 times, and was based on comparison with the reference collection of present-day seeds and fruits in the Department of Palaeobotany, Institute of Botany of the Polish Academy of Sciences in Kraków. Measurements were done under × 16 magnification, accurate to 0.1 mm, using an ocular or Brinell's micrometer. For cereals and pea 50 specimens were measured at random, for wild plants at most 10 seeds or fruits. Unless otherwise stated, dimensions are given in the following order: length × breadth × thickness. Taxonomic names have been given according to checklist of Polish flora (Mirek et al. 1995).

DESCRIPTION OF PLANT REMAINS

CEREALS

Avena sativa L. – oat

(Pl. 1 fig. 3, Pl. 2 figs 7–8)

Among 67 preserved florets there were 45 typical for *Avena sativa* and 8 typical for *Avena fatua* (Fig. 3). These two species differ in the shape of the floret. The florets of *Avena fatua* separate by oblique abscission leaving a distinctive suckermouth base, while those of *A. sativa* do so by horizontal fracture leaving no distinct basal scar (Renfrew 1973). Both lemmas and paleas of the two species have longitudinal nervation and some have papillae. About 1250 (24 cm^3) oat grains were identified (Fig. 4). They are elongate, thicker at the lower end and slightly flattened in the upper part. The lower part is almost circular in cross-section. The furrow is shallow and straight. Hairs or traces of them are visible on the grain surface. The naked charred grains of the two oat species are similar to each other. Hence those discovered could belong to either species as their separation was not possible. All oat remains were well preserved: for size see Table 1.

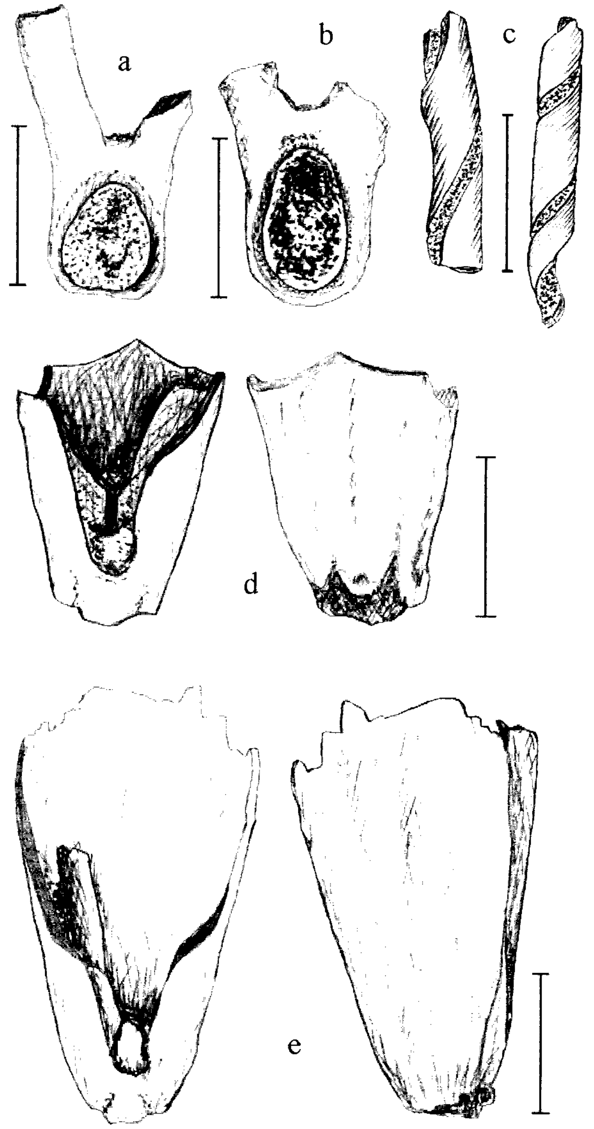


Fig. 3. Remnants of *Avena* sp.: **a**, **b** – basal part of *Avena fatua* floret with distinct suckermouth base; **c** – awns of *Avena* sp.; **d**, **e** – basal part of *Avena sativa* floret in ventral and dorsal view. Scale bars equal 1 mm

Hordeum vulgare L.
– six-rowed hulled barley

(Pl. 1 fig. 4)

About 4400 grains of six-rowed hulled barley (125 cm^3) were identified (Fig. 4). The grains are fusiform and clearly dorsally compressed. The furrow is shallow, frequently S-shaped and most of the grains are asymmetrical. Remains of lemmas and paleas are preserved on the surface of the grains. A few narrow spikelets were found, composed of a small grain enclosed by the lemma and palea with a rather elongate spikelet base. They appear to be lateral spikelets of the triplets. These two features, some asymmetrical grains

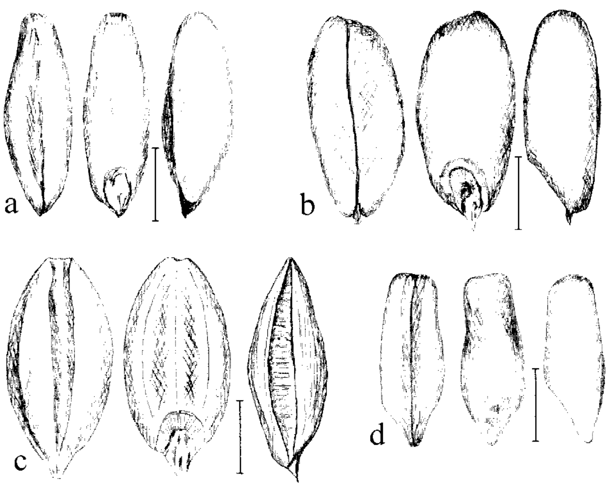


Fig. 4. Grains of cereals in ventral, dorsal and lateral view: **a** – *Avena* sp.; **b** – *Triticum spelta*; **c** – *Hordeum vulgare*; **d** – *Secale cereale*. Scale bars equal 2 mm

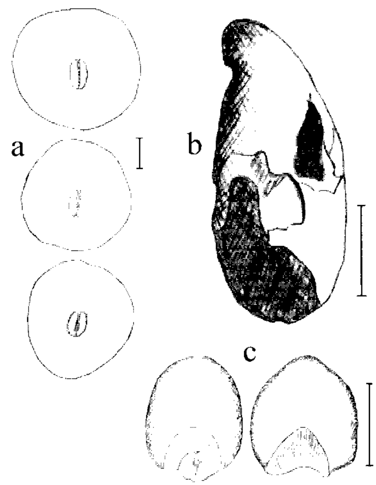


Fig. 5. **a** – seeds of *Pisum sativum* with visible hilum; **b** – *Linum usitatissimum* seed; **c** – *Panicum miliaceum* grains in dorsal view. Scale bars equal 1 mm

and narrow spikelets with elongate bases, indicate that this was a loose-eared barley. Only one rachis internode was found. The barley grains were better preserved than those of other cereals: for size see Table 1.

Panicum miliaceum L. – common millet

Only 4 grains of millet were found (Fig. 5). Their measurements in mm: 1.9 × 1.4 × 1.3; 2.0 × 1.3 × 1.0; 1.4 × 1.4 × 1.0; 1.5 × 1.3 × 0.8.

Secale cereale L. – rye
(Pl. 2 fig. 5)

Rye was represented by 235 grains (ca 5 cm^3). The grains (Fig. 4) are elongate, with rounded edge on the dorsal and deep, straight furrow on the ventral side; ± triangular in cross-section, thickest in the lower part and becoming narrower towards the top, truncate. Embryo long, in some cases reaching half the length of the grain. Rye grains are very fragile and their state of preservation is not as good as in barley and oat, but better than wheat: for size see Table 1.

Triticum spelta L. – spelt
(Pl. 1 fig. 1)

346 spikelet bases and 289 glume bases were identified as *Triticum spelta;* 1 spikelet base and 9 glume bases might belong to *Triticum dicoccon* (Fig. 6). These two species differ in the morphology of the glumes but identification of the bases alone is sometimes very difficult. The glume characters listed below were used in this study (see Jacomet 1987, Tomczyńska & Wasylikowa 1988; morphological terminology after Nesbitt & Samuel 1996):

Triticum spelta

1. lateral nervation clearly visible, all nerves prominent down to the glume base,
2. secondary keel does not differ from other nerves,
3. primary keel distinct near glume base, up to its top becomes less pronounced,
4. in cross section, a little above glume base, an edge is visible formed by primary keel, secondary keel invisible,
5. lateral face of glume is regularly convex,
6. glumes are generally coarse and tough in texture.

Triticum dicoccon

1. on lateral side, between primary and secondary keels, nerves disappear down to the base, sometimes a few nerves well visible,
2. secondary keel clearly marked as sharp edge,
3. primary keel clearly marked at glume base, becomes more pronounced at the upper part of glume,
4. in cross-section, a little above glume base, two edges formed by primary and secondary keels are visible,
5. lateral face of glume, above the base is depressed,
6. glumes are generally more delicate in appearance.

Fig. 6. Spikelet bases and glume bases of *Triticum spelta*: **a** – specimen from pit 3 identified by A. Orlicz (1967) as *T. spelta* in ventral, dorsal and lateral view and from the base; **b** – specimen from pit 3 identified by A. Orlicz (1967) as *T. dicoccum* in ventral, dorsal, lateral and from the base view; **c** – specimen from pit 17 in ventral and lateral view; **d** – specimen from pit 17 in ventral and dorsal view and from the base; **e**, **f** – glumes from pit 17 with indistinct *T. spelta* characters, e – in lateral and ventral view, f – in lateral view. Scale bars equal 1 mm

The specimens which could possibly be emmer have some characters of both species, which could be due to the charring of unripe spikelets. Apart from spikelet forks and glume bases a great number of naked kernels of spelt were found (1776 specimens; 48 cm^3) (Fig. 4). Because the majority of spikelet fragments are identified as *Triticum spelta* all grains are classified to this species but the possibility of some admixture of *T. dicoccon* grains cannot be ruled out. Naked grains of these two wheats in charred condition are difficult to distinguish from each other.

OTHER CULTIVATED PLANTS

Linum usitatissimum L. – flax

The only seed of flax (Fig. 5) had measurements: 3.5 × 1.6 × 1.4 mm.

Table 1. Dimensions in mm, and indices for cereal grains from Wąsosz Górny, site 3, pit 17

		L	B	T	L/B	T/B
Avena	min.	4,3	1,7	1,5	228	65
sativa	aver.	6,2	2,2	1,8	286	85
N= 50	max.	8,2	2,6	2,3	361	111
Hordeum	min.	4,2	2,2	1,6	161	65
vulgare	aver.	5,6	2,9	2,3	197	81
N= 50	max.	6,9	3,5	3	254	96
Secale	min.	5	1,6	1,6	193	71
cereale	aver.	5,9	2,3	2,2	261	94
N= 48	max.	7,4	2,8	2,8	375	116
Triticum	min.	4,8	2,4	2	152	72
spelta	aver.	5,8	3	2,5	193	83
N= 50	max.	7	3,6	3	241	97

Pisum sativum L. – garden pea
(Pl. 1 fig. 6)

Nearly 5500 pea seeds(225 cm^3) were found (Fig. 5). They are spherical, many of them with destroyed testa, but some have the oval hilum visible. Length and breadth of 20 hila: 1.08 (0.9–1.2) × 0.6 (0.5–0.7) mm, diameter of 50 seeds: 3.77 (2.9–4.5) mm.

WILD PLANTS

Asteraceae (Compositae)

Centaurea phrygia L. or ***C. stoebe*** L.

Number: 1 fruit. Dimensions: 2.0 × 0.7 × 0.6 mm.

The achene is strongly deformed, resembling those of these two species in size and shape.

Cichorium intybus L.

Number: 2 fruits. Dimensions: 2.2 × 0.9 × 0.9 mm.

Two kinds of achene are represented: one is a marginal fruit, trigonous, slightly convex on one face and flattened on the others; the second is a cylindrical fruit from the centre of the capitulum. Both have their surfaces covered with delicate, longitudinal ribs and are very finely transversely rugose.

Asteraceae indet.

Number: 3 fruits.

Brassicaceae (Cruciferae)

Neslia paniculata (L.) Desv.

Number: 86 fruits. Dimensions: 1.81 (1.4–2.0) × 1.72 (1.4–2.2) × 1.35 (0.9–1.6) mm.

The 1-locular indehiscent silicula is subglobose, slightly compressed, with style remains on the top and characteristic coarsely rugose sculpture.

Thlaspi arvense L.

Number: 5 seeds (3 more or less damaged). Dimensions of two seeds: 1.6 × 1.3 × 0.8; 1.7 × 1.3 × 0.8 mm.

The seeds are oval in outline, compressed, with concentric ridges on the surface.

Caryophyllaceae

Agrostemma githago L.

Number: 68 seeds. Dimensions: 2.34 (2.1–2.7) × 2.07 (1.7–2.4) × 1.58 (1.3–2.0) mm.

The seeds are rather poorly preserved, frequently without testa, 10 undamaged specimens were measured.

Dianthus armeria L.

Number: 2 complete seeds and 1 seed fragment. Dimensions: 1.0 × 0.8 × 0.5; 1.1 × 0.7 × 0.6 mm.

The identification was based on quantitative features given by Kowal and Wojterska (1966), such as length, breadth and thickness of seeds and on the basis of present-day reference material particularly outline, size, shape and sculpture. There are two species with seeds of similar size, *Dianthus deltoides* and *D. armeria*. They differ in sculpture, outline and thickness. *D. armeria* has seeds ovate in outline, 0.41–0.5 mm thick, covered with regular lines of papillae. The present-day seeds of *D. deltoides* are thinner, 0.21–0.3 mm thick, elliptical in outline and the papillae are arranged in irregular lines, particularly chaotic in the central part of the seed. The charred seeds resemble *D. armeria* and have similar size.

Melandrium album (Mill.) Garcke

Number: 48 typical seeds (Fig. 7) and 1521 only approximating to *Melandrium album*, listed in tables as *M.* cf. *album*. Dimensions: 1.11 (0.9–1.4) × 0.92 (0.8–1.0) × 0.71 (0.6–0.8) mm. For description see *M.* cf. *noctiflorum*.

Melandrium cf. **noctiflorum** (L.) Fr.

Number: 37 seeds. Dimensions: All specimens are damaged so measurements cannot be performed. Similar in size to *Melandrium album*.

The charred seeds of *M. album* and *M. noctiflorum* are frequently swollen and cracked and differentiation between them is very difficult. Seeds with convex dorsal face were identified as *M. album*, those dorsally flattened as *M. noctiflorum*. Another difference is a fold (Fig. 7) surrounding the hilum in seeds of *M. album*; in seeds of *M. noctiflorum* it is present only on two, opposite sides of the hilum. The seed surface is frequently damaged and dirty, which obliterates the difference in papillae distribution. The majority of seeds were included in *M.* cf. *album* but the presence of *M. noctiflorum* cannot be ruled out.

Scleranthus sp.

Number: 7 fruits. Dimensions: 1.88 (1.6–2.1) × 1.12 (1.0–1.2) mm.

The fruit (Fig. 7) is enclosed within the hard receptacle (torus). The sepal margins, which are a diagnostic feature, have not been preserved so species identification proved impossible.

Spergula arvensis L.

Number: 148 seeds. Dimensions: diameter 0.88 (0.5–1.3) mm; thickness 0.67 (0.6–0.9) mm.

The seeds (Fig. 7) are circular in outline, compressed, with remains of a narrow wing. Papillae present on surface, trichomes not preserved. This collective species comprises small-seeded forms, *Spergula vulgaris* and *S. sativa,* with diameter 0.9–1.2 mm (cultivated form 1.1–1.6 mm); and coarse-seeded forms, *S. maxima* and *S. linicola*, with diameter 1.6–2.0 mm (Kulpa 1974). According to the seed measurements, the charred specimens belong to a small-seeded form, but differentiation of charred *S. vulgaris* and *S. sativa* is not possible because the trichomes characteristic for *S. vulgaris* have not been preserved.

Stellaria graminea L.

Number: 4 seeds. Dimensions: diameter 0.6–0.8 mm; thickness 0.4–0.6 mm.

The seed (Fig. 7) surface is covered with concentric rings of elongate papillae with stellate bases.

Stellaria media (L.) Cyr.

Number: 2 seeds. Dimensions: 0.9 × 0.9 × 0.5; 0.9 × 0.9 × 0.6 mm.

The seeds (Fig. 7) are covered with flat, circular papillae with stellate bases; papillae more elongate towards radicle.

Caryophyllaceae indet.

Number: 367 seeds.

Chenopodiaceae

Chenopodium album L. s.l.

Number: 844 seeds. Dimensions: 1.09 (0.9–1.3) × 1.08 (0.9–1.5) × 0.66 (0.5–1.0) mm.

The seeds (Fig. 7) are ± circular in outline, lenticularly compressed. Some are flattened at the margin but the great majority are rounded there. Radicle clearly divergent from the seed outline. The sculpture consists of delicate lines radiating from the centre towards the circumference. *Chenopodium opulifolium* and *Ch. vulvaria* have similar seeds (Kowal 1953).

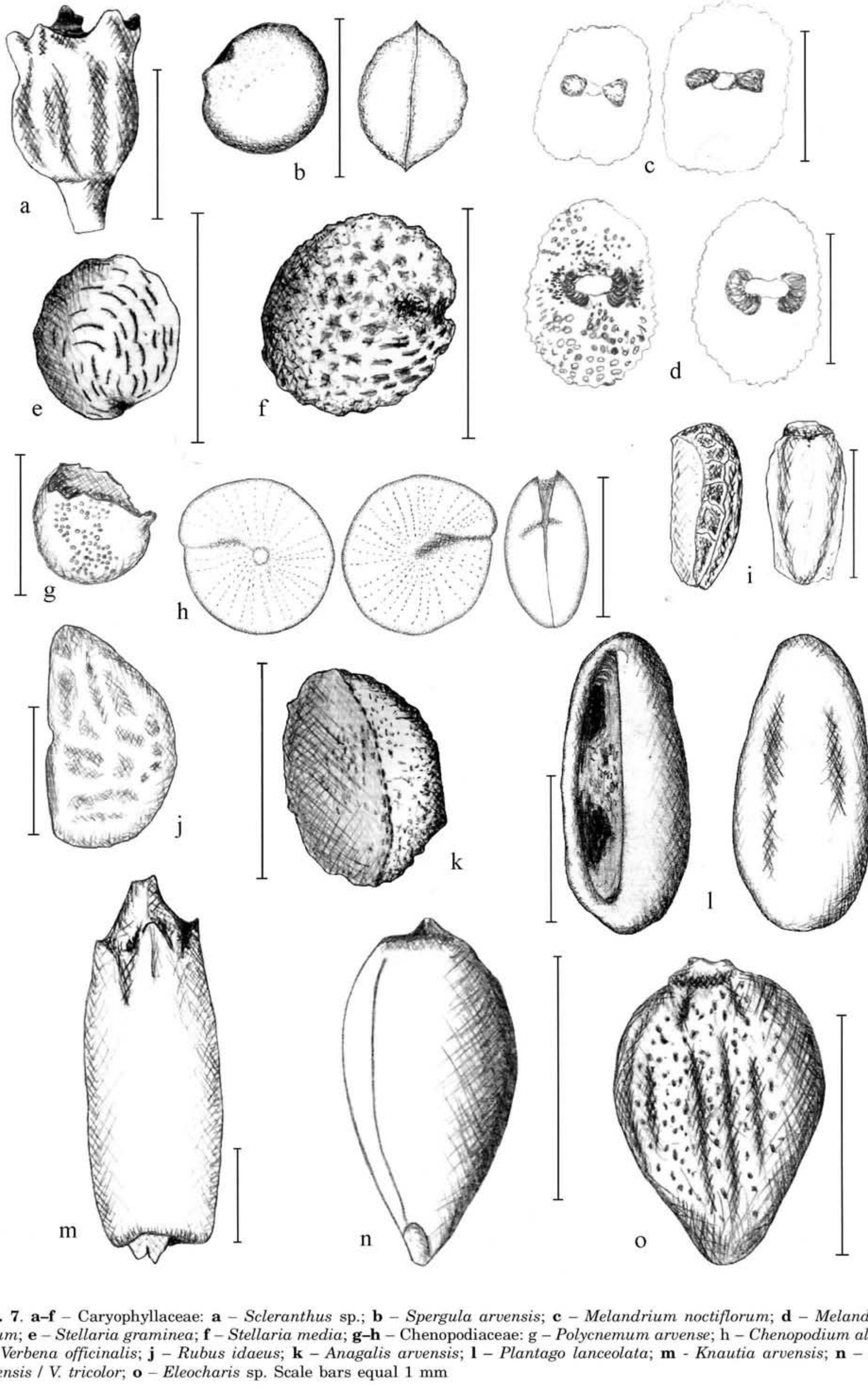


Fig. 7. **a–f** – Caryophyllaceae: **a** – *Scleranthus* sp.; **b** – *Spergula arvensis*; **c** – *Melandrium noctiflorum*; **d** – *Melandrium album*; **e** – *Stellaria graminea*; **f** – *Stellaria media*; **g–h** – Chenopodiaceae: g – *Polycnemum arvense*; h – *Chenopodium album*; **i** – *Verbena officinalis*; **j** – *Rubus idaeus*; **k** – *Anagalis arvensis*; **l** – *Plantago lanceolata*; **m** - *Knautia arvensis*; **n** – *Viola arvensis* / *V. tricolor*; **o** – *Eleocharis* sp. Scale bars equal 1 mm

Chenopodium ficifolium Sm.

Number: half of one seed.

Only one upper side of a seed was preserved. It is covered with the characteristic sculpture in the form of a shallow reticulum.

Chenopodium sp.

Number: 1349 seeds.

All specimens damaged, most without testa, those with preserved fragments of testa belong to *Chenopodium album*.

Polycnemum arvense L.

Number: 1 seed fragment (Fig. 7).

The surface is covered with small, circular papillae, thinly and regularly scattered.

Convolvulaceae

Convolvulus arvensis L.

Number: 3 seeds. Dimensions: 3.0 × 2.3 × 2.3; 2.7 × 1.8 × 1.9; ? × 1.5 × 1.2 mm.

The seeds are obovate in outline, with a large hilum at the lower end. The dorsal face is convex and the ventral arched. The surface is rough, with numerous papillae.

Cyperaceae

Eleocharis sp.

Number: 1 fruit. Dimensions: 1.4 × 1.0 × 0.6 mm.

The fruit (Fig. 7) is obovate in outline, slightly compressed, remains of beak at apex, stylopodium not preserved, thus making species identification impossible. Coarse longitudinal wrinkles are visible on the surface.

Dipsacaceae

Knautia arvensis (L.) Coult.

Number: 2 fruits. Dimensions: 3.8 × 1.5 × 1.2; 3.9 × 1.5 × 1.2 mm.

The calyx (Fig. 7) of the propagule is of similar shape to those of *Knautia arvensis* and *K. dipsacifolia*, but in the latter species it becomes narrower towards the top. The subfossil specimens do not show this feature; they are somewhat oblong and were identified as *K. arvensis*.

Fabaceae (Papilionaceae)

Coronilla varia L.

Number: 9 seeds. Dimensions: length: 2.79 (2.3–3.1) mm; thickness and breadth: 0.99 (0.5–1.3) mm.

The seeds are oblong in outline, cylindrical, with rounded ends. In some specimens a small depression with a circular hilum in its centre can be seen. Seed surface smooth. The seeds of *Coronilla varia* are very similar to *C. vaginalis* scarcely occurring on limestone in the Tatra Mountains at the beginning of our century (Szafer et al. 1953), which can be excluded on the basis of distribution. *C. coronata*, the third species probably occurring in Poland (Szafer et al. 1953), has seeds shorter and broader than the charred specimens.

Trifolium arvense L. / ***T. dubium*** Sibth. type

Number: 387 seeds. Dimensions: 0.68 (0.6–0.8) × 0.96 (0.8–1.2) × 0.56 (0.5–0.6) mm.

Seed radicle reaches 2/3–3/4 of the length of the cotyledons. The majority of seeds are damaged, without testa. On their surface a delicate reticulate pattern can be seen.

Lamiaceae (Labiatae)

Galeopsis ladanum L.

Number: 57 fruits. Dimensions: 2.11 (1.8–2.4) × 1.20 (1.0–1.5) × 1.04 (0.8–1.2) mm.

The schizocarps (Fig. 8) are obovate in outline, with a well formed central edge ca two thirds as long as the fruit on the ventral side; the small attachment scar is almost triangular. The fruits are clearly narrower than those of *Galeopsis tetrahit* and are somewhat similar to those of *G. angustifolia*.

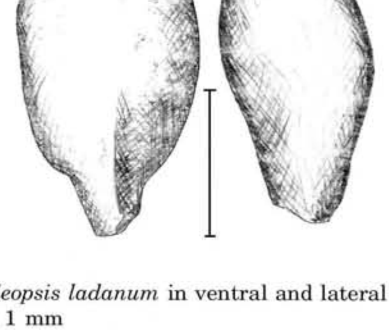


Fig. 8. *Galeopsis ladanum* in ventral and lateral view. Scale bar equals 1 mm

Galeopsis speciosa Mill.

Number: 1 fruit. Dimensions: 2.9 × 2.0 × 1.4 mm.

The schizocarp is similar to *Galeopsis tetrahit* but more flattened, with a distinct margin. The central part of the dorsal side is more convex than marginal belt looking like a hat round.

Galeopsis tetrahit L. type

Number: 117 fruits. Dimensions: 2.34 (2.0–2.7 × 1.66 (1.4–2.1) × 1.36 (1.1–1.6) mm.

Galeopsis tetrahit, G. bifida and *G. pubescens* have similar schizocarps (Fig. 9) differing slightly in size (Kulpa 1974). Compared to *G. ladanum* their fruits are broader with an almost invisible central edge; they are larger and the attachment scar is big and circular. The possibility that a few inflated fruits of *G. speciosa* were included in this group cannot be ruled out. It is very likely that *G. tetrahit* is the main species represented in Wąsosz Górny because it is the most common weed nowadays.

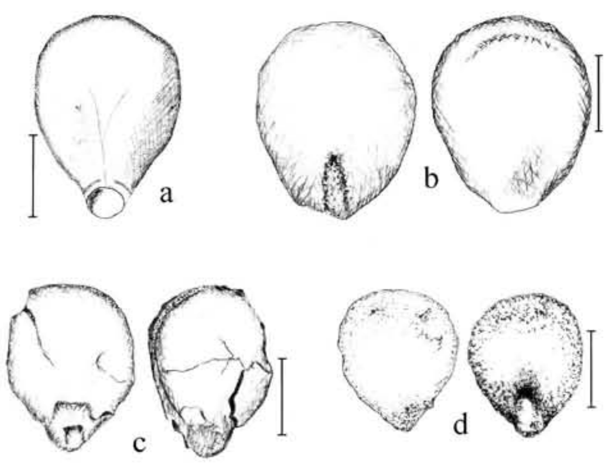


Fig. 9. **a** – ancient fruit of *Galeopsis tetrahit* type in ventral view; **b** – extant seed of *Galeopsis tetrahit* in ventral and dorsal view; **c** – ancient damaged fruit of *Galeopsis* sp. in ventral and dorsal view, seed visible from dorsal side; **d** – ancient seed of *Galeopsis* sp. in dorsal and ventral view. Scale bars equal 1 mm

Galeopsis sp.

Number: 48 fruits and 10 seeds. Dimensions of seeds: 1.86 (1.4–2.3) × 1.38 (0.9–1.7) × 0.82 (0.4–1.3) mm.

The fruits are damaged and deformed so they cannot be measured.

The seeds (Fig. 9) have a similar outline to the fruits. At the lower pointed end, the long, narrow hilum with delicate, radial wrinkles is visible. The seeds are red-black in colour.

Origanum vulgare L.

Number: 1 fruit. Dimensions: 0.6 × 0.4 × 0.3 mm.

The fruit is ovate in outline, slightly dorsally compressed, asymmetrical. The lower part of the ventral side is arched.

Stachys annua L.

(Pl. 2 figs 1–5)

Number: 184 fruits, 1 whole seed, 3 embryos. Dimensions of fruits: 1.59 (1.3–1.8) × 1.32 (1.2–1.6) × 1.01 (0.8–1.2) mm.

The schizocarps (Fig. 10) are broadly obovate in outline, with strongly flattened margins at the lower end. The ventral side has a central edge which takes the form of a delicate line reaching up the ± half of the length of the fruit. The surface is covered with a charac-

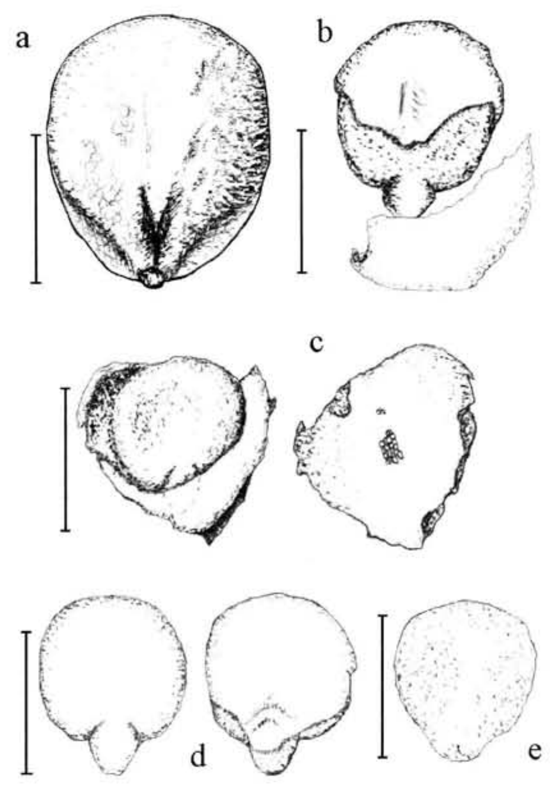


Fig. 10. **a** – ancient fruit of *Stachys annua* in ventral view; **b** – extant seed of *S. annua* with embryo visible inside in ventral view; **c** – ancient embryo of *S. annua* with remnants of testa and pericarp having typical sculpture on the surface, in ventral and dorsal view, radicle visible; **d** – ancient embryo of *S. annua* with remnants of testa in dorsal and ventral view; **e** – ancient seed of *S. annua* in ventral view. Scale bars equal 1 mm

teristic reticulum which made it possible to identify three strongly deformed fruits, one of which was damaged but with three layers visible (Fig. 10c): 1) a pericarp fragment having typical sculpture on the surface, 2) the testa, 3) the embryo with patent radicle. Because of this, three further embryos with pericarp fragments preserved and one complete seed could be identified (Fig. 10). The seed is dorsally compressed, dorsal side slightly convex, ventral side arched with a linear hilum at its lower end; its testa is similar to the specimen retaining remnants of pericarp. The embryos are dorsally flattened, almost circular in outline, with distinctly patent radicle; they are red-black in colour.

Stachys cf. _recta_ L.

(Pl. 2 fig. 6)

Number: 1 fruit. Dimensions: 1.5 × 1.3 × 0.9 mm.

It differs from *Stachys annua* in distinct ventral edge reaching almost to the top of the fruit.

Lamiaceae indet.

Number: 12 fruits.

Malvaceae

Malva sp.

Number: 5 seeds. Dimensions: (1.15–1.35) × (0.95–1.35) × (0.8–1.05) mm.

The seeds are laterally compressed, reniform, with convex dorsal side, edges obscure. Testa not preserved.

Plantaginaceae

Plantago cf. _lanceolata_ L.

Number: 39 seeds. Dimensions: 1.86 (1.6–2.3) × 0.83 (0.7–1.1) × 0.62 (0.5–0.9) mm.

The seeds (Fig. 7) are oblong or elliptical in outline, almost triangular in transverse section. Their dorsal side is convex and the concave ventral side has inrolled margins, flattened in 6 specimens. The hilum is situated on an elongate, longitudinal ridge.

Two species: *Plantago lanceolata* L. and *P. arenaria* Waldst. & Kit. (=*P. indica* L.), have very similar seeds. According to Swarbrick and Raymond (1970) they differ as follows:

1) *P. lanceolata* has seeds with the margins strongly inrolled or infolded, usually covering the inner side to at least one third of its total width: those of *P. arenaria* have slightly inrolled or infolded margins usually not covering more than one-third of the total width. 2) The inner side of the *P. lanceolata* seed has a definite longitudinal ridge from the hilum to the base of the seed: the *P. arenaria* seed has its hilum at the lowest point, rarely on a central ridge, with the inner side strongly concave. 3) The central part of the *P. lanceolata* seed is relatively thick dorsiventrally: the *P. arenaria* seed is thin. Most of the morphological features of the seeds of these two species overlap, especially when unripe.

According to Rymkiewicz (1979) *P. arenaria* and *P. lanceolata* seeds differ mainly in their aucubina content and not in morphological characters. *P. lanceolata* seeds contain a lot of this substance, while those of *P. arenaria* only a vestigial amount. In addition *P. arenaria* seeds may have a shallow furrow lying equatorially on the dorsal side, a feature also noticed by Kulpa (1974). This character has not been observed on the studied present-day and charred seeds. According to the criteria given by Swarbrick and Raymond, the material consisted mainly of typical *P. lanceolata* seeds; 6 seeds are similar to those of *P. arenaria* but they are probably unripe *P. lanceolata* seeds.

Poaceae (Gramineae)

Avena fatua L.

(Pl. 2 fig. 8)

Number: 8 floret bases (Fig. 3). For description see *Avena sativa*.

Bromus secalinus L.

Number: 3 complete grains and 2 lower fragments of grains. Dimensions: 5.3 × 2.0 × ca 1.4; 5.0 × 2.0 × ?; ca 5.6 × 1.9 × 1.4 mm.

The grains are oblong, almost linear in outline, upper end truncate, lower end pointed. The dorsal side is convex, the ventral almost flat with a thin furrow caused by inflation during charring.

Bromus sp.

Number: 19 badly damaged grains.

Digitaria ischaemum (Schreb.) Muehleub.

Number: 511 grains. Dimensions: 1.27 (1.1–1.4) × 0.71 (0.6–0.8) × 0.41 (0.3–0.5) mm.

The grains (Fig. 11) are elongate, dorsally compressed. The embryo is up to half as long as the caryopsis. The present-day *Digitaria ischaemum* grains are shorter and thicker than those of *D. sanguinalis*; according to Kulpa (1974) the length is 1.3–1.6 mm in the former species and 1.5–2.0 mm in the latter. The grains from Wąsosz Górny have a length matching that of *D. ischaemum*. Many specimens are preserved with glumes. The two species differ in the length of the second glume, that in *D. ischaemum* is as long as the caryopsis but in *D. sanguinalis* it is only 1/3–1/2 as long as the caryopsis. The preserved second glumes in the charred specimens agree in length with those of *D. ischaemum*.

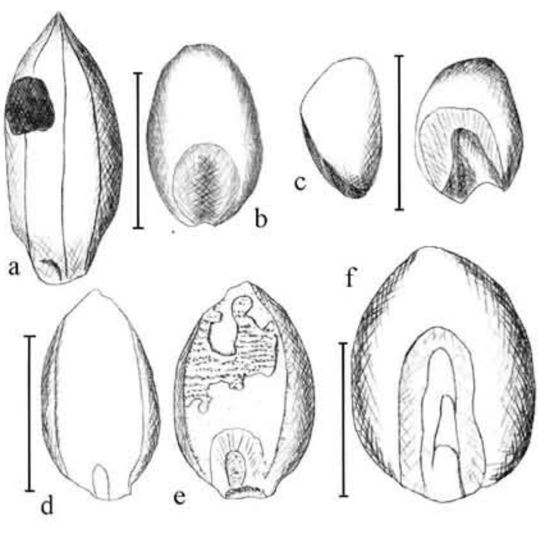


Fig. 11. Poaceae: **a** – grain of *Digitaria ischaemum* with glumes in dorsal view, **b** – grain of *Digitaria ischaemum* without glumes in dorsal view; **c** – grain of *Echinochloa crus - galli* in lateral and dorsal view; **d–f** – grains of *Setaria viridis* / *S. verticillata*, d, e – in ventral view, e – with remnants of palea, f – in dorsal view. Scale bars equal 1 mm

Echinochloa crus-galli (L.) P.B.

Number: 53 grains. Dimensions: 1.46 (1.3–1.7) × 1.13 (1.1–1.2) × 0.76 (0.7–0.9) mm.

The naked grains (Fig. 11) are ovate in outline, obtuse or truncate at the tip. The embryo is broad, rounded at the top and is three quarters of the length of the grain. The dorsal side is convex, the ventral flat. The majority of specimens are preserved without embryo. A few grains have fragments of lemma and palea with distinct longitudinal bands of broad cells.

Setaria viridis (L.) P.B.
/ ***S. verticillata*** (L.) P.B.

Number: 570 grains, the majority with lemma and palea. Dimensions: 1.29 (1.1–1.5) × 0.75 (0.7–1.0) × 0.48 (0.4–0.7) mm.

The grains (Fig. 11) are ovate in outline, truncate at the tip, dorsal side convex, ventral almost flat. The embryo is long and reaches three quarters of the length of the grain. The lemma and the central part of the palea are covered with small papillae arranged in transverse, wavy lines. This feature is clearly visible in the charred material.

Poaceae indet.

Number: 5 large grains and 139 small ones belonging to the Paniceae tribe.

Polygonaceae

Fallopia convolvulus (L.) Á. Löve

Number: 755 whole fruits and 329 seeds with damaged pericarp. Dimensions: length 2.51 (2.0–2.9) mm; breadth and thickness 1.79 (1.5–2.0) mm.

The nutlets (Fig. 12) are bluntly trigonous, their faces walls are symmetrical, concave or convex due to inflation caused by charring. The surface has a characteristic papillose sculpture.

Polygonum aviculare L.

Number: 5 whole fruits and one severely damaged. Dimensions: 1.95 (1.8–2.1) × 1.18 (1.15–1.2) × 0.9 (0.8–1.0) mm.

The nutlets (Fig. 12) are trigonous, broadest in the lower part, narrower above, asymmetrical. Their surface is covered by rows of papillae.

Polygonum lapathifolium L.
subsp. ***lapathifolium*** (***P. nodosum*** Pers.)

Number: 7 typical fruits. Dimensions: 2.13 (2.0–2.3) × 1.56 (1.4–1.8) × 0.69 (0.6–0.8) mm. For description see *P. lapathifolium* s.l.

Polygonum lapathifolium L. subsp. ***pallidum*** (WITH.) FR. (***P. tomentosum*** Schrank)

Number: 7 typical fruits. Dimensions: 2.03 (1.8–2.4) × 1.69 (1.6–1.8) × 0.65 (0.6–0.7) mm. For description see *P. lapathifolium* s.l.

Polygonum lapathifolium L. s.l.

Number: 66 fruits. Dimensions: 2.21 (1.4–2.5) × 1.57 (1.2–1.9) × 0.96 (0.7–1.2) mm.

The nutlets (Fig. 12) of *Polygonum lapathifolium* subsp. *lapathifolium (P. nodosum)* are very similar to those of *P. lapathifolium* subsp. *pallidum* (*P. tomentosum*). The typical fruits of the former have a broadly elliptical outline, narrowing slightly below; the fruits of the latter are broadly ovate in outline with a broader basal part (Marek 1954). Specimens having an intermediate shape are assigned to *P. lapathifolium* s.l.

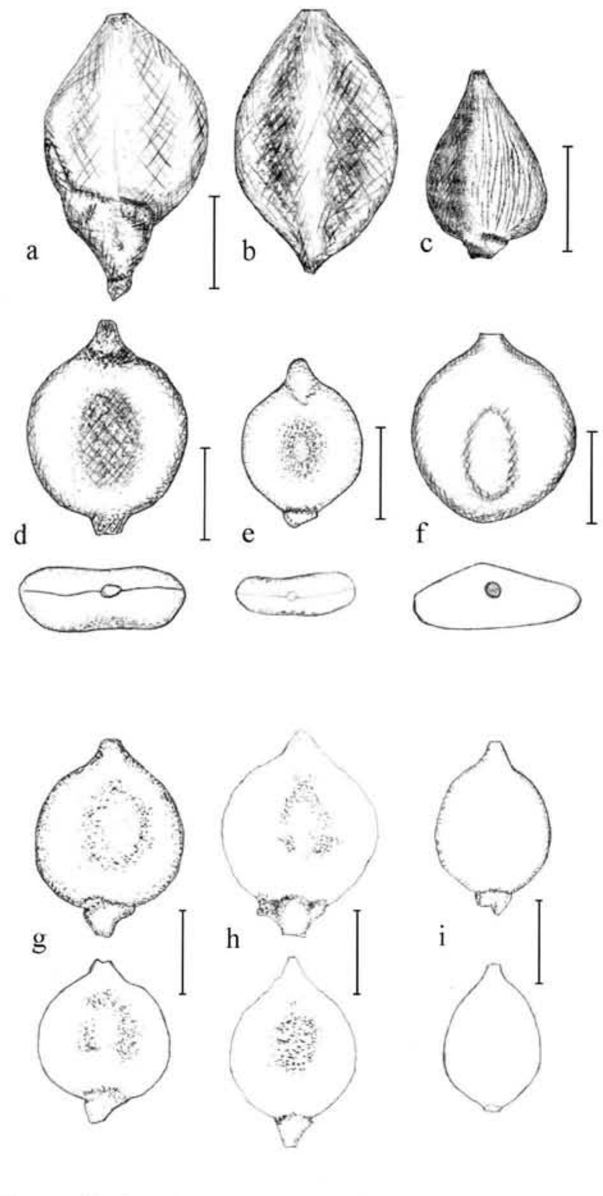


Fig. 12. Nutlets of *Polygonaceae*: **a**, **b** – *Fallopia convolvulus*, **a** – specimen with remnants of perianth; **c** – *Polygonum aviculare*; **d**, **e** – *P. lapathifolium* s.l.; **f** – *P. persicaria*; **g** – *P. lapathifolium* ssp. pallidum (P. *tomentosum*); **h** – *P. lapathifolium* ssp. *lapathifolium* (*P. nodosum*); **i** – *P. minus*. Scale bars equal 1 mm

Polygonum minus L.

Number: 3 fruits. Dimensions: 1.7 × 1.2 × 0.8 ; 2.0 × 1.3 × 1.0 ; 2.05 × 1.4 × 1.0 mm.

The nutlets (Fig. 12) are ovate in outline, rather narrow, lenticularly compressed.

Polygonum persicaria L.

Number: 7 fruits. Dimensions: 1.97 (1.6–2.2) × 1.68 (1.4–1.8) × 0.82 (0.7–0.9) mm.

The nutlets (Fig. 12) are broadly ovate in outline, lenticular; they differ from *Polygonum lapathifolium* by having one face slightly convex towards its base.

Polygonum sp.

This group consists of 693 lenticular fruits, that can belong to *Polygonum minus*, *P. persicaria* or *P. lapathifolium* and 721 seeds without or with partly destroyed pericarp.

Rumex acetosella L. s. l.

(Pl. 2 fig. 9)

Number: 197 fruits. Dimensions: 0.82 (0.65–1.0) × 0.6 (0.5–0.65) mm.

The nutlets are trigonous, frequently almost spherical due to charring, surprisingly small in size. Different dimensions are given by various authors for fruits of extant *Rumex acetosella*. Rechinger (1964) in the first edition of “Flora Europaea” describes two species differing in fruit length, *R. acetosella* L. 1.3–1.5 mm and *R. tenuifolius* (Wallr.) Á. Löve 0.9–1.3 mm. Tacik (1992) in “Flora Polski” (Flora of Poland) also describes these two species but in his opinion they differ only vegetatively (leaves, stems), while their fruits have a similar size: *R. acetosella* (0.9–)1.1–1.3 (-1.5) mm, *R. tenuifolius* (0.7-)0.9–1.1(-1.3) mm. In the second edition of volume 1 of “Flora Europaea”, Akeroyd (1993) has revised Rechinger’s account. He recognizes four subspecies of *Rumex acetosella*, absorbing *R. tenuifolius* within *R. acetosella* ssp. *acetosella* (as *R. acetosella* ssp. *acetosella* var. *tenuifolius* Wallr.). The range of nutlet length for the aggregate species is 0.8–1.5 mm, with no indication of restricted dimensions for the nutlets of any of the four subspecies.

In the studies of uncharred materials from the Middle Ages from Wawel Hill (Wasylikowa 1978) and the Main Market Square in Cracow

(Wieserowa 1979) identification of *Rumex* nutlets was based on fruit length as the diagnostic feature according to Rechinger (1964). The nutlets from the Wawel Hill were 0.96 (0.65–1.2) mm long and were described as *R. tenuifolius* (Wallr.) Á. Löve. The nutlets from the Main Market Square were a little larger, their length averaging 1.08 (0.8–1.4) mm. They were identified as *R. acetosella* L. s.l., being a mixture of *R. tenuifolius* and *R acetosella* L. s. str. with a predominance of the first. On the basis of fruit size, *R. tenuifolius* nutlets were described by Knörzer (1970, 1981) from the Roman Iron Age in Germany. Taking into account the opinions about the size of modern fruits and size changes due to charring all the specimens from Wąsosz Górny are identified as *Rumex acetosella* s.l. and probably other identification made before 1993 should be restricted to aggregate species *R. acetosella*. This certainly concerns nutlets from Wawel Hill.

Primulaceae

Anagallis arvensis L.

Number: 4 seeds. Dimensions: 1.2 × 0.9 × 0.7 ; 0.9 × 0.7 × 0.7 mm.

The seeds (Fig. 7) have the form of pyramids truncated at the top. The oblong hilum is situated on the top and the surface is covered with papillae.

Rosaceae

Fragaria vesca L.

Number: 1 fruit. Dimensions: 0.8 × 1.4 × 1.2 mm.

The nutlet is ovate in outline, slightly laterally compressed, with a little beak at one end and the attachment scar near the other, on the ventral side. A distinct ridge runs along the dorsal side.

Rubus idaeus L.

Number: 1 fruit. Dimensions: 1.8 × 1.0 × 0.9 mm.

The fruit-stone (Fig. 7) is laterally compressed, ovate in outline. Its surface is coarsely reticulate, with the mesh becoming elongate towards the narrower end.

Rubiaceae

Galium aparine L.

Number: 1 fruit. Dimensions: 2.2 × 2.1 × 1.7 mm.

The mericarp (Fig. 13) is almost spherical, slightly compressed around a circular hollow. The surface is covered with a fine network of elongate cells arranged in rows, a characteristic feature of the species, visible in specimens in which the outer pericarp layer is missing (Szydłowski & Wasylikowa 1973, Lange 1979).

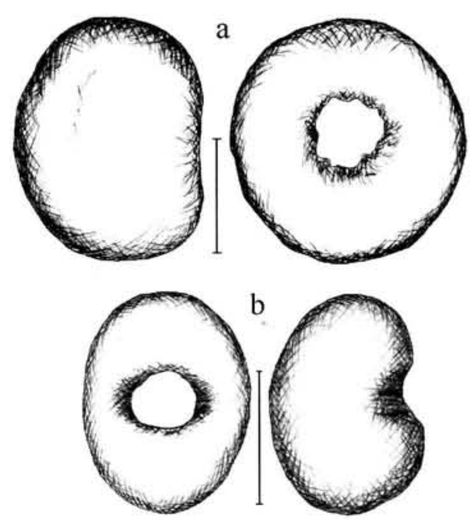


Fig. 13. **a** – *Galium aparine*, **b** – *Galium spurium* in ventral and lateral view. Scale bars equal 1 mm

Galium spurium L.

Number: 2455 fruits. Dimensions: 1.46 (1.0–2.1) × 1.22 (0.9–1.6) × 1.11 (0.9–1.4) mm.

The mericarps (Fig. 13) are elliptical when viewed dorsiventrally and reniform in lateral view. A transversaly elongate hollow lies on the ventral side. All the specimens are preserved without pericarp. Their surface is covered with a network composed of isodiametric or slightly elongate (never more than 2–3 times longer than broad) cells, always shorter than in *G. aparine* and rather irregularly distributed (Szydłowski & Wasylikowa 1973, Lange 1979).

Solanaceae

Solanum nigrum L.

Number: 1 complete seed and 1 seed fragment. Dimensions: 1.7 × 1.2 × 0.7 mm.

The seed is almost triangular in outline. The surface sculpture is composed of intersecting sinuate coarse wrinkles (Wojciechowska 1972).

Verbenaceae

Verbena officinalis L.

Number: 1 fruit. Dimensions: 1.3 × 0.5 × 0.5 mm.

The mericarp (Fig. 7) is elliptical in outline, cylindrical, with characteristic ribs on the dorsal side.

Violaceae

Viola arvensis Murr./***V. tricolor*** L.

Number: 2 seeds. Dimensions: 1.4 × 0.8 × 0.8 ; 1.4 × 0.8 × 0.8 mm.

The seeds (Fig. 7) are obovate in outline, circular in transverse section. A fine but clearly visible ridge runs along the seed side. The hilum is distinctly visible at the lower end.

Undetermined specimens

About 100 specimens could not be identified. They probably belonged to at least 9 species: 10 specimens of one morphological type (T-1) (Fig. 14), well-preserved; 2 of a second morphological type (T-2) (Fig. 14); 2 which were probably unripe spikelets of barley; 1, probably a calyx; 1 was oblong-triangular in outline, slightly compressed, probably a grass; 6 were small and spherical; 31 were trigonous or tetragonal; 25 were similar in outline to seeds of *Polygonum lapathifolium* s.l.; 25 were strongly deformed; 1 coprolite.

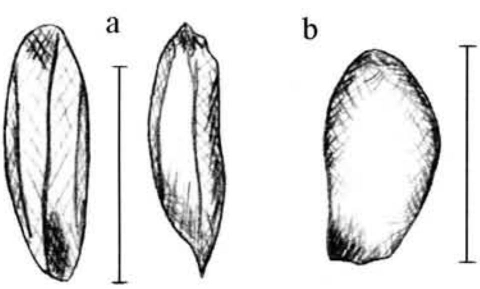


Fig. 14. **a** – unidentified specimen of T-1 morphological type in ventral (?) and lateral view; **b** – unidentified specimen of T-2 morphological type in lateral view. Scale bars equal 1 mm

Charcoals

In pit 17 ca 300 cm^3 of charcoals were found: these were analyzed by Zofia Tomczyńska, A.E.. Almost the whole material belongs to pine, probably *Pinus sylvestris*. It consisted mostly of pieces composed of one growth ring. Besides pine the following genera were represented in small quantity: *Quercus* sp. – 35 fragments (size 0.5–2.5 cm), *Alnus* sp. – 11 (size 0.5–2.0 cm), *Betula* sp. – 2 (size 0.5 cm), *Acer* sp. – 2 (size 0.3 cm), *Tilia* sp. – 1 (size 0.5 cm).

A CHARACTERIZATION OF THE PLANT REMAINS FROM PIT 17, SITE 3 AT WĄSOSZ GÓRNY

A good many remains of cultivated plants, weeds and trees were found in this pit; the ratio of the volume of herbaceous remains to trees was 5:3. Pea (*Pisum sativum*) was the most abundantly represented cultivated plant. Six-rowed hulled barley (*Hordeum vulgare*) predominated among the cereals, but spelt (*Triticum spelta*) and oat (*Avena sativa*) were also preserved in high quantity. Rye (*Secale cereale*), common millet (*Panicum miliaceum*) and flax (*Linum usitatissimum*) were scarce (Tab. 2).

The majority of wild species were classified as typical field weeds from the orders Centauretalia cyani and Polygono-Chenopodietalia (Medwecka-Kornaś et al. 1972, Matuszkiewicz 1981). Several other species which grow mainly in ruderal, grassland and forest herb layer communities could also appear in cultivated fields (Medwecka-Kornaś et al. 1972, Matuszkiewicz 1981).

On the basis of the ecological numbers of wild plants (Zarzycki 1984) an attempt at habitat characterization was undertaken. To this aim, species most probably growing in field crops were listed together (Tab. 3a). Besides typical crop weeds (Secali-Violetalia arvensis), species from the Rudero-Secalietea class which may grow in ruderal and segetal communities were also included in this group. Species of summer and winter crop associations have not been separated, because of the probable heterogeneous origin of the examined store and the strong likelihood of a significant difference in the compositions of present-day

Table 2. List of plants from pit 17 (Wąsosz Górny, site 3) arranged according to the number of specimens. Life forms according to Tymrakiewicz (1959) and Szafer et al. (1953); SA – summer annual, WA – winter annual, B – biennial, P – perennial. Volume in cm^3

Taxa	Number of specimens	Volume	Life form			
			SA	WA	B	P
I. Cereals:						
Hordeum vulgare	4 410	125				
Triticum spelta	1 776	48				
Avena sativa	1 248	24				
Secale cereale	235	5				
Panicum miliaceum	4					
SUM	7 673	202				
II. Other cultivated plants:						
Pisum sativum	5 465	225				
Linum usitatissimum	1					
SUM	5 466					
III. Weeds:						
Galium spurium	2 455	4,1	●			
Chenopodium cf. *album*	2 193	0,9	●			
Melandrium cf. *album*	1 569	0,8			●	●
Polygonum sp.	1 414	1,3				
Fallopia convolvulus	1 084	4,3	●			
Setaria viridis/ *S. verticillata*	570	0,3	●			
Digitaria ischaemum	511	0,2	●			
Trifolium arvense/ *T. dubium* type	387	0,1	●	●	●	
Caryophyllaceae indet.	367	0,2				
Rumex acetosella	197	<0,1				●
Stachys annua	184	0,3	●			
Spergula arvensis	148	<0,1	●	●		
Poaceae indet. (Gramineae)	144	0,1				
Galeopsis tetrahit type	117	0,5	●			
Neslia paniculata	86	0,3	●			
Agrostemma githago	68	0,3	●	●		
Polygonum lapathifolium s.l.	66	0,1				
Galeopsis sp.	58	0,1				
Galeopsis ladanum	57	0,1	●			
Echinochloa crus-galli	53	<0,1	●			
Plantago lanceolata	39	0,1				●
Melandrium noctiflorum	37	<0,1	●			
Bromus secalinus	24	0,2	●	●		
Lamiaceae indet. (Labiatae)	12	<0,1				
Coronilla varia	9					●
Avena fatua	8		●			
Scleranthus sp.	7					
Polygonum lapath. ssp. *lapath.*	7		●			
P. lapath. ssp. *pallidum*	7		●			
P. persicaria	7		●			
P. aviculare	6		●			
Thlaspi arvense	5		●	●		
Anagallis arvensis	4		●	●		

Table 2. Continued

Taxa	Number of specimens	Volume	Life form			
			SA	WA	B	P
Stellaria graminea	4					●
Asteraceae indet. (Compositae)	3					
Convolvulus arvensis	3					●
Polygonum minus	3		●			
Dianthus armeria	3				●	
Cichorium intybus	2					●
Knautia arvensis	2					●
Solanum nigrum	2		●			
Stellaria media	2		●	●		
Viola arvensis / V. tricolor	2		●	●		
Centaurea phrygia / C. stoebe	1				●	●
Eleocharis sp.	1					
Fragaria vesca	1					●
Galium aparine	1		●	●		
Origanum vulgare	1					●
Polycnemum arvense	1		●			
Rubus idaeus	1					●
Stachys cf. *recta*	1					●
Verbena officinalis	1					●
SUM	11 935		28	9	4	14

weed communities and those in Roman times (Jones 1992, Karg 1995). Even nowadays the differences between summer and winter crop weed communities are frequently blurred, especially in spring cultivations (Kornaś 1972). In the analysis of ecological numbers, specimens identified only to genera (*Eleocharis* sp., *Scleranthus* sp.), or as two alternative species differing in ecological requirements (*Trifolium arvense / T. dubium* type) have been omitted. Indices of soil moisture, fertility, reaction, dispersion and content of organic matter and humus were taken into account. The percentages were calculated from the number of all listed specimens for which the index was known.

In respect of moisture almost all the weeds could have originated from similar habitats. The majority of them (93%) prefer fresh soil (W3), but some of them could grow on dry (W2; 20%), and moist soil (W4; 33%) as well. *Rumex acetosella* was the only species growing solely on dry soil (Tab. 3a).

The requirements of weeds in relation to the mineral content of the soil are more diverse. Most of the species prefer rich soils (Tr4; 73%) and moderately poor (Tr3; 43%), but a few grow only on poor soils (Tr2; 13%), namely: *Digitaria ischaemum*, *Rumex acetosella* and *Polycnemum arvense.* The very frequent *Chenopodium album* occupies rich (Tr4) and very rich (Tr5) sites; three other species found in small numbers (*Stellaria media, Galium aparine, Chenopodium ficifolium*) (Tab. 3a) have similar requirements.

The weeds are also adapted to various conditions of soil reaction. 15 species (52%) were found which grow on weakly acid (R4) or neutral (R5) soils, very numerous among them were *Galium spurium* and *Fallopia convolvulus* and less abundant *Stachys annua, Galeopsis tetrahit* type, *Neslia paniculata, Agrostemma githago, Melandrium album, M. noctiflorum, Avena fatua* and *Polygonum lapathifolium.* The last two species are probably underrepresented; *A. fatua* because all the naked grains of oat were included in *A. sativa* and *Polygonum lapathifolium* because a large number of specimens were identified only to the genus due to bad preservation. Weeds preferring acid (R3) and strongly acid (R2) soils comprise 7 species (24%): *Setaria viridis / verticillata, Digitaria ischaemum, Rumex acetosella, Spergula arvensis, Echinochloa crus-galli, Bro-*

Table 3a. Ecological requirements of weeds. The numbers in parentheses indicate: (2) – found also in pit 2; (3) – found also in pit 3. W – soil moisture: 2 – dry, 3 – fresh, 4 – moist, 5 – wet; Tr – soil fertility: 2 – poor, 3 – moderately poor, 4 – fertile, 5 – very fertile; R – soil reaction: 2 – very acid (3.5< pH<4.5), 3 – acid (4.5<pH<5.5), 4 – slighty acid (5.5< pH<6.5), 5 – neutral and alkaline (pH>6.5); D – soil dispersion (mechanical composition): 1 – rocks, 2 – gravel, scree etc., 3 – sand, 4 – light and medium loamy sands and loam with high contents of rock skeleton, 5 – heavy loam; H – organic matter and humus content of soil: 2 – scarce, 3 – mineral-humic soil (Zarzycki 1984)

Species	Number of specim.	Ecological numbers																
		W			Tr				R				D				H	
		2	3	4	2	3	4	5	2	3	4	5	2	3	4	5	2	3
Galium spurium (3)	2455	●	●				●				●	●			●	●		●
Chenopodium album (2),(3)	1349		●				●	●		●	●	●			●	●		●
Fallopia convolvulus (2)	1084	●	●	●		●	●				●	●			●	●		●
Setaria viridis / verticillata	570		●			●				●				●	●		●	●
Digitaria ischaemum (3)	511		●		●				●	●			●	●			●	
Rumex acetosella (3)	197	●			●				●	●				●	●		●	
Stachys annua	184		●			●	●					●			●	●		●
Spergula arvensis (3)	148		●	●		●	●		●	●				●	●		●	
Galeopsis tetrahit type	117		●	●		●	●				●				●			●
Neslia paniculata	86		●				●					●			●	●		●
Galeopsis ladanum	57	●	●			●				●	●	●	●	●			●	
Agrostemma githago	48		●			●	●				●	●		●	●			●
Melandrium album (3)	48		●				●				●			●	●			●
Melandrium cf. *noctiflorum*	37		●				●					●			●	●		●
Echinochloa crus-galli (3)	32		●	●			●			●					●			●
Bromus secalinus	24		●			●				●				●	●			●
Avena fatua	8		●			●					●	●			●	●		●
Polygonum lapathifolium s.l. (2),(3)			●	●			●				●	●			●			●
Polygonum persicaria (2),(3)	7		●			●	●		●	●	●				●			●
Polygonum aviculare (2)	6		●			●	●				●	●			●	●	●	●
Thlaspi arvense	5		●				●				●	●			●			●
Anagallis arvensis	4		●				●			●	●	●			●			●
Polygonum minus	3		●	●			●				●				●			●
Solanum nigrum (3)	2		●				●				●				●	●		●
Viola arvensis / tricolor	2	●	●		●	●	●			●	●			●	●	●	●	●
Stellaria media	2		●	●			●	●		●	●	●			●	●		●
Polycnemum arvense (2,3)	1	●	●		●					●				●			●	
Galium aparine	1			●			●	●		●	●	●			●	●		●
Chenopodium ficifolium	1		●	●				●						●	●	●		●
Galeopsis speciosa	1		●	●		●	●				●				●			●
SUM OF SPECIES			30			30				29				30			30	
SUM OF ECOLOGICAL NUMBERS		6	28	10	4	13	22	4	4	14	19	15	2	11	27	13	8	25
PERCENTAGE (%)		20	93	33	13	43	73	13	14	48	66	52	7	37	90	43	27	83

mus secalinus and *Polycnemum arvense* (Tab. 3a). Six species have broader ecological tolerance but, despite that, separation of species into the two types of habitat is more distinct than in the case of the trophic index.

The index of soil dispersion (mechanical composition) also indicates that weeds originated from different sites. Most plants grow on light and medium loamy sands and loam with high rocky skeleton content (D4; 90%). Species growing on sands and gravels (D2, D3) were also present in the material, they were *Digitaria ischaemum* – a sand indicator (Mowszowicz 1955), *Galeopsis ladanum* and *Polycnemum arvense*. The majority of weeds represented by large numbers of seeds or fruits could even grow on heavy soils and clays (D5; 43%) (*Galium spurium, Fallopia convolvulus, Stachys annua, Chenopodium album, Neslia paniculata*) (Tab. 3a).

Regarding the organic matter and humus content of the soil, the requirements of the found plants are rather similar and indicate that most of the species grew on mineral-humus soils (H3) (Tab. 3a). *Digitaria ischaemum, Rumex acetosella, Spergula arvensis, Galeopsis ladanum* and *Polycnemum arvense* prefer soil with a small humus content.

The edaphic requirements of species which do not usually grow as field weeds (Tab. 3b) suggest that in the surroundings of the site there were patches of xerothermic grassland on dry (W2), moderately poor soils (Tr3) with a very small humus content (H2). Typical meadowland taxa occurred on mineral-humus (H3), fresh (W3) and the more fertile (Tr 4) soils. A few species of forest clearings, woodland margins and waste places suggest the presence of such communities in the area. Most of these species could have occured sporadically in fields.

This analysis in conjunction with our knowledge about present-day soils in the Wąsosz Górny neighbourhood (Fig. 2) indicates that some cultivation was carried out on at least three kinds of soil:

1) neutral to alkaline, rather fertile soils – these could have been rendzinas and loams rich in $CaCO_3$. The cultivation of those soils is indicated by *Stachys annua, Knautia arvensis, Coronilla varia, Melandrium noctiflorum, Neslia paniculata* and *Galium spurium* which frequently or exclusively grow on calcareous soils (Tymrakiewicz 1959, Mowszowicz 1975).

2) more or less acid in reaction, poor sands or slightly loamy sands without $CaCO_3$ – probably sandy podsolic soils. *Rumex acetosella* and *Spergula arvensis* are indicators of strongly acid conditions, while *Digitaria ischaemum* is a typical species of sandy soils (Tymrakiewicz 1959).

3) podsolic, more or less loamy, with various degrees of fertility. Such soils are common in the Wąsosz Górny region and their cultivation is indicated by the presence of species with a wide ecological tolerance.

Table 3b. Ecological requirements (Zarzycki 1984) of wild plants, other than typical weeds. For key see Table 3a

Syntaxa	Species	Number of specim.	Ecological numbers															
			W			Tr			R			D					H	
			2	3	4	2	3	4	3	4	5	1	2	3	4	5	2	3
Onopordetalia acanthii	*Verbena officinalis*	1		●				●							●			●
	Cichorium intybus	2	●	●			●		●	●	●			●	●	●	●	
Molinio-Arrhenatheretea	*Knautia arvensis*	2		●			●	●	●	●	●				●			●
	Plantago cf. *lanceolata* (3)	39	●	●	●		●	●		●					●			●
	Stellaria graminea	4		●				●		●					●			●
Festuco–Brometea	*Centaurea phrygia /C. stoebe*	1	●			●					●		●	●	●		●	
	Convolvulus arvensis	3	●	●			●		●	●	●				●	●	●	
	Dianthus armeria	3	●				●		●	●	●			●	●		●	
	Stachys cf. *recta*	1	●				●				●	●	●	●	●		●	
Trifolio-Geranietea sanguinei	*Coronilla varia*	9	●				●			●	●		●	●	●		●	●
	Origanum vulgare	1	●	●			●	●			●		●	●	●			●
Atropetalia	*Rubus idaeus*	1		●			●	●	●	●	●				●			●
	Fragaria vesca	1		●			●		●	●					●			●
		SUM OF SPECIES	13			13			12			13					13	
		SUM OF ECOLOGICAL NUMBERS	8	9	1	1	10	6	6	9	9	1	4	6	13	2	6	8
		PERCENTAGE (%)	62	69	8	8	77	46	50	75	75	8	31	46	100	15	46	62

On the basis of an analysis of life forms, the times of crop sowing can be estimated (Tab. 2). In pit 17 summer annual species predominated (28 species), some of them having also winter (9 species), and biennial forms (*Trifolium*). Biennial and perennial species, 14 in number, are represented in general by a small number of specimens, except for *Rumex acetosella* and *Plantago lanceolata*. The presence of the seeds and fruits of perennial plants among weeds may be the result of using a field rotation system in which fields were periodically allowed to lie fallow. The small number of propagules belonging to perennial plants could also be a consequence of the different reproduction strategy of therophytes (mainly by seeds) and perennial plants (also vegetatively by underground organs). The predominance of summer annual weeds was probably associated with the cultivation of pea and spring crops, barley and oat. Spelt and rye are winter crops and the presence of typical winter annual weeds like *Agrostemma githago* and *Bromus secalinus*, as well as a few other species, may be connected mainly with the cultivation of these two cereals.

Based on the comparison of the ecological demands of weeds from pit 17 with the requirements of present-day cultivated plants (Listowski 1951, Herse 1980) we can suppose that spring barley was sown on rendzinas; oat, probably mixed with pea (Herse 1980), on lighter, slightly acid soils; rye on light, sandy, acid soil; or rye mixed with spelt, in the ratio 1:4 (Percival 1921), on heavier soils rich in $CaCO_3$.

A QUESTION OF WHEAT IDENTIFICATION AT WĄSOSZ GÓRNY

Wheat was found in all three pits (Tab. 4). In pit 2, dated to the Late Roman Period (III-IV centuries AD), only 43 strongly damaged grains but no glume or spikelet remains were preserved. These wheat grains were identified by Orlicz (1967) only as *Triticum* sp.. Pit 3, dated to the Early Roman Period (I-II centuries AD), comprised a large number of wheat remains (Pl. 2 fig. 2) described by Orlicz as 3 species: *Triticum dicoccum* (= *T. dicoccon*), *T. spelta* and *T. vulgare* (= *T. aestivum*). After a re-examination of that material, in which close attention was paid to the morphology of the glumes and spikelets, the present author determined all the glume and spikelet remains as belonging to *Triticum spelta* (Fig. 6). The small spikelets identified by Orlicz (1967) as *T. dicoccum* also belonged to *T. spelta* because they showed the diagnostic glume nervation and secondary keel character of spelt glumes (see description of plant remains). The small size of the spikelets (Fig. 15) could have been caused by their having come from the upper part of an ear or cereal growing on poor soils (Fig. 2).

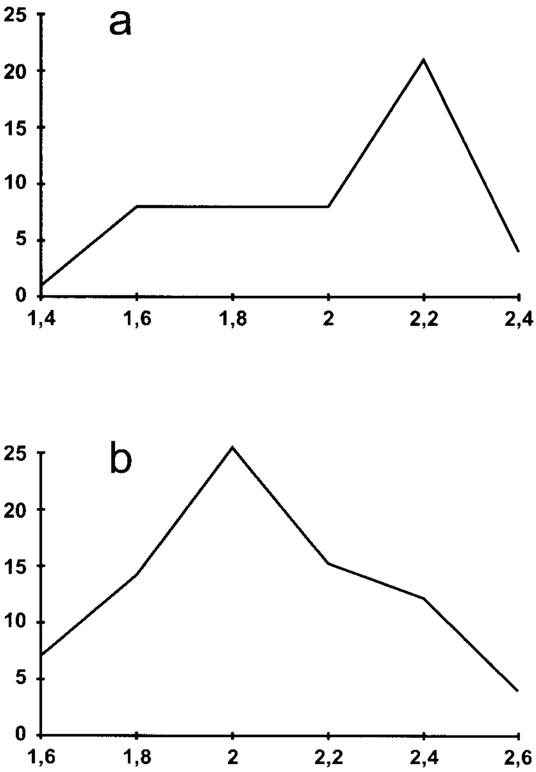


Fig. 15. *Triticum spelta*, breadth of spikelet base (A measurement), Wąsosz Górny, **a** – pit 3, N=48; **b** – pit 17, N=77

The grains of spelt and emmer were separated by Orlicz on the basis of their size and shape, but these features are notoriously variable even within one species. Charring had a tendency to change the shape of the grains, making them shorter but thicker and broader. In the present study all wheat grains from pit 3 were mixed together and 50 grains were taken at random for new measurements. The results were very similar to those from pit 17 (Fig. 16). They differed only slightly in length and consequently in length to breadth ratio (L/B); the grains from pit 3 were slightly shorter and broader than those in pit 17. The difference might be the effect of charring under various conditions or of the grain originating from different populations separated in time

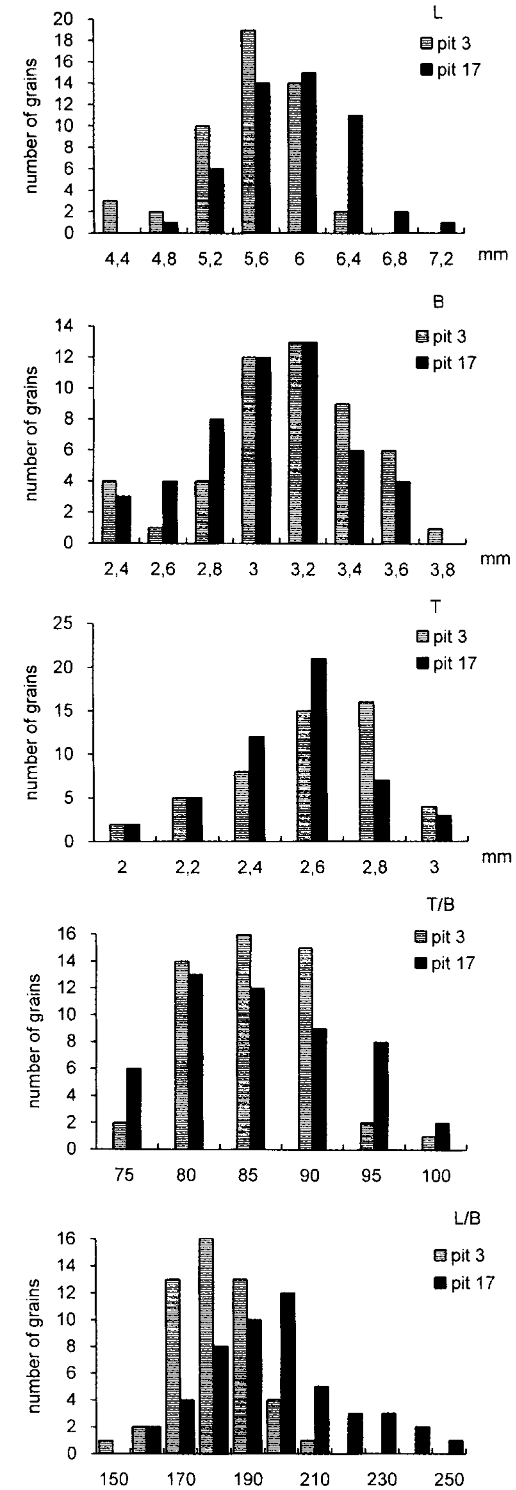


Fig. 16. Comparison of size and shape of grains of *Triticum spelta* from pits 3 and 17; L – length, B – breadth, T – thickness

or space. The one-peak curves (Fig. 15) obtained for both series give no grounds for distinguishing three species. On the basis of the presence in pits 3 and 17 of spelt spikelets only, it can be assumed that all the grains probably also belong to this species.

SETARIA PUMILA OR *ECHINOCHLOA CRUS-GALLI* IN PIT 3 FROM THE EARLY ROMAN PERIOD

Caryopses described by Orlicz (1967) as *Setaria glauca* (= *S. pumila*) and *Setaria* sp. vel *Echinochloa* sp. were examined again and their identification reassessed. All 94 specimens identified earlier as *Setaria* sp. vel *Echinochloa* sp. were now classified as *Echinochloa crus-galli*, whereas the grains which had been included in *S. pumila*, were now assigned to *Panicum miliaceum* (8 specimens), *E. crus-galli* (29 specimens) and to an unknown grass (11 specimens) (Tab. 4). Identification was based mainly on the outline and size of the embryo and the frequently preserved hilum (Wasylikowa 1978). Also the remains of glumes, lemmas and paleas were crucial for identification. All preserved fragments of lemma and palea had the typical smooth surface of *E. crus-galli* with its distinct longitudinal broad bands of cells, whereas *S. pumila* has both its lemma and palea covered with small papillae arranged in transverse wavy lines.

COMPARISON OF THE CONTENTS OF PITS 3, 2 AND 17

The studied pits clearly differed in the composition of cultivated plants contained in them (Tab. 4, Fig. 17). Pit 3 (ERP) contained a store of three cereals: common millet (*Panicum miliaceum*) which predominated, then rye (*Secale cereale*) and in least quantity spelt (*Triticum spelta*). All the cereals were represented by a rather large number of grains which may indicate that they were cultivated separately, and the storage pit contained the harvest from three fields. The quantitavive predominance of common millet over rye may be insignificant, because common millet grains are considerably smaller than those of rye and the pit contains similar volumes of both cereals. The contents of pit 2 (LRP) were clearly dominated by rye (*Secale cereale*), suggesting that it was the harvest from one field. Common millet (*Panicum miliaceum*) and an undetermined wheat (*Triticum* sp.) were admixtures that were either growing in the field or represented remnants of former harvests retained in this pit. Pit 17 (LRP) had the most heterogenous composition of cultivated plants. Pea (*Pisum sati-*

Table 4. List of plants found in site 3 at Wąsosz Górny; ERP – Early Roman Period, LRP – Late Roman Period. Plant composition in pits 3 and 2 after A. Orlicz (1967) – O., for pit 3 also veryfied. Geographical-historical classification after Zając (1983, 1986, 1987, 1988); Trzcińska-Tacik & Wasylikowa (1982) Ar – archaeophyte, ap – apophyte

Name of species	Pit 3 ERP verified	Pit 3 ERP O.	Pit 2 LRP O.	Pit 17 LRP	Geographic historical clasification
I. Cereals:					
Avena sativa				1 248	
Hordeum vulgare				4 410	
Panicum miliaceum	10 390	10 382	57	4	
Secale cereale	5 394	5 394	7 051	235	
Triticum dicoccon		333			
Triticum spelta	1 588	98		1 776	
Triticum vulgare		87			
Triticum sp.		1070	43		
II. Other cultivated plants:					
Pisum sativum			9	5 465	
Linum usitatissimum	1	1		1	
SUM	17373	17 365	7160	13 139	
III. Weeds:					
Agrostemma githago				68	Ar
Anagalis arvensis				4	Ar
Asteraceae indet.				3	
Avena fatua				8	Ar
Bromus secalinus				24	Ar
Caryophyllaceae indet.				367	
Centaurea phrygia / C. stoebe				1	ap
Chenopodium album	22	22	4	844	ap
Ch. cf. *album*	5	5		1 349	
Ch. ficifolium				1	Ar
Cichorium intybus				2	Ar
Convolvulus arvensis				3	ap/Ar
Coronilla varia				9	ap
Dianthus armeria				3	
Digitaria ischaemum	1	1		511	ap
Echinochloa crus-galli	264	141		53	Ar
Eleocharis sp.				1	
Fallopia convolvulus			1	1 084	Ar
Fragaria vesca				1	
Galeopsis ladanum				57	Ar
Galeopsis sp.				58	
G. speciosa				1	
Galium aparine				1	ap
G. spurium	1	1		2 455	Ar
G. tetrahit type				117	ap
Knautia arvensis				2	ap
Lamiaceae indet.				12	
Malva sp.			1	5	
Melandrium album	2	2		48	ap
M. noctiflorum				37	Ar
Melandrium sp.				1 521	
Neslia paniculata				86	Ar
Origanum vulgare				1	ap
Plantago cf. *lanceolata*	2	2		39	ap

Table 4. Continued

Name of species	Pit 3 ERP verified	Pit 3 ERP O.	Pit 2 LRP O.	Pit 17 LRP	Geographic historical clasification
Poaceae indet.	13	2		144	
Polycnemum arvense	1	1	4	1	ap
Polygonum aviculare			1	6	ap
P. lapathifolium s.l.				66	ap
P. lapathifolium ssp. *lapathifolium*	3	3	1	7	ap
P. lapathifolium ssp. *pallidum*				7	ap
P. minus				3	ap
P. persicaria	2	2	3	7	ap
Polygonum sp.	1	1		1 414	
Rubus idaeus				1	
Rumex acetosella	1	1		197	ap
Scleranthus sp.				7	Ar
Setaria pumila (=S. glauca)		48			
Setaria sp. vel *Echinochloa* sp.		94			
S. viridis / S. verticillata				570	Ar
Solanum nigrum	1	1		2	Ar
Spergula arvensis	2	2		148	Ar
Stachys annua				184	Ar
Stachys cf. *recta*				1	
Stellaria graminea				4	ap
S. media				2	ap
Thlaspi arvense				5	Ar
Trifolium arvense / T. dubium type				387	ap/?
Verbena officinalis				1	Ar
Viola arvensis / V. tricolor				2	Ar/ap

vum) was the most numerous of all, with six-rowed hulled barley (*Hordeum vulgare*) slightly less abundant; oat (*Avena sativa*) and spelt (*Triticum spelta*) were also relatively numerous; rye (*Secale cereale*) grains were fewest of all. These were probably crops from a number of different fields, but some of them could also have been sown intentionally as mixtures; spelt with rye (4:1) (Percival 1921) and pea with oat (Herse 1980).

The almost complete absence of common millet in storage pits of the Late Roman Period is interesting. Two possible explanations should be considered. Common millet grows well on a humus rich soil, not weed infested. It gives good yields when cultivated on new soils (Listowski 1951, Kozłowska 1972, Herse 1980). The cultivation of common millet might have been given up by people living at the site due to soil impoverishment and an increase in the weed population caused by prolonged tillage in the area of the relatively old settlement at Wąsosz Górny. However, the lack of common millet could have been caused by chance, it just happened that the pits were used for storing other crops. The appearance of a great number of pea seeds, together with a considerable number of oat grains in pit 17 is remarkable. At present, peas cultivated for seed are often sown mixed with oat to prevent the lodging of pea and the excessive growth of weeds. The soil preparation for oat and pea is similar and oat provides support for pea (Herse 1980). Oat was a common cereal in the Roman Period but up to now more than 200 specimens have never been found on one site. The greatest numbers have been found in the Late Roman sites at Lubieszewo, site 2 (Dębczyno group) with 200 charred specimens; at Jakuszowice, site 2 (Przeworsk group) 122 charred specimens; and at Lesko, site 1 (Przeworsk group) 111 charred specimens. At these sites the number of pea seeds was 0 (Lubieszewo), 3 (Jakuszowice) and 2 (Lesko), respectively (Lityńska-Zając 1997). The occurrence of a large number of pea and oat specimens in pit 17 at Wąsosz Górny may point to mixed cultivation of these two species. In the other two pits from site 3 at

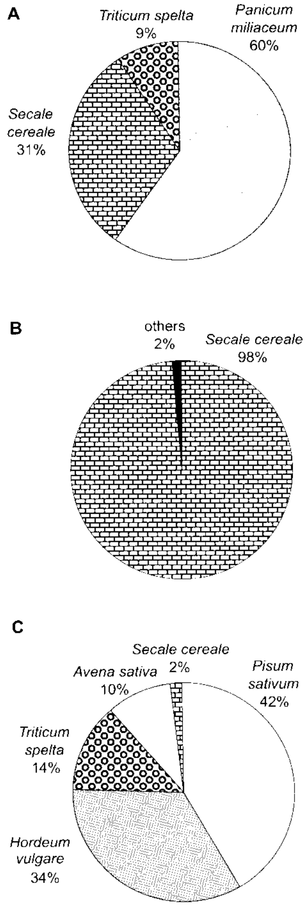


Fig. 17. Comparison of the composition of the cultivated plants in pits 3 (A), 2 (B) and 17 (C). Percentages were calculated from the sum of the crops in each pit

Wąsosz Górny oat was not preserved, while pea was found in pit 2 only in a very small number. Two flax seeds in pits 3 and 17 provide evidence of the cultivation of this plant.

The three pits, despite the use of uniform methods in their examination, were clearly distinct in the number of weeds they contained (Tab. 5). In pit 17 weed propagules made up almost half of all the specimens present, in the other two they formed only a small part (Fig. 18). The degree of contamination expressed by the proportion of the number of wild plant propagules to those of cultivated plants reaches 0.908 for pit 17, considerably higher than for the other two pits (Tab. 5). In pits 2 and 3 it seems likely that pure crops, ready for consumption or for sowing, were stored, while the large number of weeds in pit 17 could indicate that the material had not been cleaned at all. The presence of numerous *Echinochloa crus-galli* grains in pit 3 could be connected with common millet cultivation. Similar to millet in size and shape, *E. crus-galli* grains are edible and probably were not removed from the crop.

The degree of contamination in pit 17 was very high, not only in comparison with pits 2 and 3 but also when compared with data from other sites and periods. For materials from Roman sites, the ratio did not exceed 0.05 at Wyszembork (pit 66) and at Pruszcz Gdański the crop was almost pure, the degree of contamination being only 0.0002 (Lityńska-Zając 1997). The index for crops coming from the Castle Hill at Przemyśl, dated to XI-XII centuries AD, reached 0.04 for wheat and 0.03 for rye (Wieserowa 1967, Wasylikowa 1983). The samples of extant rye (*Secale cereale*) and bread wheat (*Triticum aestivum*) from Lubomia near Wodzisław Śląski, harvested in 1971, were also slightly infested with weeds. The degree of contamination of the rye sample, calculated with the exclusion of infesting cereals, reached 0.13 and rose only to 0.16 when they were included. In the wheat sample this ratio was 0.07 in both cases (Szydłowski & Wasylikowa 1973). The small number of weeds in pits 3 and 2 made habitat analysis based on ecological numbers difficult (Tab. 3). In the Early Roman Period (pit3) it is probable that soils similar to those in the Late Roman Period (pit 17) were under cultivation. Only the cultivation of rendzinas is uncertain because no characteristic rendzina species such as *Stachys annua, Melandrium noctiflorum* and *Neslia paniculata* have been found in pit 3. However, the use of poor sandy soil seems unquestionable, for it is indicated by the presence of *Digitaria ischaemum, Polycnemum arvense* and *Rumex acetosella* in pit 3.

Table 5. Degree of crop contamination from site 3 at Wąsosz Górny

	Total of cultivated plants	Total of weeds	Degree of contamination
Pit 3 (Early Roman Period)	17 365	330	0,019
Pit 2 (Late Roman Period)	7 160	15	0,002
Pit 17 (Late Roman Period)	13 139	11 935	0,908

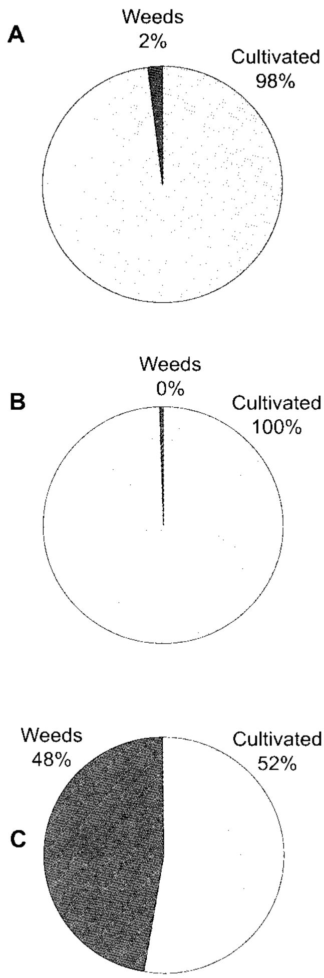


Fig. 18. The ratio of wild to cultivated plants in pits 3 (A), 2 (B), and 17 (C) at Wąsosz Górny, site 3

As far as the geographical-historical classification of the synanthropic flora from site 3 is concerned (Tab. 4) it included almost equal numbers of apophytes, indigenous to the Polish flora, and archaeophytes that came to Poland before the 15th century AD (Trzcińska-Tacik & Wasylikowa 1982, Zając 1983, 1986, 1987, 1988). The archaeophytes, according to their origin, belonged to the following groups of species: Mediterranean (7), south-east Asian (3), Irano-Turanian (3), Ponto-Pannonian (2), archaeophyta anthropogena (3) and of unknown origin (3). The appearance of *Chenopodium ficifolium* in pit 17 is very interesting because this archaeophyte had not previously been found in materials from the Roman Period (Lityńska-Zając 1997), although it has been recorded from the Hallstatt period (Trzcińska-Tacik & Wasylikowa 1982). Apart from *Chenopodium ficifolium* 47 archaeophytes have been found in Polish materials from the Roman Period (Lityńska-Zając 1997).

POSSIBLE EXPLOITATION OF WILD PLANTS

The gathering of wild plants to complement the human diet is still practised nowadays. Archaeological and ethnographic data collected up to the present (Twarowska 1983) have shown that procuring food in this way dates back to the dawn of prehistory. Different plant organs have been gathered, including fruits and seeds, green parts, rhizomes, tubers etc. Plants could have been gathered regularly or only occasionally during periods of famine. A number of edible wild plants, which could have been used by man, have been found at Wąsosz Górny. To the plants having edible fruits or seeds belong *Avena fatua*, *Bromus secalinus*, *Echinochloa crus-galli*, *Setaria viridis*, *Chenopodium album*, *Fallopia convolvulus*, *Polygonum lapathifolium*, *Polygonum persicaria*, *Polygonum aviculare* and *Thlaspi arvense*. Their seeds and fruits might enter the crops as weeds but because of their useful properties they were not deliberately removed. Among the plants having edible green parts, usually consumed during the pre-harvest time or stored in dried form or as silage, propagules of *Convolvulus arvensis*, *Galeopsis tetrahit*, *Galium aparine*, *Galium spurium*, *Plantago lanceolata*, *Stellaria media* and *Rumex acetosella* were found. Among the wild species identified occurred plants which had medicinal uses, including *Agrostemma githago*, *Galeopsis tetrahit*, *Galium aparine*, *Plantago lanceolata*, *Polygonum aviculare*, *Rumex acetosella*, *Fragaria vesca*, *Rubus idaeus* and *Solanum nigrum*. Smelling like garlic, *Thlaspi arvense* seeds might have been gathered as spice.

The presence of these plants is not unequivocal evidence of their use because most of them are common weeds and they could have entered the pit accidentally. The large accumulation of *Chenopodium album* seeds and *Fallopia convolvulus* fruits does suggest gathering. However, one cannot be certain, because of the presence of a large number of *Galium spurium* fruits, whose shoots were gathered only at times of scarcity in spring (Twarowska 1983) before the fruits matured.

The exploitation of forest resources is indicated by the presence of charcoals in pits 17 and 3. Pit 17 contained scots pine *Pinus sylvestris*, oak *Quercus* sp., birch *Betula* sp., lime *Tilia* sp., maple *Acer* sp. and alder *Alnus* sp..

Charcoals from pit 3 had been partly studied by Orlicz (1967) who identified 667 pieces of *Pinus sylvestris*; later the remaining material was investigated by Z. Tomczyńska, AE who, besides the abundant pine, found 10 pieces of oak (*Quercus* sp.). The preserved charcoals could indicate use of wood obtained mainly from oak-pine forest and groves. The number of specimens points to a predominant use of pine and oak wood. In forest clearings and on their margins, raspberries (*Rubus idaeus*) and wild strawberries (*Fragaria vesca*) could have been picked.

CONCLUSIONS

In the three pits from site 3 at Wąsosz Górny there are noticeable differences in the composition of cultivated plants. Pit 3 (ERP) is distinguished by a large amount of common millet (*Panicum miliaceum*), sporadically represented in Late Roman pits. Pit 2 (LRP) contains an almost pure harvest of rye (*Secale cereale*). Pit 17 (LRP), decidedly the richest, differs from the other two in the abundance of garden pea (*Pisum sativum*), oat (*Avena sativa*) and six-rowed hulled barley (*Hordeum vulgare*), the almost total lack of common millet (*Panicum miliaceum*) and the noticeably smaller amount of rye (*Secale cereale*). In all the pits wheat was preserved, in two cases identified as spelt (*Triticum spelta*) (pit 17 and pit 3, redetermined) and in one only as *Triticum* sp. (pit 2). Traces of flax cultivation (*Linum usitatissimum*) are evident from the occurrence of 2 seeds in pits 3 and 17.

The great number of weed species found in pit 17 gives an insight into the agricultural practices which may have been employed at the time. The presence of perennial plants would indicate the use of a field rotation system with fallows; unploughed fields were probably used for grazing as is indicated by the presence of *Plantago lanceolata* seeds. The predominance of summer annual plants points to the prevailing use of spring sowing (pea, barley, millet, oat); however, the presence of typical winter annual weeds (*Agrostemma githago, Bromus secalinus*) could point to winter cultivation of spelt and rye. Nowadays spelt is an exclusively winter crop (Listowski 1951).

The analysis of edaphic indices showed some use of rendzinas, loamy soils rich in $CaCO_3$, and more general cultivation of sandy podsolic soils and heavier loams with various degrees of fertility. The crops from pit 17 no doubt originated from several fields. Spring barley was probably cultivated on rendzinas, since at present soils of this kind are preferred for it (Herse 1980). Pea and oat, probably sown as a mixture, do not require very good soil, so they could have been cultivated on the light, more acid soils (sandy podsolic soils). Rye also could grow on poor soil, or as a mixture with spelt on fertile, loamy almost neutral soil. Pit 3 (ERP) is similar to pit 17 in its composition of wild species. Although the weeds are not numerous, they show a range of ecological requirements which suggests that the stored crops had been grown in a number of different fields, as in the case of pit 17. The analysis of ecological numbers indicates that in the Early Roman Period the kinds of soil used for cultivation were similar to those of the Late Roman Period. However, the use of rendzinas in the Early Roman Period is unconfirmed.

The large numbers of species of cultivated and wild plants preserved in pit 17 suggests that they were repeatedly introduced into it. The abundance of weed propagules makes it unlikely that the contents of this store were designated for sowing or consumption. This is consistent with the hypothesis of K. Godłowski (oral information) that the pit had a ritual significance. Its use as a rubbish heap can be excluded by the abundance of cultivated seeds and grains. Pits 2 and 3 were probably stores in which cereal grains for consumption or sowing were kept, as it is indicated by the low degree of contamination. The abundance of wild plants could point to the gathering of some of them, but the material provides no evidence for that. The presence of an enormous number of wild plants which are known to be sometimes exploited by man, but at the same time are common weeds, could just be the result of ineffective crop cleaning.

Against the background of data relating to the Przeworsk group of the Roman Period in Poland (Lityńska-Zając 1997), the composition of the plant remains found at site 3 at Wąsosz Górny is not surprising. *Avena sativa* has been found in 14 sites (25% of all sites of the Przeworsk group with preserved cultivated plants), *Hordeum vulgare* in 19 (33%), *Linum usitatissimum* in 5 (9%) *Panicum miliaceum* in 20 (35%), *Pisum sativum* in 12 (21%), *Secale cer-*

eale in 19 (33%), and *Triticum spelta* in 7 sites (12%). However, the number of specimens accumulated is unusual. Oat (*Avena sativa* and *Avena* sp.) had never exceeded 200 specimens before (Lubieszewo site 2, Dębczyno group), while in pit 17 at Wąsosz Górny there were over 1200 oat grains. Pea (*Pisum sativum*) had not been found in numbers larger than 363 seeds (Osinki, West Baltic group) while in pit 17 at Wąsosz Górny there were over 4000 pea seeds.

Pit 17 contained a great number of weeds and other wild plants, among them species not previously recorded from the Roman time in Poland (Lityńska-Zając 1997): *Centaurea phrygia*/*C. stoebe*, *Chenopodium ficifolium*, *Dianthus armeria*, *Fragaria vesca*, *Trifolium arvense*/*T. dubium* and *Verbena officinalis*.

The preserved charcoal remains indicate the exploitation primarily of pine and oak, and to a lesser degree other deciduous trees like birch, lime, maple and alder.

ACKNOWLEDGEMENTS

I would like to thank Professor Krystyna Wasylikowa for help with identification of the material and preparation of this text. I also wish to thank Zofia Tomczyńska, A.E. for identification of charcoals from pits 3 and 17. I am very grateful to Dr. Maria Lityńska-Zając for making available to me her unpublished data and for discussions. I owe much to the Late Professor Kazimierz Godłowski, who has rendered accessible his field notes and shown great interest in my botanical work. I also should be grateful to Professor Kazimierz Latowski for sending me reference material of some species from the genus *Dianthus* L..

REFERENCES

AKEROYD J.R. 1993. *Rumex* L. In: Tutin T.G., Burges N.A., Chater A.O., Edmondson J.R., Heywood V.H., Moore D.M., Valentine D.H., Walters S.M. & Webb D.A. (eds). Flora Europaea, 1: 99–107, Cambridge University Press.

GEDL M., GINTER B. & GODŁOWSKI K. 1971. Pradzieje i wczesne średniowiecze dorzecza Liswarty. 2. Śląski Instytut Naukowy, Katowice (in Polish).

GODŁOWSKI K. 1963. (unpubl.) Notatki terenowe (Terrain notes). Institute of Archaeology, Jagiellonian University, Cracow.

HEREŹNIAK J. 1993. Stosunki geobotaniczno-leśne Północnej części Wyżyny Śląsko-Krakowskiej na tle zróżnicowania i przemian środowiska. (The variability and changes of forest vegetation in the northern part of the Silesia-Cracow Uplands.) Monographiae Botanicae, 75: 5–368 (in Polish).

HERSE J. (ed.) 1980. Szczegółowa uprawa roślin. PWN, Warszawa (in Polish).

JACOMET S. 1987. Prähistorische Getreidefunde. Eine Anleitung zur Bestimmung prähistorischer Gersten- und Weizen- Funde. Botanisches Institut der Universität, Abteilung Pflanzensystematik und Geobotanik, Basel.

JONES G. 1992. Weed phytosociology and crop husbandry: identyfying a contrast between ancient and modern practice. Review of Palaeobotany and Palynology, 73: 133–143.

KARG S. 1995. Plant diversity in late medieval cornfields of northern Switzerland. Vegetation History and Archaeobotany, 4: 41–50.

KNÖRZER K.-H. 1970. Römerzeitliche Pflanzenfunde aus Neuss. Novaesium IV, Limesforschungen 10. Verlag Gebr. Mann, Berlin.

KNÖRZER K.-H. 1981. Römerzeitliche Pflanzenfunde aus Xanten. Archaeo-Physika, 11. Rheinland-Verlag GmbH, Köln.

KORNAŚ J. 1972. Zespoły synantropijne. In: Szafer W. & Zarzycki K. (eds). Szata roślinna Polski. 1. PWN, Warszawa (in Polish).

KOWAL T. 1953. Klucz do oznaczania nasion rodzajów *Chenopodium* L. i *Atriplex* L. (summary: A key for determination of the genera *Chenopodium* L. and *Atriplex* L.). Monographiae Botanicae, 1: 87–163.

KOWAL T. & WOJTERSKA H. 1966. Studia systematyczne nad nasionami *Dianthus* L. (summary: Systematic studies on the seeds of the genus *Dianthus* L.). Monographiae Botanicae, 21: 271–297.

KOZŁOWSKA 1972. Rola roślin uprawnych w historycznym rozwoju kultury materialnej Polski. In: Szafer W. & Zarzycki K. (eds). Szata roślinna Polski. PWN, Warszawa (in Polish).

KULPA W. 1974. Owoce i nasiona chwastów. PWN, Warszawa (in Polish).

LANGE E. 1979. Verkohlte Pflanzenreste aus den slawischen Siedlungsplätzen Brandenburg und Zirzow (Kr. Neubrandenburg) In: Körber-Grohne U. (ed.). Archaeo-Physika. 8: 191–215. Festschrift Maria Hopf., Köln.

LISTOWSKI A. (ed.) 1951. Szczegółowa uprawa roślin. PWRiL, Warszawa (in Polish).

LITYŃSKA-ZAJĄC M. 1997. Roślinność i gospodarka rolna w okresie rzymskim. Studium Archeobotaniczne (summary: Vegetation and agriculture in the Roman Iron Age. An archaeobotanical study). Institute of Archaeology and Ethnology, Polish Academy of Sciences, Kraków.

MATUSZKIEWICZ W. 1981. Przewodnik do oznaczania zbiorowisk roślinnych Polski. PWN, Warszawa (in Polish).

MAREK S. 1954. Cechy morfologiczne i anatomiczne owoców rodzajów *Polygonum* L. i *Rumex* L. oraz klucze do ich oznaczania (summary: Morphological and anathomical features of the fruits of genera *Polygonum* L., *Rumex* L. and keys for their determination). Monographiae Botanicae, 2: 77–161.

MIREK Z., PIĘKOŚ-MIRKOWA H., ZAJĄC A. & ZAJĄC M. 1995. Vascular plants of Poland, a checklist. Polish Botanical Studies. Guidebook Series, 15.

MEDWECKA-KORNAŚ A., KORNAŚ J., PAWŁOWSKI B. & ZARZYCKI K. 1972. Przegląd ważniejszych zespołów roślinnych Polski. In: Szafer W. & Zarzycki K. (eds). Szata roślinna Polski. PWN Warszawa (in Polish).

MOWSZOWICZ J. (1955) 1975. Krajowe chwasty polne i ogrodowe. PWRiL, Warszawa (in Polish).

NESBITT M. & SAMUEL D. 1996. From staple crop to extinction? The archaeology and history of the hulled wheats. In: Padulosi S., Hammer K. & Heller J. (eds). Hulled wheats. Proceedings of the First International Workshop on Hulled Wheats, 21–22 July 1995, Castelvecchio Pascoli, Tuscany, Italy: 41–100. International Plant Genetic Resources Institute, Roma.

ORLICZ A. 1967. Szczątki roślinne z okresu rzymskiego z wykopalisk archeologicznych w Wąsoszu Górnym koło Kłobucka (summary: Plant remains of Roman Age from the archaeological excavation at Wąsosz Górny near Kłobuck). Folia Quaternaria, 27: 1–9.

PERCIVAL J. 1921. The wheat plant. Duckworth and Co., London.

RALSKA-JASIEWICZOWA M. 1977. Impact of prehistoric man on natural vegetation recorded in pollen diagrams from different regions of Poland. Folia Quaternaria, 49: 77–92.

RECHINGER K.H. 1964. *Rumex* L.: 82–89. In: Tutin T.G., Heywood V.H., Burges N.A., Valentine D.H., Walters S.M. & Webb D.A. (eds.). Flora Europaea, 1, Cambridge University Press.

RENFREW J.M. 1973. Palaeoethnobotany. The prehistoric food plants of the Near East and Europe. Methuen & Co Ltd, London.

RYMKIEWICZ A. 1979. Badania nad gatunkami rodzaju *Plantago* L. z uwzględnieniem karpologii i chemotaksonomii (summary: Studies on the species of the genus *Plantago* L. with the reference to carpology and chemotaxonomy). Monographiae Botanicae, 57: 71–103.

SWARBRICK J.T. & RAYMOND J.C. 1970. The identification of the seeds and achenes of the British Plantaginaceae. Annals of Botany, New Series, 34: 1123–1129.

SZAFER W., KULCZYŃSKI S. & PAWŁOWSKI B. 1953. Rośliny polskie. PWN, Warszawa (in Polish).

SZYDŁOWSKI J. & WASYLIKOWA K. 1973. Cereals from the early medieval fortified settlement in Lubomia, Wodzisław Śląski district, southern Poland. Folia Quaternaria, 42: 38–93.

TACIK T. 1992. *Rumex* L.. In: Jasiewicz A. (ed.). Flora Polski. Rośliny naczyniowe. 3: 90–117. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków (in Polish).

TOMCZYŃSKA Z. & WASYLIKOWA K. 1988. Plant material from a Hallstatt settlement at Kamieniec near Toruń, northern Poland (A reinvestigation): 281–287. In: Küster H.J. (ed.) Der Prähistorische Mensch und seine Umwelt. Konrad Theiss Verlag, Stuttgart.

TRZCIŃSKA-TACIK H. & WASYLIKOWA K. 1982. History of the synanthropic changes of the flora and vegetation of Poland. Memorabilia Zoologica, 37: 47–69.

TWAROWSKA E. 1983. Zdobywanie pożywienia (Zbieractwo wczesnośredniowieczne w Polsce): 218–232. In: Kozłowski K.J., Kozłowski K.S. (eds). Człowiek i środowisko w pradziejach. PWN, Warszawa (in Polish).

TYMRAKIEWICZ W. 1959. Atlas chwastów. PWRiL, Warszawa (in Polish).

WASYLIKOWA K. 1978. Plant Remains from Early and Late Medieval times found on the Wawel Hill in Cracow. Acta Palaeobotanica, 19(2): 115–200.

WASYLIKOWA K. 1983. Antropogeniczne zmiany roślinności w holocenie. In: Kozłowski K.J., Kozłowski K.S. (eds). Człowiek i środowisko w pradziejach: 53–72, PWN, Warszawa (in Polish).

WIESEROWA A. 1967. Wczesnośredniowieczne szczątki zbóż i chwastów z Przemyśla (summary: Early Medieval remains of cereals and weeds from Przemyśl, SE Poland). Folia Quaternaria, 28: 1–16.

WIESEROWA A. 1979. Plant remains from the Early and Late Middle Ages found in the settlement layers of the Main Market Square in Cracow. Acta Palaeobotanica, 20(2): 137–212.

WOJCIECHOWSKA B. 1972. Studia systematyczne nad nasionami rodz. Solanaceae Pers. (summary: Systematic studies on the seeds of the Solanaceae Pers. family). Monographiae Botanicae, 29: 113–126.

ZAJAC A. 1983. Studies on the origin of archaeophytes in Poland. Part I. Methodical considerations. Zeszyty Naukowe UJ 670, Prace Botaniczne, 11: 87–107.

ZAJĄC A. 1986. Studies on the origin of archaeophytes in Poland. Part II. Taxa of Mediterranean and Atlantic-Mediterranean origin. Zeszyty Naukowe UJ 790, Prace Botaniczne, 14: 7–50.

ZAJĄC A. 1987. Studies on the origin of archaeophytes in Poland. Part III. Taxa of Irano-Turanian origin. Zeszyty Naukowe UJ 834, Prace Botaniczne, 15: 93–129.

ZAJĄC A. 1988. Studies on the origin of archaeophytes in Poland. Part IV. Taxa of Pontic-Pannonian, Mediterraneo-South Asiatic, South Asiatic and Middle European origin. Archaeophyta anthropogena. Arhaeophyta resistentia. Archaeophytes of unknown origin. Zeszyty Naukowe UJ 872, Prace Botaniczne, 17: 23–51.

ZARZYCKI K. 1984. Ekologiczne liczby wskaźnikowe roślin naczyniowych Polski (Indicator values of vascular plants in Poland). W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

PLATES

Plate 1

1. Grains of *Triticum spelta* (pit 17)
2. Grains of *Triticum spelta* (pit 3)
3. Grains of *Avena* sp. (pit 17)
4. Grains of *Hordeum vulgare* (pit 17)
5. Grains of *Secale cereale* (pit 17)
6. Seeds of *Pisum sativum* (pit 17)

Scale bar equals 1 cm

Fot. A. Pachoński

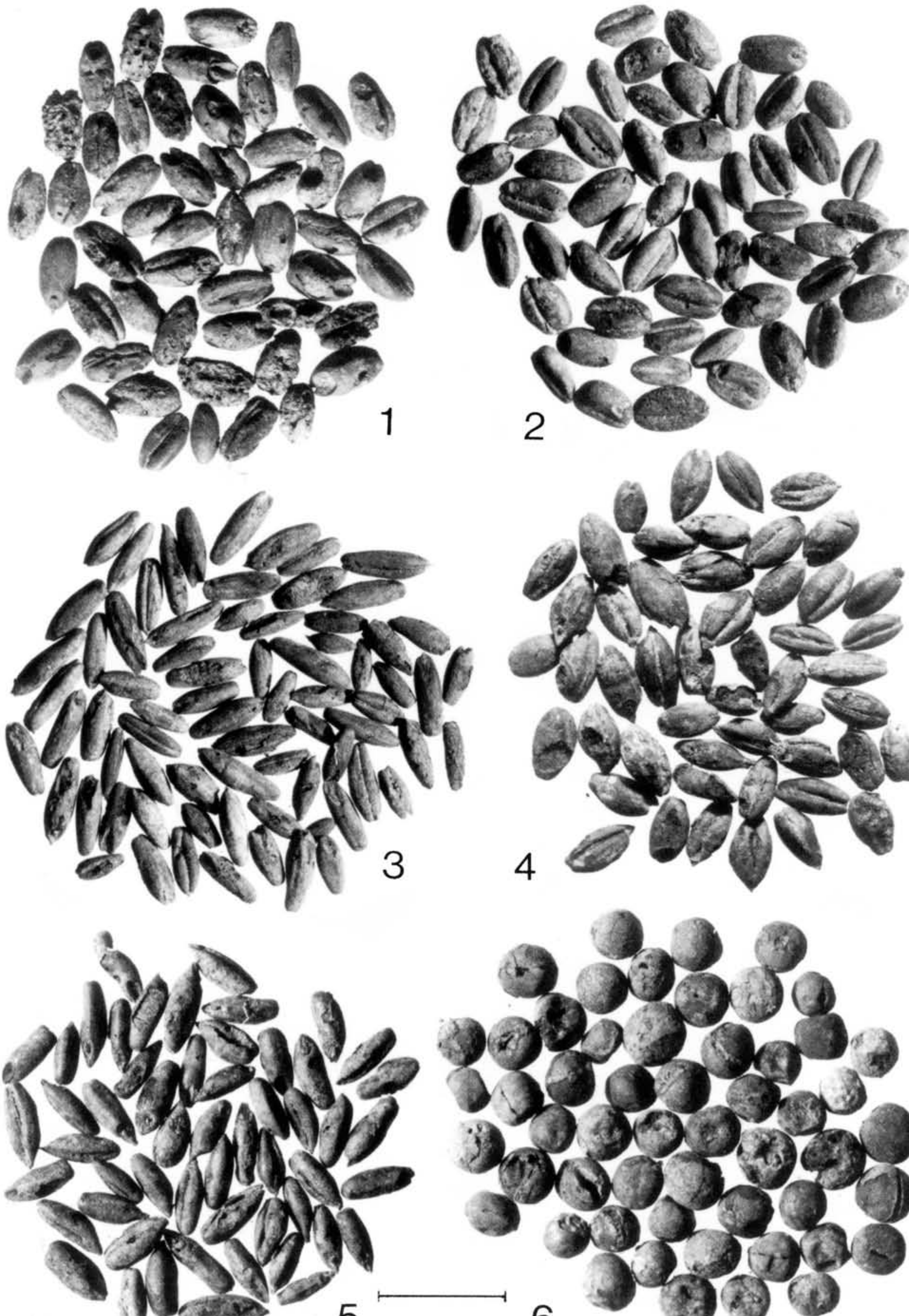
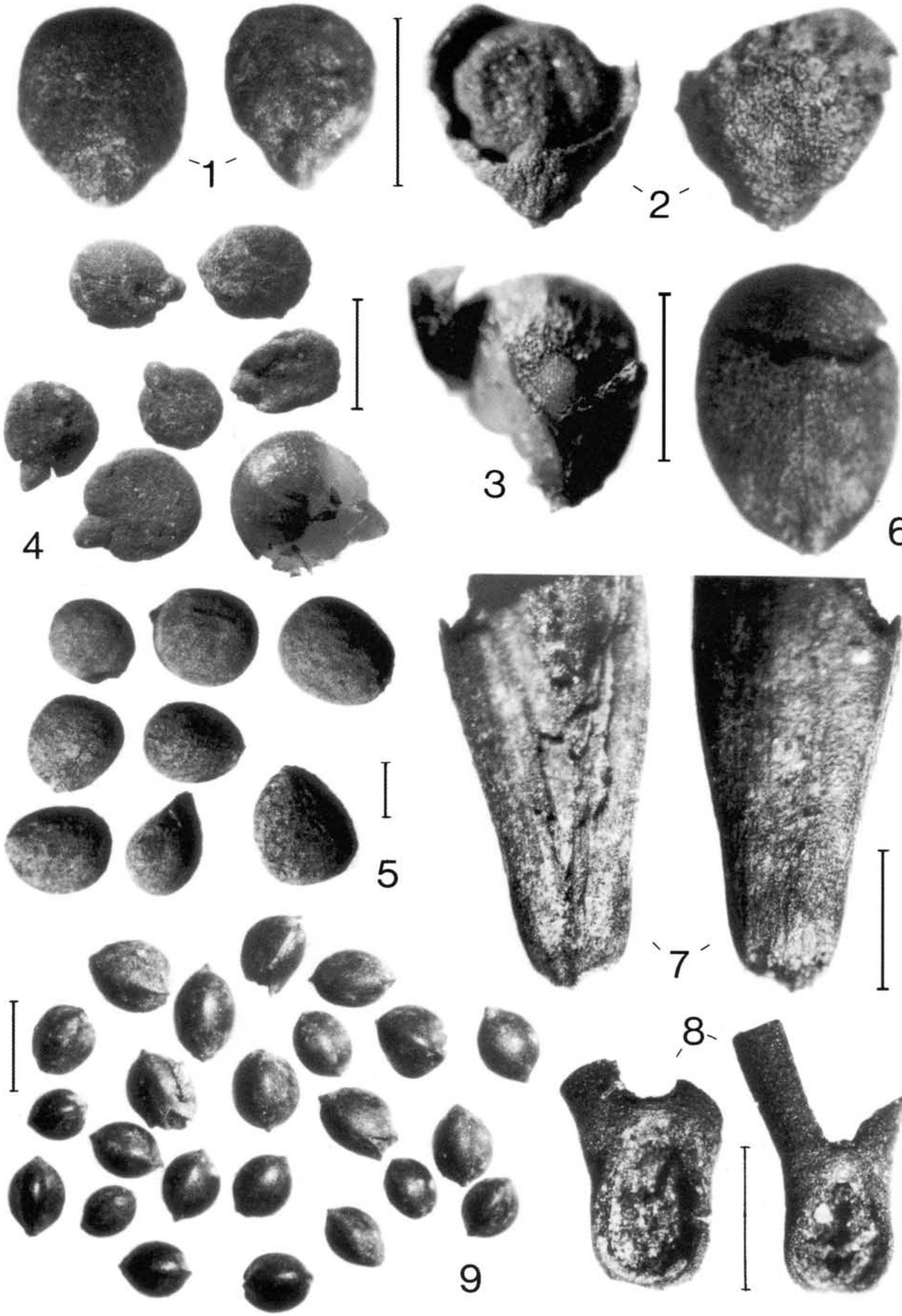

1
2
3
4
5
6

Plate 2

1. Seeds of *Stachys annua*
2. Embryo of *S. annua* with remnants of testa and pericarp having typical sculpture on the surface, in dorsal and ventral view
3. Modern fruit of *S. annua* with visible embryo inside in dorsal view
4. Group of *Stachys annua* seeds, in right-down corner modern seed
5. Group of *Stachys annua* fruits
6. Fruit of *Stachys* cf. *recta*
7. Floret base of *Avena sativa*
8. Floret bases of *Avena fatua*
9. Group of *Rumex acetosella* s.l. nutlets

Scale bars equal 1 mm

Fot. A. Bieniek


1
2
3
4
5
6
7
8
9