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PLANT REMAINS FROM THE EARLY AND LATE MIDDLE AGES FOUND IN THE SETTLEMENT LAYERS OF THE MAIN MARKET SQUARE IN CRACOW*

Szczątki roślinne z wczesnego i późnego średniowiecza znalezione w warstwach osadniczych na Rynku Głównym w Krakowie

ABSTRACT. The early- and late-medieval material described in this paper comes from the archaeological excavations in the Main Market Square in Cracov. Analysis of the macroscopic remains permitted the identification of 149 species, of which 17 had not hitherto been reported from other archaeological localities in Poland. The finding of seeds of *Ficus carica* for the first time in Poland is a noteworthy fact. A total of 340 taxa (200 species) have been determined on the basis of macroscopic remains and sporomorphs. The taxa are classified with respect to phytosociology and descriptions of the plant communities which may have occurred in the vicinity of the Main Market Square are presented. The habitats are characterized on the basis of the map of the potential natural vegetation of the Cracow region.

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INTRODUCTION

Today's Cracow occupies the valley of the Vistula and its tributaries and higher-lying tracts of the Cracow Upland to the south, the Małopolska Upland to the north and the isolated hills situated between them on both sides of the Vistula (Fig. 1). The middle terrace extends at the foot of the slopes of the Małopolska Upland and the southern end of its part called the Prądnik cone leans against the northern slope of the Wawel Hill (Tyczyńska 1974). The elongated part of this cone and its widening in the region of the present town centre became the main area of settlement before Cracow was granted its foundation charter. In the early Middle Ages this area was colonized in several successive phases, defined by Radwański (1975) as four zones of settlement. The first zone of settlement covered the Wawel Hill only, the second zone included the Okół area north of Wawel, the third zone occupied the middle and northern part of the town centre lying on the widened portion of the Prądnik cone and the fourth one consisted of detached complexes of settlement distributed round the previous zones.

The Main Market Square, from which the material for this study comes, lies in the third zone of settlement. The oldest traces of settlement found in this zone, excavated in its southern part, go back to the beginning of the 10th century. Younger centres of settlement developed first in the middle of the zone (Main Market Square) and later at its periphery, where they were associated chiefly with the main roads. At the beginning of the 13th century they already formed a large complex of settlements, about 56 hectares in area, united to a great extent, although still separated from each other by less densely built-up areas (Radwański 1975). When the town received its charter in 1257, a part of the third zone of settlement, over 30 hectares in area, with the Main Market Square (200 × 200 m) situated centrally, was surrounded with defensive walls. In the first quarter of the 14th century the further development of settlement led to the union of the newly founded town with Okół and Wawel by means of a common ring of fortifications and to the formation of the compact urban complex of medieval Cracow. At the end of the 13th century the population of this area, estimated circumspectly, may have been 7000–8000 people (Borowiejska-Birkenmajerowa 1975).

Important roads and trade routes, running from south to north and from east to west, and numerous local roads crossed in the area of today's Main Market Square. This area was also used as a market place as early as the begin-

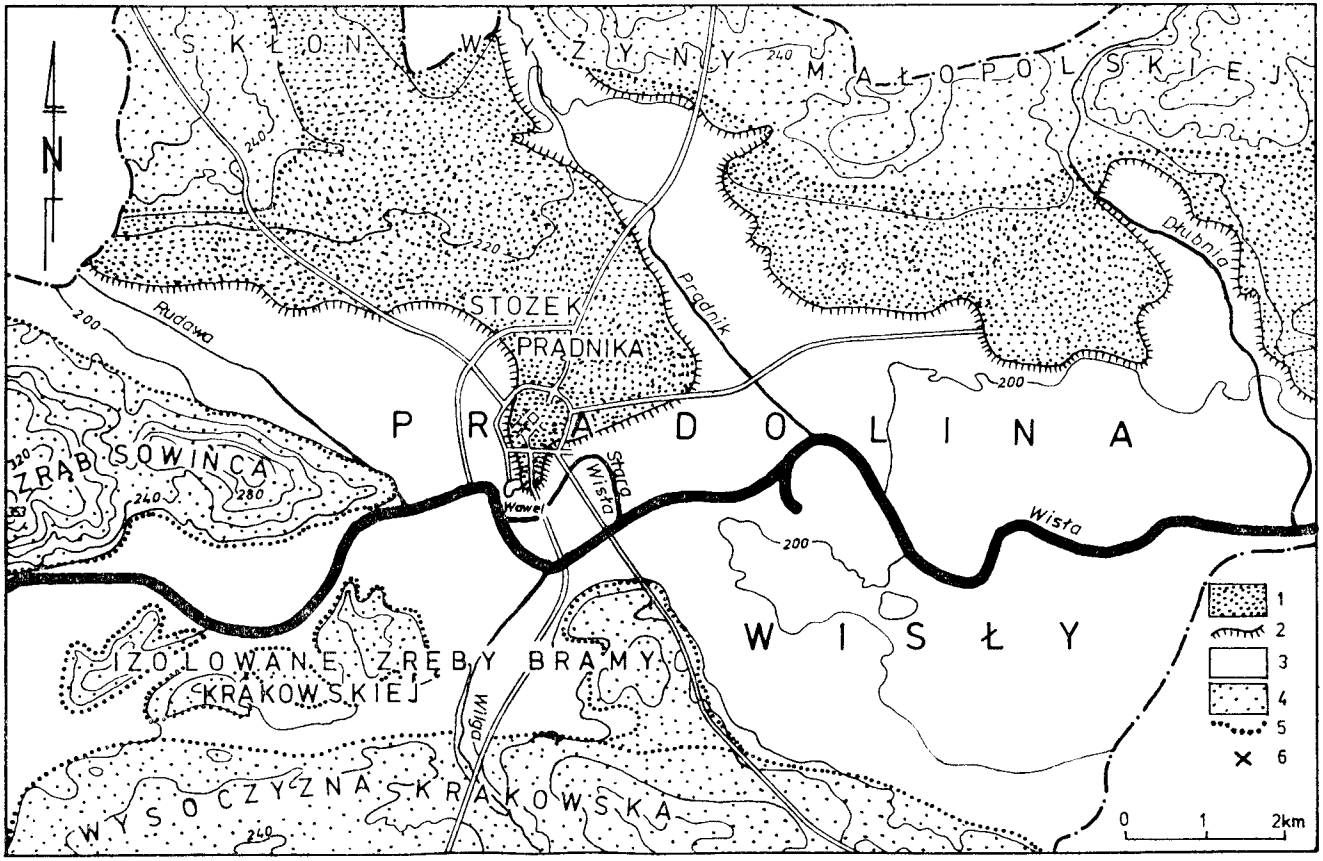

Fig. 1. Main geomorphological units of the Cracow area, after M. Tyczyńska (1968), complemented by K. Radwański (1975): 1 — Prądnik cone (middle terrace), 2 — edge of middle terrace, 3 — ice-marginal valley of the Vistula, 4 — upland areas, 5 — boundaries of main geomorphological units, 6 — Main Market Square

Ryc. 1. Główne jednostki geomorfologiczne Krakowa wg M. Tyczyńskiej (1968) z uzupełnieniami K. Radwańskiego (1975): 1 — stożek Prądnika (terasa średnia), 2 — krawędź terasy średniej, 3 — pradolina Wisły, 4 — obszary wyżynne, 5 — granice głównych jednostek geomorfologicznych, 6 — Rynek Główny

ning of the 11th century. Thus the preservation in the settlement deposits of remains not only of plants growing on the spot but also of those brought to market intentionally or unintentionally was quite possible. The purpose of studies carried out on this material has been to widen our knowledge of the economy of the medieval Cracow population (11th–15th c.) and to make an attempt to reconstruct the local vegetation of the Main Market Square itself.

LOCATION AND DATING OF SAMPLES

The material used for the present palaeobotanic work was collected during archaeological studies carried out by the Archaeological Museum in Cracow under the direction of Doc. Dr. K. Radwański in 1961–1963. In 1962 Doc. Dr. K. Wasylikowa took samples for palynological and carpological studies from excavations situated in different parts of the Main Market Square. Profiles from two excavations were chosen for close examination; Dr. W. Koperowa (unpubl.) made a pollen analysis and the author of the present paper analysed the macroscopic remains. These excavations were situated along the N–S axis in the eastern part of the Main Market Square. The profiles are: No. 4 from excavation I in the NE quarter and No. 11 from excavation II in the SE quarter (Fig. 2). The dating of the samples is based on archaeological criteria (Radwański 1975; T. Radwańska and A. Wałowy, oral communication).

In excavation I, situated near St. Mary's church, a semi-subterranean building, measuring 386 by 440 cm, was uncovered at the level of the subjacent sand bed, in which it was partly sunk; its long axis was oriented north-south, there was no hearth in it and it had been destroyed by fire. Three spurs, a buckle, a knife, numerous fragments of pottery and split animal bones were found in it. They were dated at the 12th century (Radwański 1975). Nineteen samples were taken from a continuous profile exposed outside the building in the northern wall of the excavation (Fig. 3). Samples *a–j* were dated on the basis of pottery to the period from 12th/13th to the second half of the 13th century. The top samples, *i* and *j*, of this series come from the Gothic layer, in which more than 90% of the pottery found was from the early Middle Ages and about 8% from the late Middle Ages (A. Wałowy, oral communication). The layers represented by samples *k–s* were formed in the period from the mid-13th century throughout the 14th century. Sample *t* comes from modern layers which have not been dated exactly.

Description of archaeological layers (acc. to T. Radwańska, oral information):

Quarter NE, excavation I, wall N, meter 5·0 profile 4 (Fig. 3)

Present day and modern times:

Ia — pavement 1 and sub-crust, grey-brown sand with humus

Ib — humus with brick rubble and mortar; pavement 2 between layers Ib and IIa

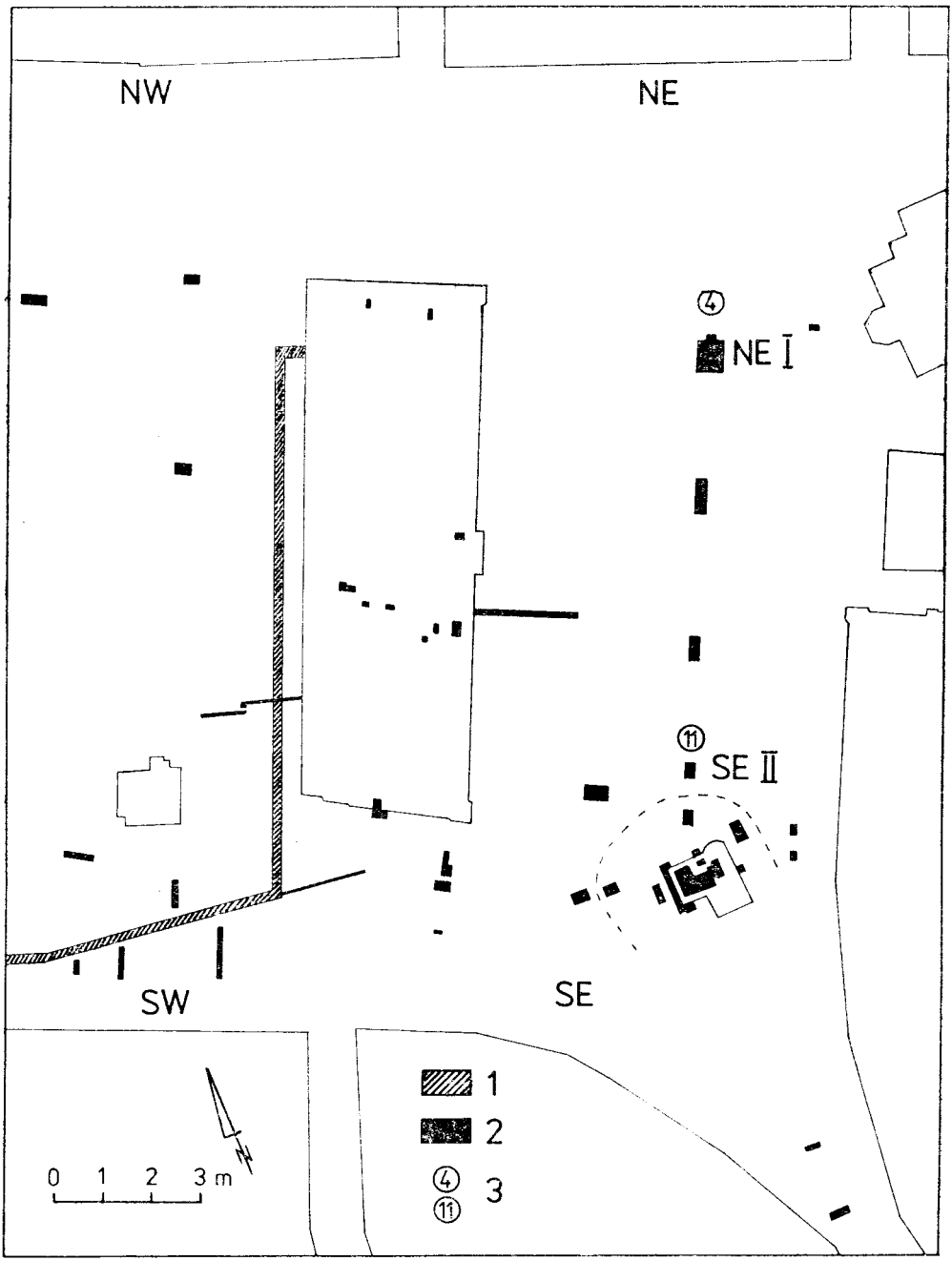

Fig. 2. Cracow, Main Market Square. Situation of excavations, after K. Radwański (1975): 1 — piping excavation of 1957, 2 — archaeological excavations of 1961–1963, 3 — excavations in which samples were taken for palaeobotanical studies

Ryc. 2. Kraków, Rynek Główny, lokalizacja wykopów wg K. Radwańskiego (1975): 1 — wykop instalacyjny z 1957 r., 2 — wykopy archeologiczne z lat 1961–1963, 3 — wykopy, z których pobrano próby do badań paleobotanicznych

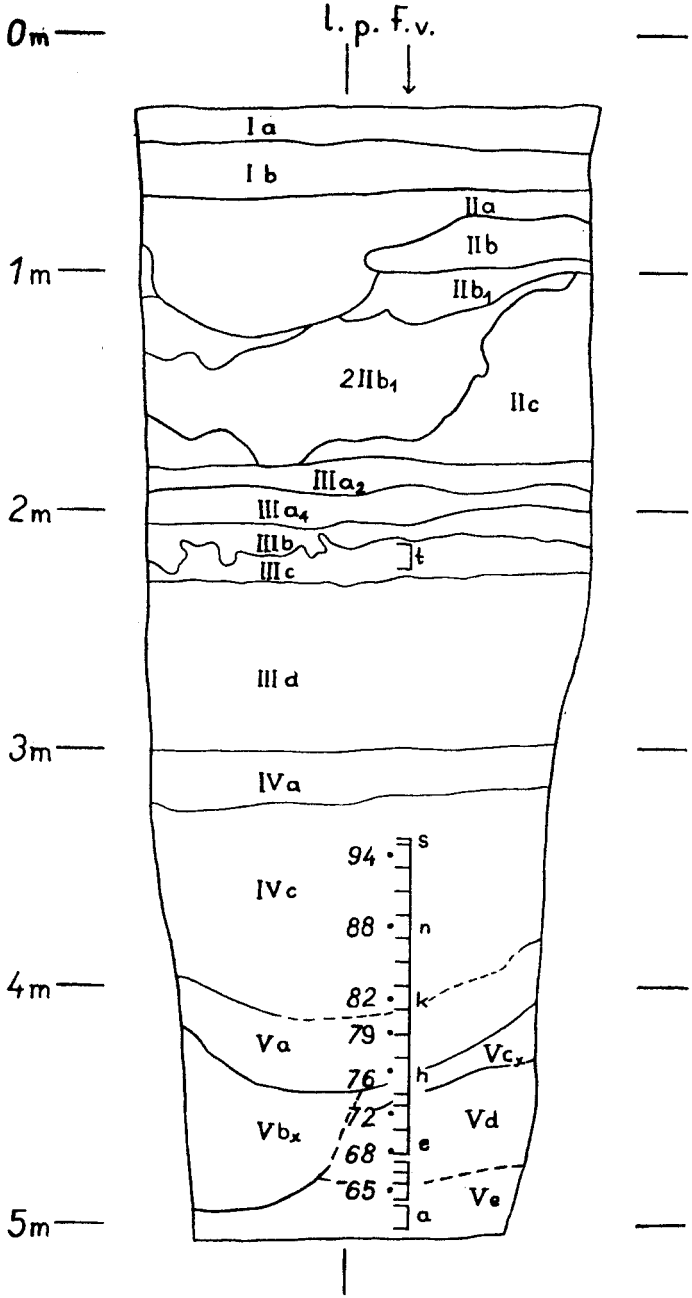

Fig. 3. Cracow, Main Market Square, quarter NE. Profile of wall N in excavation 1. 0=211·91 m a.s.l., scale 1:20 (after T. Radwańska): l. p. — reference line, F. v. — places where botanical samples were taken (profile 4), a–t — macroscopic samples, 65–94 — pollen samples, Ia–Ve — archaeological layers (see p. 140)

Ryc. 3. Kraków, Rynek Główny, kwartał NE wykop I. Profil ściany N, 0=211·91 m n.p.m., skala 1:20 (wg T. Radwańskiej): l. p. — linia pomiarowa, F. v. — miejsca pobrania prób botanicznych (profil 4), a–t — próby makroskopowe, 65–94 — próby palinologiczne, Ia–Ve — warstwy archeologiczne (patrz str. 140)

IIa — humus with sand, admixture of organic remains and brick rubble; pavement 3 between IIa and IIb
IIb — yellowish-grey loose filling sand
IIb_1 — grey sand with humus
2 IIb_1 — grey sand with humus and large number of stones
IIc — yellowish-grey loose filling sand (like IIb)
$IIIa_2$ — dark brown clayey humus with sand, large number of charcoal pieces
$IIIa_4$ — fairly loose sand with humus
IIIb — yellow filling sand
IIIc — medium-compact humus with small admixture of sand and plant remains; fragment of 17th-century vessel found in IIIc; $IIIa_2$–IIIc are levelling, filling layers, containing early- and late-medieval and modern material (A. Wałowy, oral communication)

Late Middle Ages (from mid-13th c. throughout the 14th c.):

IIId — very moist yellow sand with horizontal streaks of humus; filling layer
IVa — black clayey humus, small amount of sand and gravel, organic remains, pieces of wood, manure; compact consistency
IVc — dark brown clayey humus with organic remains, manure, hazelnut shells, pieces of wood; medium-compact consistency; bottom portion more sandy

Early Middle Ages (12th/13th c. to mid-13th c.):

Va — black-brown sandy humus with fine organic remains and small number of small pieces of charcoal; fairly compact consistency; this so-called Gothic layer is connected with pavement 4.
Vbx — pit; thin layers of brown sand, which turns lighter downwards; upper portion more clayey
Vcx — loose brown-grey-yellowish sand (levelling layer), pottery dated from 12th/13th c. to 2nd half of 13th c.
Vd — yellow sand mixed with humus, pottery dated from 12th/13th c. to mid-13th c.
Ve — yellow sand, no archaeological material

Three pits were discovered in excavation II, situated near St. Adalbert's church; two of them with fragments of the lower parts of cupola-furnace for melting iron and one with a part of a slightly sunk building. The pottery from one furnace pit was dated at the end of the 10th century and the beginning of the 11th and that from the other one at the 1st half of the 11th century. The pottery from the pit with the fragments of a building comes from the turn of the 11th century (Radwański 1975). Samples *a–d* from profile 11 may be referred to the period from the mid-11th century to the mid-13th, since they were collected below the level of pavement 4, laid down about 1250. Samples *e–g* were derived from the layers covered by pavement 3 from 1391 and thus they belonged to the period from the mid-13th century throughout the 14th.

Sample *h* was taken from the levelling layer overlying pavement 3 and samples *i–j* were referred to the 15th century.

Description of archaeological layers (acc. to T. Radwańska's oral information): Quarter SE, excavation II, wall N, meter 0·0, profile 11 (Fig. 4)

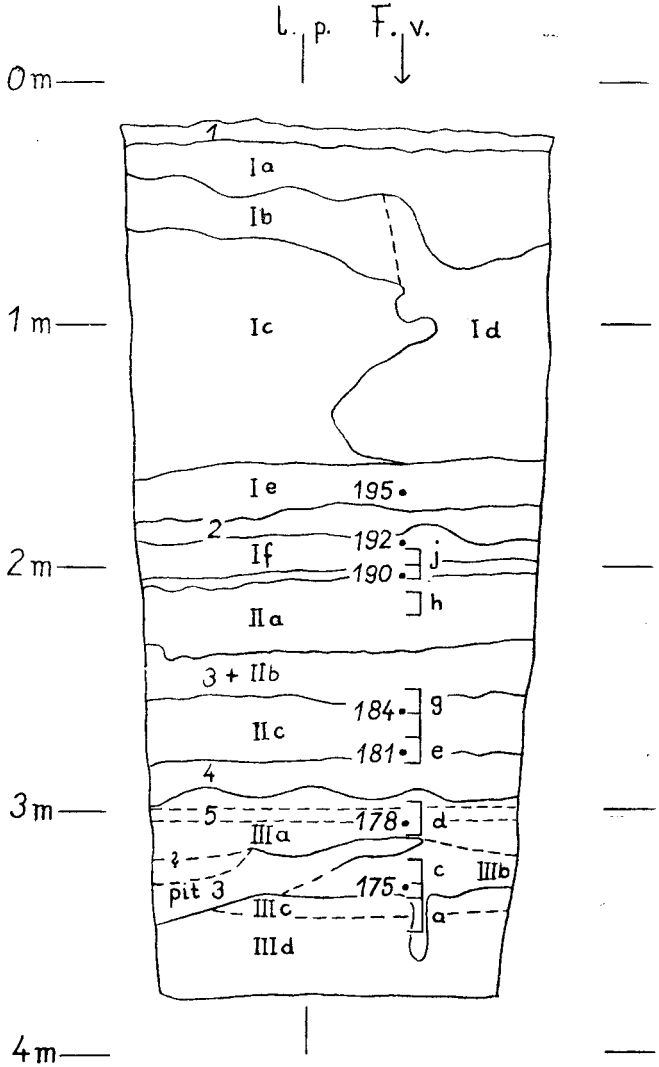

Fig. 4. Cracow, Main Market Square, quarter SE. Profile of wall N in excavation II. 0 = 211·47 m a.s.l., scale 1:20 (after T. Radwańska): l. p. reference line, F. v. — places where botanical samples were taken (profile 11), a–j — macroscopic samples, 175–195 — pollen samples, 1–5 — pavements, Ia–IIId — archaeological layers (see p. 143)

Ryc. 4. Kraków, Rynek Główny, kwartał SE wykop II. Profil ściany N, 0 = 211,47 m n.p.m., skala 1:20 (wg T. Radwańskiej): l. p. — linia pomiarowa, F. v. — miejsca pobrania prób botanicznych (profil 11), a–j — próby makroskopowe, 175–195 — próby palinologiczne, 1–5 — bruki, Ia–IIId — warstwy archeologiczne (patrz str. 143)

Sample *h* was taken from the levelling layer overlying pavement 3 and samples *i*—*j* were referred to the 15th century.
Description of archaeological layers (acc. to T. Radwańska's oral information): Quarter SE, excavation II, wall N, meter 0·0 profile 11 (Fig. 4).

Present-day and modern times:

Pavement 1

Ia — humus mixed with brick rubble
Ib — dark, compact clayey humus
Ic — yellow soft filling sand with intercalations of brown humus
Id — dark brown humus
Ie — dark brown humus with admixture of lumps of clay, pugging and splinters of wood

Late Middle Ages (from mid-13th c. to 15th c.):

Pavement 2

If — black-brown humus with pieces of wood
IIa — yellow filling sand with horizontal intercalations of brown sand (levelling horizon)
IIb — fat black-brown earth with large admixture of organic remains, among other things, wood, manure, hazel-nut shells; level connected with pavement 3 from 1391
IIc — fat black-brown earth with admixture of small brick fragments, pugging, large number of wood pieces, hazel-nut shells and other organic remains

Pavement 4 from mid-13th c.

Pavement 5 from mid-13th c.

Early Middle Ages (from mid-11th c. to mid-12th c.):
IIIa — brown sandy humus, pottery dated from mid-11th c. to 11th/12th c.
IIIb — brown sand with admixture of humus and interbeddings of yellow sand; pottery dated from mid-11th c. to 1st half of 12th c.
IIIc — yellow sand with admixture of brown sand, no archaeological material
IIId — yellow sand, small amount of archaeological material; dating as for layer IIIb.

METHOD OF STUDY

Each sample provided 200 cc of material, which was boiled in water with an admixture of Na_2CO_3 or 10% KOH and washed on sieves with 0·5 and 0·2 mm mesh. The material obtained was segregated under a low power binocular microscope. A Zeiss low power binocular microscope, magnifying 10 to 100 times and, if necessary, a microscope of higher power were used in determining macroscopic remains. Measurements were taken by means of a Brünell's micrometer to an accuracy of 0·05 mm. Drawings were made for nearly all the material

determined (Plates I–XII) except very heavily damaged specimens, and some species were described. The drawings were made by Z. Tomczyńska. A list of all the taxa found is given in Table 1 (is under the cover), which includes the macroscopic remains elaborated by the author of this paper and sporomorphs determined by W. Koperowa (unpubl.). The results of the carpological analysis are presented in the form of two diagrams (Figs. 7 and 8). The histograms show the absolute numbers of fruits or seeds in 200 cc samples. The number of specimens is the sum of the number of whole specimens and that of fragments, recalculated appropriately (2 halves = 1 specimen, etc.).

DESCRIPTION OF MACROSCOPIC PLANT REMAINS

Descriptions are arranged in alphabetical order of families. Plant names are according to Rośliny Polskie (Polish Plants, Szafer *et al.* 1953), names in brackets according to Flora Europaea. Most fruits and seeds are uncharred, otherwise it is stated in particular descriptions.

Alismataceae

Alisma plantago-aquatica L. (Pl. I, 1)

Profile 4: 3 fruits and 1 seed in 4 samples

Profile 11: 1 fruit and 1 seed in 1 sample

Fruits elliptical in outline, cuneiform, indented at base; lateral sides smooth, dull, finely longitudino-obliquely striated in middle part. Size of fruits: 1·9 × 1·0 mm, 1·8 × 0·9 mm, 1·8 × 0·75 mm, 1·6 × 1·0 mm. Size of seeds: 1·3 × 0·9 mm, 0·9 × 0·5 mm.

Similar seeds of *Echinodorus ranunculoides* (L.) Engelm. are somewhat smaller, relatively shorter and broader, and with surface pitted (Körber-Grohne 1967). The epidermal cells of seeds in *Echinodorus* are subsquare, arranged in regular rows, whereas in *Alisma plantago-aquatica* they are more elongate. The elongate cells were observed on a fossil seed in transmitted light at a magnification of about 120 ×.

Sagittaria sagittifolia L. (Pl. I, 2)

Profile 4: 1 seed in 1 sample

Seed shaped like that of *Alisma plantago-aquatica* but markedly larger. Size: 2·4 × 1·3 mm.

This species has not hitherto been described from archaeological localities in Poland.

Amaranthaceae

Amaranthus sp.

Profile 4: 2 seeds in 1 sample

Both specimens heavily damaged. Size of 1 seed: 1·2 × 1·0 mm.

Betulaceae

Alnus incana (L.) Mnch. (Pl. I, 3)

Profile 4: 1 nutlet in 1 sample

Size: 2·7 × 3·0 mm.

Betula cf. *verrucosa* Ehrh. (*B. pendula* Roth., Pl. I, 4)
Profile 4: 1 nutlet in 1 sample
Nutlet obovate. Size: 1·9×1·0 mm.
Corylus avellana L.
Profile 4: 29 fragments of nutshells in 11 samples
Profile 11: 16 fragments of nutshells in 3 samples
Boraginaceae
Lithospermum arvense L. (*Buglossoides arvensis* (L.) I. M. Johnston)
Profile 4: 2 fruits in 2 samples
Small fragments of hard, brittle, verrucose, whitish-grey outer layer of pericarp preserved only on one specimen. Size of 1 specimen: 2·4×1·5 mm.
Myosotis arvensis (L.) Hill. type (Pl. I, 5)
Profile 11: 1 fruit in 1 sample
Ventral side somewhat roof-shaped, with inconspicuous edge in upper part of fruit. Size 1·15×0·7 mm.
Fruits similar in size and shape occur in the group of species, of which *M. arvensis* (L.) Hill. and *M. micrantha* Pall. are the commonest in Poland.
Myosotis silvatica (Ehrh.) Hoffm. or *M. palustris* (L.) Nathorst (Pl. I, 6)
Profile 4: 1 fruit in 1 sample
Lateral edges sharp, flattened, embracing schizocarp all around, somewhat shifted on to ventral side. Ventral side slightly convex, without edge. Size: 1·6×0·9 mm.
Myosotis sp.
Profile 4: 1 fruit in 1 sample
Campanulaceae
Campanula persicifolia L. (Pl. II, 3)
Profile 11: 1 seed in 1 sample
Size: 0·7×0·45 mm. Very similar seeds of *C. patula* L. are somewhat smaller (Wasylikowa 1978).
Cannabaceae
Cannabis sativa L. (Pl. II, 1)
Profile 4: 4 halves and 4 fragments of fruits in 7 samples
Size of 2 halves, damaged in upper parts: 2·9×2·3 mm and 3·9×2·7 mm.
Humulus lupulus L. (Pl. II, 2)
Profile 4: 27 complete fruits and 11 fragments in 14 samples (fruits from samples *4e* and *4p* probably charred)
Profile 11: 11 complete fruits and 4 fragments in 4 samples
Size of 10 fruits: 2·3 (2·1–2·6)×1·9 (1·6–2·1) mm.
Caprifoliaceae
Sambucus sp.
Profile 4: 5 fragments of fruit-stones in 2 samples
Caryophyllaceae
In the measurements of seeds the length is the greatest diameter and the breadth the diameter perpendicular to it.

Agrostemma githago L. (Pl. I, 10)
Profile 4: 17 complete and 92 fragments of seeds in 15 samples
Profile 11: 1 seed (charred, in sample 11 *d*) and 33 seed fragments in 6 samples
Size of 1 uncharred seed: 3·0 × 2·3 mm.
Arenaria serpyllifolia L. (Pl. I, 7)
Profile 4: 12 seeds and 1 seed fragment in 6 samples
Profile 11: 2 seeds in 2 samples

Seeds reniform, slightly flattened along dorsal side. Narrow and elongate hilum, oriented transversely to circumference, in a small but distinct depression of the ventral side. Lateral sides covered with radially elongated, flat tubercles, arranged in several concentrical rows. On the dorsal side the tubercles are equally flat but shorter, ± square in outline. Size of 10 seeds: 0·51 (0·4–0·6) × × 0·45 (0·4–0·5) mm.

Seeds of *A. serpyllifolia* may easily be confused with those of *Viscaria vulgaris* Röhl.
Cerastium vulgatum L. (*Cerastium caespitosum* Gilib., Pl. I, 9)
Profile 4: 6 seeds in 4 samples (in sample 4*p* one seed looks charred)
Profile 11: 4 seeds in 3 samples
Size of 7 seeds: 0·6 (0·4–0·7) × 0·55 (0·45–0·6) mm.
Cerastium sp.
Profile 4: 4 seeds in 2 samples
Profile 11: 1 seed in 1 sample
Dianthus sp.
Profile 4: 1 seed fragment in 1 sample
Profile 11: 1 seed in 1 sample
Gypsophila muralis L. (Pl. I, 14)
Profile 4: 2 seeds in 1 sample

Seeds triangularly reniform, near the hilum narrowed, laterally flattened. The surface is covered with very narrow, strongly radially elongated and flat tubercles, arranged in several concentrical rows. Size: 0·4 × 0·3 mm, 0·4 × 0·4 mm.
Lychnis flos-cuculi L. (Pl. I, 8)
Profile 4: 17 seeds in 9 samples (charred in samples 4 *o* and 4 *m*)
Profile 11: 7 complete and 3 fragments of seeds in 3 samples
Size of 10 seeds: 0·72 (0·6–0·9) × 0·59 (0·5–0·7) mm.
Malachium aquaticum (L.) Fr. (*Myosoton aquaticum* (L.) Moench, Pl. I, 11)
Profile 4: 1 seed in 1 sample

Seed ± circular. Tubercles of dorsal side conical with broad circular base, on lateral sides elongated, less regularly arranged, stellate. Size: 0·9 × 0·9 mm.
Melandrium album (Mill.) Garcke (*Silene alba* (Miller) E. H. L. Krause, Pl. I, 12)
Profile 4: 3 seeds in 2 samples
Profile 11: 1 testa in 1 sample

Hilum roundish, surrounded with elongate, radially arranged tubercles, which usually form a horseshoe-shaped thickening. Damaged seeds of *M. album* may easily be confused with those of *M. noctiflorum* (L.) Fr. Size: 0·9 × 1·1 mm.

Melandrium noctiflorum (L.) Fr. (*Silene noctiflora* L., Pl. I, 13)
Profile 4: 11 seeds in 5 samples
Profile 11: 4 complete and 3 fragments of seeds in 3 samples

Seeds reniform, somewhat angular; dorsal side flattened. Hilum oval, narrow, oriented transversely to seed circumference. Near hilum, on each lateral side wart-like thickening formed of strongly elongated narrow tubercles. Size of 9 seeds: 1·29 (1·0–1·6) × 1·14 (0·9–1·3) mm.

Sagina cf. *procumbens* L.
Profile 4: 1 damaged seed in 1 sample

Seed triangular–ovate, flattened laterally and on dorsal side. Surface covered with flat, radially elongated tubercles, arranged in several concentrical rows. Size: 0·30 × 0·25 mm.

Seeds of another species common in Poland, *S. nodosa* (L.) French, are larger, their size acc. to Kulpa (1974) being 0·45 (0·36–0·50) × 0·35 (0·3–0·42)mm. The measurements given by Kulpa for *S. procumbens* are 0·32 (0·28–0·34) × × 0·28 (0·20–0·30) mm.

This species has not hitherto been described from archaeological localities in Poland.

Scleranthus cf. *annuus* L. (Pl. I, 18)
Profile 4: 23 complete fruits and 1 half in 6 samples
Profile 11: 6 complete fruits and 1 half in 5 samples

Size of 10 fruits (length of fruit without sepals and pedicle): 1·07 (0·7–1·5) × × 0·89 (0·4–1·2) mm.

S. perennis L. has very similar fruits, but their sepals are pressed closer together than in the fossil specimens and the pedicel is shorter and usually wedge-like narrowed.

Silene gallica L. (Pl. I, 19)
Profile 11: 2 seeds in 1 sample

Size: 1·2 × 0·8 and 1·0 × 0·8 mm.

Silene sp.
Profile 4: 1 seed in 1 sample

Spergula arvensis L.
Profile 4: 3 complete seeds and 32 halves in 7 samples
Profile 11: 15 halves of seeds in 2 samples

All specimens compressed, greatest diameter about 1·2 mm. Judging by their size, they may belong to *S. arvensis* L. var. *arvensis* or *S. arvensis* L. var. *sativa* (Boenn.) Mert. et Koch. (Kulpa 1974).

Only 2 halves of seeds from 1 sample (4*s*) have their club-shaped hairs on the surface and the narrow membranous wings preserved (Pl. I, 21). These details permit their inclusion in the variety *S. arvensis* L. var. *arvensis* (*S. vulgaris* Boenn.). It may well be that the specimens from the other samples belong to the same variety.

Stellaria graminea L. (Pl. I, 16)
Profile 4: 36 complete seeds and 1 half in 8 samples

Profile 11: 14 complete seeds and 1 fragment in 5 samples

Size of 10 seeds: 0·97 (0·8–1·2) × 0·87 (0·7–1·0) mm.

Stellaria media Vill. (Pl. I, 15)

Profile 4: 11 complete and 6 fragments of seeds in 8 samples (in sample 4*f* two seeds probably charred)

Profile 11: 7 complete seeds and 1 fragment in 3 samples

Very fine spinules are seen at as low a magnification as 25 × on the tubercles, notably on the dorsal side, whereas they have not been found on the seeds of other species of this genus at magnifications up to 100 ×. The presence of spinules makes it possible to distinguish the seeds of *S. media* from the circular seeds of *S. nemorum* L. Size of 9 seeds: 1·12 (1·0–1·5) × 1·01 (0·8–1·3) mm.

Stellaria nemorum L. (Pl. I, 17)

Profile 4: 4 seeds in 4 samples

Profile 11: 4 complete seeds and 1 fragment in 3 samples

Seeds ± circular or somewhat elongated towards the radicle tip. Lateral sides covered with elongate tubercles arranged in more or less concentric rows. Tubercles on dorsal side less pointed than those in *Malachium aquaticum* and somewhat flattened laterally, stellate. Size of 7 seeds: 0·86 (0·8–0·9) × 0·82 (0·75–0·9) mm.

Stellaria sp.

Profile 4: 1 seed and 1 fragment in 2 samples

Viscaria vulgaris Röhl. (*Lychnis viscaria* L., Pl. I, 20)

Profile 4: 3 seeds, of which one charred, in 3 samples

Seeds roundish-reniform, on dorsal side and at flanks flattened. Round, relatively large hilum on flattened ventral side. On dorsal side several rows of pointed conical tubercles. On lateral sides tubercles strongly radially elongated, flat or, more rarely, with a spinous process in the middle (cf. description of *Arenaria serpyllifolia*). Size: 0·4 × 0·4 mm and 0·5 × 0·45 mm.

Chenopodiaceae

The terms used by Kowal (1953), shown in Fig. 5, have been adopted in the descriptions of seeds of *Atriplex* and *Chenopodium*. The length and breadth of seeds of *Atriplex* were measured in the same way as in *Chenopodium*

Atriplex patulum L. (Pl. II, 4)

Profile 4: 2 seeds in 2 samples

Atriplex patulum produces two types of seeds (Kowal 1953; Kulpa 1974). The material from the Main Market Square represents the type of smaller seeds with a more persistent testa. Size: 1·7 × 1·5 mm.

Chenopodium album L.

Out of the seeds of the *Chenopodium* species, those of *C. album* L., *C. opulifolium* Schrad. and *C. viride* L. were the hardest to discern in the subfossil state. Ripe seeds of herbarial specimens the determination of which had been checked by H. Trzcińska-Tacik were used as reference material, from 3 localities for *C. album*, from 6 localities for *C. opulifolium* and from 2 localities for *C. viride*. The descriptions of seeds given by Kowal (1953) and Aellen (1960) were

also used. The most important characters taken into account in distinguishing these species concerned the outline of seeds, the separation of the radicle, the transverse sections through seeds, and the sculpture of testa.

Chenopodium album includes 6 subspecies, numerous varieties and forms, and often produces hybrids, which occur more commonly in nature than do the pure forms of this species (Aellen 1960; Kowal 1953). The seeds of these forms differ from each other in certain details, not always easy to see in the fossil state. Only single typical specimens were distinguished as *C. album* s. str. in the material from the Main Market Square. Most seeds, probably those of hybrids, are described here as *C. album* s. l.

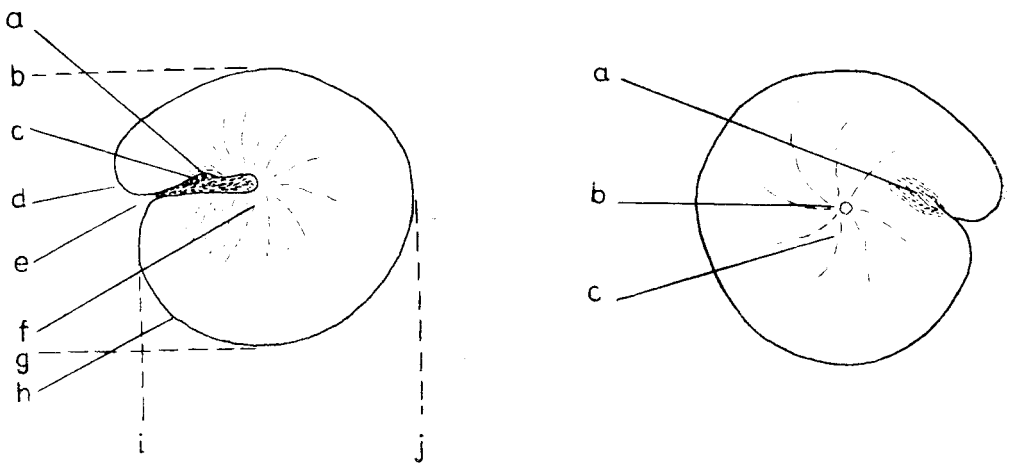

Fig. 5. Seed of *Chenopodium*. I. side with trough (lower): a — depression in trough, b–g — seed length, c — trough, d — radicle tip, e — notch under radicle, f — direction of sculpture radiation, h — seed edge, i–j — seed breadth. II. troughless side (upper), a — depression under radicle, b — sculpture centre, c — direction of sculpture radiation (after T. Kowal 1953)

Ryc. 5. Nasienie *Chenopodium*, I. strona z rynienką (dolna): a — wgłębienie w rynience, b–g — długość nasienia, c — rynienka, d — szczyt korzonka, e — wcięcie pod korzonkiem, f — kierunek rozchodzenia się skulptury, h — brzeg nasienia, i–j — szerokość nasienia. II. strona bez rynienki (górna), a — wgłębienie pod korzonkiem, b — centrum skulpturalne, c — kierunek rozchodzenia się skulptury (wg T. Kowala 1953)

Chenopodium album L. s. str. (Pl. II, 5)
Profile 4: 15 seeds in 4 samples
Profile 11: 1 seed in 1 sample

Seeds ± circular in outline, slightly elongated towards the radicle tip. Radicle well marked, slightly protruding beyond seed circumference. Seeds lenticular, with lower side more convex, upper side flattened, edge distinct and fairly sharp. On the lower side a trough runs from a small notch in seed circumference under the radicle to the centre; the trough is not clearly outlined and usually slightly widened towards the radicle more or less in the middle of its length. The sculpture consists of delicate lines radiating from the trough towards the circumference. Near the radicle tip on the upper side there is a short triangular-roundish depression, which does not reach the notch in the circumference.

A round pit occurs in the centre of the upper side and delicate lines radiate from it to the circumference. The surface of both sides is intensely shiny and smooth. Size of 10 seeds: 1·28 (1·2–1·4)×1·22 (1·1–1·4) mm.

Chenopodium album L. s. l.

Profile 4: 243 complete seeds and 34 halves in 16 samples

Profile 11: 43 complete seeds and 2 halves in 6 samples

Size of 10 seeds: 1·36 (1·2–1·45)×1·28 (1·1–1·45) mm.

Chenopodium ficifolium Sm. (Pl. II, 10)

Profile 4: 7 seeds in 6 samples

Profile 11: 1 seed in 1 sample

The surface of the upper side of seeds is covered with a characteristic sculpture in the form of a shallowly pitted reticulum, which partly passes on to the edges of the lower side. Size of 5 seeds: 0·95 (0·8–1·05)× 0·87 (0·75–1·0) mm.

Chenopodium glaucum L. (Pl. II. 7)

Profile 4: 1 seed in 1 sample

Size: length — 0·65 mm.

The seeds of *C. glaucum* differ from those of *C. rubrum* L. in being circular in outline and uniformly flattened all over their surface.

Chenopodium hybridum L. (Pl. II, 6)

Profile 4: 2 complete seeds and 2 fragments in 3 samples

Profile 11: 1 seed in 1 sample

Size: 1·2×1·2 mm, 1·7×1·6 mm.

Chenopodium cf. *opulifolium* Schrad. (Pl. II, 8)

Profile 4: 8 seeds in 4 samples

Profile 11: 1 seed in 1 sample

Seeds circular in outline, lenticular, with well-marked radicle slightly projecting beyond seed circumference. Both sides equally convex, marginal part of seed rounded, without distinct edge. On the lower side a gently arched trough runs from a small notch in seed circumference under the radicle to the centre and distinct lines radiate from it towards the periphery. Near the radicle tip on the upper side there is a shallow but fairly distinct depression, which reaches the notch in the circumference. In the centre of upper side there is most frequently a flat small wart or more rarely a small depression, with very fine tubercles round it and well-marked striae radiating to the seed margins. The sculpture of the upper side is somewhat more conspicuous than it is in *C. album* (cf. the description of *C. album*). Size of 10 seeds: 1·43 (1·3–1·5)×1·31 (1·2–1·35) mm.

Chenopodium polyspermum L. (Pl. II, 9)

Profile 4: 13 seeds in 7 samples

Size of 6 seeds: 0·81 (0·7–0·9)× 0·74 (0·65–0·8) mm.

Chenopodium cf. *urbicum* L. (Pl. II, 11)

Profile 4: 3 seeds in 3 samples

Profile 11: 2 seeds in 2 samples

Size: 0·9× 0·85 mm, 1·0× 0·9 mm, 1·0× 0·9 mm.

Chenopodium cf. *viride* L. (*C. suecicum* Murr., Pl. II, 13)
Profile 4: 8 seeds in 5 samples
Profile 11: 2 seeds in 2 samples

Seeds circular in outline, lenticular, nearly equally convex on both sides. A small but distinct notch occurs in seed circumference under the tip of the radicle. Radicle does not protrude beyond the seed circumference. The circumferential edge is well-marked but not very sharp. On the lower side a more or less sharply delineated trough runs from the notch under the radicle to the centre with lines radiating from it towards the circumference. Shallow and not very regular pits can be seen in the peripheral parts of this side. The upper side has a very shallow depression near the radicle tip and, centrally, a circular wart (or fine pitting), surrounded by irregular and shallow pits, which cover the surface up to the seed edge. Size of 8 seeds: 1·38 (1·3–1·5) × 1·29 (1·2–1·4) mm.

Chenopodium cf. *vulvaria* L. (Pl. II, 12)
Profile 4: 3 seeds in 2 samples

Size: 0·9 × 0·8, 0·9 × 0·9, 1·0 × 1·0 mm.

Determination based on characters given by Kowal (1953). Seeds of *C. vulvaria* may be confused with small atypical seeds of *C. album*.

Chenopodium sp.
Profile 4: 106 complete seeds and 104 fragments in 13 samples
Profile 11: 32 complete seeds and 10 fragments in 9 samples

Compositae

Achillea cf. *millefolium* L. (Pl. III, 8)
Profile 4: 2 achenes in 1 sample

Size of 2 fruits: 2·0 × 0·6 and 1·2 × 0·4 mm. Determination uncertain, since *A. nobilis* L., a species rare in the Małopolska Upland, has identical fruits. The similar fruits of *Bellis perennis* L. are more flattened and somewhat shorter but broader.

Anthemis arvensis L. (Pl. III, 1–4)
Profile 4: 113 complete achenes, 37 halves and 3 fragments in 11 samples
Profile 11: 12 complete achenes and 4 halves in 5 samples

Two types of fruits have been distinguished in the material. Marginal fruits, few in number, trigonous, slightly arcuate, with membranous rim at top and pointed at base. Much more numerous central fruits, subcylindrical or somewhat tetragonous, straight, truncated at both ends, furnished with pedicel at bottom and with thick fold at top (Pl. III, 1–2). There are about 10 blunt ribs on the surface of these fruits (Kulpa 1974). Size of 10 central fruits: 1·95 (1·65–2·2) × 1·01 (0·8–1·4) mm.

In fossil material the outer layer of the pericarp is sometimes destroyed and then the hard inner layer, visible on longitudinal sections of the fruit, is preserved (Pl. III, 4). Such achenes are narrowly obovate, truncated or convex at the top, with a stalk in the middle. The ribs are well-marked, coalesced closely with the rest of the pericarp. The achenes usually split into two halves. Such specimens

may be confused with complete fruits of *Chrysanthemum leucanthemum* L.
Anthemis cotula L. (Pl. III, 5)
Profile 4: 6 complete achenes and 1 half in 6 samples
Profile 11: 3 achenes in 2 samples
Size of 9 fruits: 1·63 (1·3–1·9) × 0·52 (0·4–0·6) mm.
Anthemis tinctoria L. (Pl. III, 6–7)
Profile 4: 9 achenes in 4 samples
Profile 11: 2 achenes in 1 sample
Two types of fruits have been found, marginal and central fruits. The rim of the more markedly bent marginal achenes is higher on the inner side (Pl. III, 7), the rim of the central achenes is lower and uniform all round the circumference (Pl. III, 6). Size of 10 fruits: 1·60 (1·4–2·0) × 0·64 (0·6 × 0·7) mm.
Arctium cf. *lappa* L. (Pl. III, 10)
Profile 11: 1 achene in 1 sample
Size: 4·4 × 1·8 × 0·9 mm.
Arctium sp.
Profile 4: 1 achene in 1 sample
Size: 6·3 × 3·5 mm.
Bidens cernuus L. (Pl. III, 14)
Profile 4: 1 achene in 1 sample
Size of achene including awns: 7·0 × 2·0 mm, without awns: 5·0 × 2·0 mm.
Bidens tripartitus L. (Pl. III, 15)
Profile 4: 1 achene in 1 sample
Profile 11: 2 achenes in 1 sample
Size of achenes including awns: 7·5 × 2·1 mm, 7·5 × 2·1 mm, 6·7 × 1·8 mm, without awns respectively: 5·5 × 2·0 mm, 5·6 × 2·0 mm, 4·4 × 1·8 mm.
Carduus sp. (Pl. III, 16)
Profile 4: 3 achenes in 2 samples
Profile 11: 1 achene in 1 sample
Size: 2·6 × 1·3 mm, 2·3 × 1·25 mm, 2·6 × 1·0 mm.
Centaurea cyanus L. (Pl. III, 11)
Profile 4: 20 complete achenes and 5 fragments in 11 samples
Profile 11: 2 achenes in 2 samples
Size of 10 fruits soaked in glycerine mixture: 3·52 (3·3–3·7) × 1·73 (1·6–1·8) mm. Size of 5 dry fruits: 3·22 (2·8–3·6) × 1·68 (1·5–1·9) mm.
Centaurea jacea L. (Pl. III, 12)
Profile 4: 3 achenes in 3 samples
Profile 11: 1 achene in 1 sample
The semicircular indentation at the bottom of the ventral edge is much shorter than that in *C. cyanus*. Size: 2·7 × 1·5 mm, 3·0 × 1·5 mm, 3·2 × 1·5 mm.
Centaurea sp.
Profile 4: 2 fragments of achenes in 2 samples
Profile 11: 1 achene in 1 sample

Chrysanthemum leucanthemum L. (*Leucanthemum vulgare* Lam., Pl. III, 20)
Profile 4: 7 complete achenes and 5 fragments in 6 samples

Ten distinct angular thick ribs are preserved on a few fruits. The ribs are easily detached from the deeper layers of the pericarp and fall off completely. The achenes void of the external layer of the pericarp bear delicate signs of the ribs on the surface, along which they readily split (cf. description of *Anthemis arvensis*). Size of 6 fruits: 1·88 (1·4–2·1) × 0·58 (0·5–0·7) mm.

Cichorium intybus L. (Pl. III. 9)
Profile 4: 2 achenes in 2 samples
Profile 11: 1 achene in 1 sample
Size 2·3 × 1·8 mm, 1·9 × 0·8 mm.

Cirsium sp. (Pl. III, 17)
Profile 4: 2 achenes in 2 samples
Size: 3·0 × 1·0 mm, 2·6 × 0·9 mm.

Eupatorium cannabinum L. (Pl. III, 13)
Profile 4: 1 achene in 1 sample

Fruit elongated, cylindrically pentagonal, damaged at base. Top truncated, with distinct stalk in middle, surrounded with thickened rim. On surface 5 well-seen sharp-edged ribs, regularly distributed on fruit circumference. Surface dull, finely longitudinally striated, with dense transverse wrinkles (seen only under a high magnification). Size: length above 2·2 mm, breadth 0·5 mm.

This species has not hitherto been described from other archaeological localities of Poland.

Hieracium sp. (Pl. III, 19)
Profile 4: 1 achene in 1 sample
Profile 11: 1 achene in 1 sample
Size: 2·0 × 0·55 mm, 2·8 × 0·7 mm.

Lapsana communis L. (Pl. III, 18)
Profile 4: 8 achenes in 5 samples
Size of 8 fruits: 3·63 (3·3–4·0) × 0·85 (0·6–1·0) mm.

Picris hieracioides L. (Pl. IV, 1)
Profile 4: 2 achenes in 2 samples
Size: 2·7 × 0·6 mm, 3·5 × 1·2 mm.

Sonchus arvensis L. (Pl. IV, 2)
Profile 4: 1 achene in 1 sample

Fruit with 10 longitudinal ribs, 2 marginal ones better developed. All ribs clearly transversely wrinkled, furrows between ribs smooth. Size: 2·3 × 0·7 mm.

The very similar fruits of *S. oleraceus* L. have ribs and furrows transversely wrinkled.

Sonchus asper (L.) Hill. (Pl. IV, 3)
Profile 4: 1 achene in 1 sample
Size: 2·7 × 0·7 mm.

Cruciferae

Barbarea sp. (Pl. IV, 6)

Profile 4: 7 complete seeds and 1 fragment in 5 samples

Size of 5 seeds: 1·25 (1·05–1·4) × 0·88 (0·7–1·0) mm.

Brassica

The seeds of four species of *Brassica* are very much alike and hard to distinguish from each other. There are slight differences between the seeds in size. Species were determined chiefly on the basis of small differences in surface sculpture. The presence of fine punctation inside the reticular meshes, absent from *Sinapis*, is a distinctive feature of the sculpture of all *Brassica* species.

Brassica campestris L. (*B. rapa*, L., Pl. IV, 4)

Profile 4: 11 complete seeds and 5 fragments in 10 samples

Seeds circular, covered with fine but pronounced reticulum of shallow polygonal meshes all over surface. Reticulum less protruding and punctation of surface more distinct than in *B. nigra*. In the region of the round hilum the meshes diminish perceptibly, become more elongate and are radially arranged around the hilum. Diameter of seeds: 1·37 (1·25–1·50) mm.

Brassica napus L. (Pl. IV, 5)

Profile 4: 6 complete seeds and 5 fragments in 6 samples

Profile 11: 2 seeds in 2 samples

Seeds of dull-silky lustre, circular in outline, somewhat larger than those of *B. campestris* L. and *B. nigra* L. Surface covered with very indistinct reticulum of subrectangular meshes. Size of 4 seeds: 1·63 (1·4–1·8) mm. The seeds of *B. oleracea* L. are the same size and shape.

This species has not hitherto been described from archaeological localities in Poland.

Brassica nigra (L.) Koch. (Pl. IV, 8)

Profile 4: 4 complete seeds and 4 fragments in 3 samples

Profile 11: 1 complete seed and 1 fragment in 2 samples

Seed surface covered with fine but clear reticulum of fairly regular meshes, uniform all over surface and not diminishing towards hilum. Meshes deeper than in *B. campestris* and, as a result, reticulum itself more pronounced and punctation inside meshes less conspicuous. Seeds somewhat smaller than those of *B. campestris* and round or oval in outline. Diameter of 5 seeds: 1·26 (1·2–1·4) mm.

Brassica oleracea L. (Pl. IV, 9)

Profile 4: 1 complete seed and 1 fragment in 1 sample

Seeds ± circular in outline, reticulum more pronounced than in *B. napus*, meshes more elongate, with less distinct fine punctation inside. Seed diameter 2·0 mm.

This species has not hitherto been described from archaeological localities in Poland.

Brassica sp.

Profile 4: 4 complete seeds and 7 fragments in 5 samples

Profile 11: 2 fragments of seeds in 1 sample

Capsella bursa-pastoris (L.) Med. (Pl. IV, 7)
Profile 4: 7 seeds in 4 samples
Profile 11: 4 seeds in 2 samples

Seeds elliptic or elliptic-ovate, laterally flattened, uniformly thick all along the seed. Epidermal cells elongated longitudinally. Size of 10 seeds: 0·85 (0·7–1·0) × 0·49 (0·4–0·6) mm. In size and shape these seeds much resemble the seeds of *Descurainia sophia* (L.) Webb.

Descurainia sophia (L.) Webb. (Pl. IV, 10)
Profile 4: 1 seed in 1 sample

The seed differs from the very similar seeds of *Capsella bursa-pastoris* in being thickest in the middle and in that its elongated epidermal cells are arranged transversely to its long axis. Size: 0·8 × 0·5 mm.

Neslia paniculata (L.) Desv. (Pl. IV, 11)
Profile 4: 4 complete fruits, 7 halves and 11 fragments in 11 samples (1 fruit in sample 4*j* charred)
Profile 11: 3 complete fruits, 2 halves and 9 fragments in 3 samples

Size of 5 fruits: 1·8 (1·6–1·9) × 2·0 (1·7–2·1) mm.

Rorippa cf. *silvestris* (L.) Bess. (Pl. IV, 12)
Profile 4: 1 seed in 1 sample

Size: 0·6 × 0·5 mm.

Sinapis arvensis L. (Pl. IV, 13)
Profile 4: 10 complete seeds and 4 fragments in 5 samples
Profile 11: 2 seeds in 2 samples

Seeds subspherical, with very fine, shallow reticulum, poorly marked on some specimens. There is no punctation in the reticulum meshes, which differs them from the seeds of *Brassica*. Size of 5 seeds: 1·5 (1·3–1·9) × 1·38 (1·2–1·8) mm.

Thlaspi arvense L. (Pl. IV, 14)
Profile 4: 7 complete seeds and 6 fragments in 9 samples
Profile 11: 1 complete seed and 6 fragments in 2 samples

Size of 8 seeds: 1·78 (1·6–2·0) × 1·33 (1·2–1·45) mm.

Cupressaceae

Juniperus communis L. (Pl. V, 11)
Profile 4: 1 fruit-stone in 1 sample

Size: 4·1 × 2·2 mm.

Cuscutaceae

Cuscuta sp. (Pl. II, 15)
Profile 4: 7 seeds in 6 samples
Profile 11: 2 seeds in 2 samples

Size of 5 wet seeds: 1·26 (1·1–1·5) × 1·06 (1·0–1·2) mm. Size of 2 dry seeds: 0·7 × 0·6 mm, 0·8 × 0·7 mm.

Cyperaceae

Carex sp.
Profile 4: 238 complete achenes, 2 halves and 19 fragments in 15 samples
Profile 11: 95 complete achenes and 5 fragments in 6 samples

Cyperus fuscus L. (Pl. IV, 17)
Profile 4: 2 achenes in 2 samples
Profile 11: 1 achene in 1 sample

Fruits trigonous, sharp-edged, walls with 2 axes of symmetry. All fruit walls nearly the same breadth. Trigonous seed, with very delicate transverse wrinkles, visible inside pericarp. Size: 0·9 × 0·45 mm, 0·9 × 0·45 mm, 0·9 × × c. 0·4 mm. *Scirpus silvaticus* L. has very similar fruits.

Heleocharis cf. *palustris* (L.) R. et Sch. (Pl. IV, 18)
Profile 4: 8 achenes in 7 samples
Profile 11: 2 achenes in 2 samples

Fruits obovate, slightly flattened laterally. Apical part rounded, ending in a small beak surrounded by an oval rim, which is a remnant of the destroyed stylopodium. Remains of bristles preserved at base. Surface smooth, somewhat shiny. The stylopodium being destroyed, the species *H. mamillata* Lindb., rare in Poland, cannot be excluded (Strandhede 1966). Size of 10 fruits: 1·47 (1·2–1·8) × 1·03 (0·9–1·15) mm.

Scirpus silvaticus L. (Pl. IV, 16)
Profile 4: 65 achenes in 10 samples
Profile 11: 20 achenes in 4 samples

Fruits trigonous, obovate, walls with one axis of symmetry. One wall broader, two narrower and slightly convex; the edge between these last is blunter than the other two. The apical beak is fairly pronounced, the basal one short and broadened at the end. No bristles are preserved. Fruit surface smooth, somewhat shiny. Size of 10 fruits: 0·96 (0·8–1·1) × 0·62 (0·6–0·7) mm.

Cyperaceae indeterminatae
Profile 4: 13 achenes in 8 samples (1 charred specimen in sample 4*r*)
Profile 11: 4 complete achenes and 1 fragment in 2 samples

Dipsacaceae
Knautia arvensis (L.) Coult. (Pl. X, 4)
Profile 11: 1 half of fruit in 1 sample
Size: length — 4·0 mm, half breadth — 1·2 mm

Ericaceae
Vaccinium sp. (Pl. IV, 15)
Profile 11: 1 seed in 1 sample
Size: 1·05 × 0·55 mm

Euphorbiaceae
Euphorbia helioscopia L. (Pl. II, 14)
Profile 4: 1 seed in 1 sample
Size: 2·1 × 1·7 × 1·5 mm

Gramineae

The measurements of caryopses of grasses are given in the following order: length × breadth × thickness.

Avena sp. (Pl. XII, 1)
Profile 4: 1 complete caryopsis (charred, in sample 4*j*) and 1 fragment (probably charred, in sample 4*o*) in 2 samples
Profile 11: 1 complete caryopsis and 1 fragment (charred) in 1 sample
Size of 2 complete caryopses: 6·2 × 2·3 × 1·8 mm, 5·0 × 1·9 × 1·7 mm.
Digitaria sanguinalis (L.) Scop. (Pl. V, 2)
Profile 11: 1 caryopsis in 1 sample
Size: above 1·3 × 0·8 × 0·55 mm.
Echinochloa crus-galli (L.) P. B. (Pl. V, 3)
Profile 4: 6 spikelets without glumes and 8 detached lemmas and paleas in 7 samples
Profile 11: 4 naked caryopses and 1 spikelet without glumes in 2 samples
Size of 2 spikelets: 2·3 × 1·9 × 0·9 mm, 2·4 × 1·5 × 0·8 mm. Size of naked caryopsis: 2·0 × 1·5 × 0·9 mm.
Lolium sp. (Pl. V, 1)
Profile 11: 1 caryopsis (charred) in 1 sample
Caryopsis truncated and flattened at the apex, on ventral side narrowing in a wedge-like manner towards the base. Lower end broken. Hilum extending up to top of grain. Embryo broadly rounded at top (Wieserowa 1967). Size: 3·8 × × 1·5 × 1·0 mm.
Panicum miliaceum L. (Pl. XII, 3)
Profile 4: 14 spikelets and 12 detached lemmas and paleas in 11 samples
Profile 11: 1 naked caryopsis (charred) in 1 sample
Size of spikelets: 3 specimens soaked in glycerine — 3·3 × 2·0 × 1·4 mm, 3·2 × 2·2 × 1·4 mm, 3·0 × 1·8 × 1·35 mm; 2 dry specimens — 3·2 × 1·7 × 1·1 mm, 2·9 × 1·7 × 1·2 mm.
Secale cereale L. (Pl. V, 5–6)
Profile 4: the charred remains were found in 4 samples: 1 complete caryopsis, badly deformed, 2 fragments of caryopses, 4 fragments of spike rachis, 1 tuft of hair from spike rachis and 1 fragment of hispid keel of lemma.
Profile 11: 2 complete charred caryopses and 1 fragment in 2 samples
Fragments of spike rachis consist of parts of two neighbouring internodes, with long hairs on the margins. The upper part of the internode narrowed, resembling a truncated cone; remains of broken lemma and palea are preserved at the top and the basal parts of two glumes are visible at the sides below. These characteristic features differ the specimens under description from barley, in which the top of a single internode is cut horizontally and the glumes, lemmas, and paleas are attached at approximately the same level. Size of 2 caryopses: 7·8 × 3·6 × 3·2 mm, 4·7 × 2·4 × 1·9 mm.
Setaria glauca (L.) P. B. (Pl. V, 7)
Profile 4: 107 spikelets, 1 naked caryopsis and 131 detached lemmas and paleas in 17 samples
Profile 11: 10 spikelets, 5 naked caryopses and 30 detached lemmas and paleas in 6 samples

Size of 10 spikelets soaked in glycerine mixture: 2·81 (2·7–3·0)×1·79 (1·6–1·9)×1·16 (1·1–1·3) mm. Size of 3 naked caryopses soaked in glycerine mixture: 2·1×1·5×1·0 mm, 2·4×1·65×1·0 mm, 2·5×1·8×1·2 mm.

Setaria viridis (L.) P. B. or *S. verticillata* (L.) P. B. (Pl. V, 4)

Profile 4: 9 spikelets in 4 samples

Profile 11: 3 spikelets, 1 detached lemma or palea and 1 naked caryopsis (charred)

The uncharred spikelets consist of a lemma and palea without the caryopsis; one specimen has a remnant of grain coat with an oval hilum preserved. The surface of both the lemma and palea is markedly verrucose. The damaged charred naked caryopsis has its ventral side flattened and a long embryo. Size of 5 spikelets soaked in glycerine mixture: 2·1 (2·0–2·3)×1·12 (1·05–1·2)×0·9 (0·6–0·85) mm. Size of 2 dry spikelets: 2·1×1·2×0·8 mm, 2·2×1·2×0·85 mm.

Triticum aestivum L. s. l. (Pl. XII, 4)

Profile 11: 5 complete caryopses and 3 fragments (charred) in 2 samples

Size: 4·5×2·8×2·3 mm, 4·1×2·4×2·3 mm, 5·0×3·6×3·1 mm, 4·5×3·5× ×2·5 mm.

Cerealia indeterminata

Profile 4: 4 fragments of caryopses and 1 fragment of lemma or palea (charred) in 3 samples

Profile 11: 9 fragments of charred caryopses in 4 samples

Paniceae indeterminatae

Profile 4: 2 spikelets and 3 lemmas or paleas in 2 samples

Profile 11: 1 naked caryopsis and 2 detached specimens of lemma or palea in 2 samples

Gramineae indeterminatae

Profile 4: 167 naked caryopses in 12 samples (1 charred in sample 4*p*)

Profile 11: 51 and a half naked caryopses in 7 samples

Guttiferae

Hypericum cf. *acutum* Mnch. (*H. tetrapterum* Fries, Pl. V, 8)

Profile 4: 4 seeds in 4 samples

The sculpture of seeds has the form of a reticulum of fine meshes somewhat elongated transversely to the seed length. Size of 3 seeds: 0·6×0·2 mm, 0·7×0·3 mm, 0·75×0·35 mm. Very similar seeds occur in *H. maculatum* Cr.

Hypericum cf. *maculatum* Cr. (Pl. V, 9)

Profile 4: 7 seeds in 5 samples

Surface covered with fine reticulum of narrow meshes, more elongated transversely than in *H. acutum*. Size of 7 seeds: 0·77 (0·65–0·8)×0·28 (0·25–0·3) mm.

Hypericum perforatum L. (Pl. V, 10)

Profile 4: 37 complete seeds and 5 fragments in 12 samples

Profile 11: 4 complete seeds in 3 samples

Size of 10 seeds: 0·9 (0·65–1·1)×0·41 (0·3–0·5) mm.

Hypericum sp.
Profile 4: 4 seeds in 3 samples
Iridaceae
Iris sibirica L. (Pl. V, 12)
Profile 4: 4 seeds in 2 samples

Seed outline circular, flattened on one side. Testa with double wing along convex part of circumference and single wing along flattening. Surface smooth, shiny, covered with flat reticulum formed by large cells of epidermis. Seed without testa roundish-ovate, dull, with rough, slightly folded or wrinkled surface. Size of seeds with testa: 5·5 × 4·9 mm, 5·0 × 3·4 mm.

Juglandaceae
Juglans regia L.
Profile 4: 1 fragment of nut-shell in 1 sample
Juncaceae
Juncus sp.
Profile 4: 1004 seeds in 18 samples
Profile 11: 15 seeds in 2 samples

The seeds belong to several species.

Luzula multiflora (Retz.) Lej. (Pl. V, 14)
Profile 4: 2 seeds in 2 samples (1 seed charred, in sample 4*d*)
Profile 11: 2 seeds in 2 samples

Size of 3 seeds: 1·1 × 0·8 mm, 1·1 × 0·8 mm, 1·1 × 0·7 mm.

L. multiflora belongs to a group of species with somewhat larger seeds. This group includes also *L. silvatica* (Huds.) Gaud., whose seeds are slightly larger and more elongated than those of *L. multiflora* and the reticulation of their surface is finer, and *L. pilosa* (L.) Willd., which has more circular seeds with a very delicate reticulation.

Luzula sp. (Pl. V, 13)
Profile 4: 8 seeds in 6 samples
Profile 11: 4 seeds in 2 samples
Labiatae
Ajuga reptans L. (Pl. VI, 1)
Profile 4: 1 nutlet in 1 sample

Size: 1·8 × 1·3 × 1·0 mm.

Betonica officinalis L. (*Stachys officinalis* (L.) Trevisan, Pl. VI, 2)
Profile 4: 3 nutlets in 3 samples

Top of fruit flattened, wing not preserved. Size: 2·7 × 1·25 mm, 2·5 × 1·25 mm, 2·5 × 1·2 mm.

Calamintha acinos (L.) Clairv. (*Acinos arvensis* (Lam.) Dandy, Pl. VI, 3)
Profile 4: 3 nutlets in 3 samples

Fruits obovate, rounded at top, narrowing in a wedge-like manner at base. Dorsal side almost flat, ventral side roof-shaped. Edges fairly well defined only in basal part, lateral edges sharper than ventral edge. Attachment scar V-shaped, present only on ventral side. Size: 1·25 × 0·65 mm, 1·25 × ? (damaged).

This species has not hitherto been reported from archaeological excavations in Poland.

Calamintha officinalis Mnch. (*C. nepeta* (L.) Savi ssp. *glandulosa* (Req.) P. W. Ball, Pl. VI, 5)
Profile 4: 1 nutlet in 1 sample
Profile 11: 2 nutlets in 1 sample

Fruits ovate, bluntly trigonous, narrowing in a wedge-like manner at base, slightly pointed at top. Dorsal side slightly convex, ventral side roof-shaped. Attachment scar seen on both ventral and dorsal sides (Wojciechowska 1966). Size: 1·2 × 0·75 mm, 1·2 × 0·65 mm, 1·1 × 0·65 mm.

This species has not hitherto been described from archaeological localities in Poland.

Calamintha vulgaris (L.) Druce (*Clinopodium vulgare* L., Pl. VI, 9)
Profile 4: 1 nutlet in 1 sample

Fruit broadly elliptical in outline. Dorsal side slightly convex. Ventral side roof-shaped, with a clearly marked edge from the base to the middle of the fruit, where it passes into a flattened triangular field. The attachment scar surrounds the whole, slightly sharpened basal portion of fruit. Surface smooth, somewhat shiny. Size: 1·1 × 0·9 × 0·7 mm.

Galeopsis cf. *ladanum* L. (Pl. VI, 4)
Profile 4: 6 nutlets in 3 samples

Fruits obovate, broadly rounded at top, gradually narrowing downwards. Damaged at base, in the place of the triangular attachment scar. Dorsal side is slightly convex, the ventral one roof-shaped, with the well-developed ventral edge extending for about two-thirds of the fruit length. Above the edge the ventral wall descends towards the dorsal side. Surface smooth, dull. Size: 2·0 × × 1·25 mm, 2·2 × 1·3 mm.

Morphological group of *Galeopsis tetrahit*

Galeopsis pubescens Bess., *G. speciosa* Mill., *G. tetrahit* L. and *G. bifida* Boenn. have somewhat larger and broader fruits than has *G. ladanum* L. The fruits of these species are characterized by their broadly obovate outline, narrow base and large attachment scar. Slight differences in the size of fruits, the shape of the lateral edges and the position of the attachment scar made it possible to identify *G. pubescens*, *G. speciosa* and *G. tetrahit*. The specimens which could not be included in particular species were grouped together as *G. tetrahit* type.

Galeopsis pubescens Bess. (Pl. VI, 6)
Profile 4: 3 nutlets in 3 samples
Profile 11: 1 nutlet in 1 sample

Fruits somewhat shorter than those of *G. speciosa* and *G. tetrahit*. The roundish attachment scar is situated nearly perpendicularly to the long axis of the fruit. Lateral edges sharp, arcuately bent when seen from a side, somewhat shifted on to the dorsal side. Size of 5 fruits: 2·45 (2·35–2·6) × 1·96(1·85–2·15) × × 1·33(1·25–1·5) mm.

Galeopsis speciosa Mill (Pl. VI, 8)
Profile 4: 3 nutlets in 2 samples
Profile 11: 1 nutlet in 1 sample

These are the most flattened fruits in this group of species. The attachment scar is somewhat more oval than in *G. pubescens* and *G. tetrahit*, and positioned slightly obliquely to the long axis. Dorsal side almost flat, surrounded with a flattened rim nearly all round the circumference, lateral edges distinct and sharp. Size of 1 fruit: $2{\cdot}7 \times 2{\cdot}1 \times 0{\cdot}9$ mm.

Galeopsis tetrahit L. (Pl. VI, 7)
Profile 4: 3 nutlets in 3 samples

Large roundish-oval attachment scar at base, situated slightly obliquely to the long axis of fruit. Lateral edges distinct but not so sharply delineated as those in *G. pubescens*, nearly straight in the side-view and not shifted towards the dorsal side. Size: $3{\cdot}0 \times 2{\cdot}1 \times 1{\cdot}5$ mm, $2{\cdot}7 \times 2{\cdot}0 \times 1{\cdot}4$ mm.

Galeopsis tetrahit L. type.
Profile 4: 14 complete nutlets and 3 fragments in 6 samples
Profile 11: 3 nutlets in 2 samples

Glechoma hederacea L. (Pl. VI, 10)
Profile 4: 1 nutlet in 1 sample

Fruit almost cylindrical, bluntly trigonous. Dorsal wall slightly convex, ventral wall roof-shaped, ventral edge blunt. Base damaged. Surface rough, finely punctated, with gentle lustre. Pericarp thick, which is characteristic of these relatively small fruits (Wojciechowska 1966). Size: $1{\cdot}15 \times 0{\cdot}8$ mm.

This species has not hitherto been described from archaeological localities in Poland.

Lycopus europaeus L. (Pl. VII, 1)
Profile 4: 12 nutlets in 6 samples
Profile 11: 2 nutlets in 2 samples

Size of 6 fruits: $1{\cdot}38$ $(1{\cdot}25–1{\cdot}50) \times 0{\cdot}97$ $(0{\cdot}9–1{\cdot}05)$ mm.

The very similar nutlets of *L. exaltatus* L. fil. are markedly rounded at the top (Wojciechowska 1961).

Mentha cf. *arvensis* L. (Pl. VII, 2)
Profile 4: 4 nutlets in 4 samples

Size of 4 fruits: $0{\cdot}74$ $(0{\cdot}7–0{\cdot}8) \times 0{\cdot}46$ $(0{\cdot}45–0{\cdot}50)$ mm.

Mentha sp.
Profile 4: 39 nutlets in 12 samples
Profile 11: 8 nutlets in 5 samples

Nepeta cataria L. (Pl. VII, 3)
Profile 4: 1 nutlet in 1 sample

Ventral side gently roof-shaped, ventral edge poorly marked, hardly visible in basal portion. Attachment scar V-shaped, with wide open arms, at base on ventral side. Size: $1{\cdot}4 \times 1{\cdot}0$ mm; breadth: length ratio — $0{\cdot}71$; in extant specimens it averages $0{\cdot}78$ (Wojciechowska 1966).

Nepeta nuda L. (Pl. VII, 4)
Profile 4: 1 nutlet in 1 sample

Ventral side roof-shaped, with ventral edge well-defined all along fruit. Fruit smaller than extant specimens but resembling them in breadth: length ratio, averaging 0·59 in this species (Wojciechowska 1966). Size: 1·4 × 0·8 mm; breadth: length ratio — 0·57.

Origanum vulgare L. (Pl. VII, 5)
Profile 4: 34 nutlets in 12 samples
Profile 11: 6 nutlets in 4 samples

Fruits broadly ovate in outline, sometimes roundish, with distinct but rounded edges. Dorsal side almost flat, at narrowed base bent markedly towards ventral side. Ventral side slightly roof-shaped, with rounded top, broadest below the middle of fruit. Broad attachment scar with sharp longitudinal edge. Surface almost smooth, slightly lustrous, with shallow pits. Size of 10 fruits: 0·72 (0·65–0·8) × 0·53 (0·45–0·60) mm.

Some fruits of the genus *Mentha* resemble those of *Origanum vulgare* but are more trigonous and lack the finely and shallowly pitted sculpture of these last.

This species has not hitherto been described from archaeological localities in Poland.

Prunella vulgaris L. (Pl. VII, 7)
Profile 4: 127 nutlets in 13 samples
Profile 11: 44 complete nutlets and 2 fragments in 5 samples

Size of 10 fruits preserved without outer shiny layer of pericarp: 1·59 (1·2–1·8) × 0·95 (0·7–1·1) mm. Size of 5 fruits with lustrous layer of pericarp: 1·78 (1·7–1·9) × 1·1 (1·1) mm.

Salvia cf. *nemorosa* L. (Pl. XII, 5)
Profile 4: 1 nutlet in 1 sample

Size: 1·7 × c. 1·6 mm (cracked specimen).

Salvia verticillata L. (Pl. VII, 6)
Profile 4: 2 nutlets in 2 samples

Size: 2·1 × 1·5 mm.

Scutellaria galericulata L.
Profile 11: 1 nutlet in 1 sample

Fruit elliptically subspherical, somewhat flattened. Dorsal side slightly convex, ventral side more convex. Attachment scar on protruding appendage. Surface covered with relatively large distinct verrucae. Size: 1·4 × 1·0 mm.

This species has not hitherto been described from archaeological localities in Poland.

Stachys annua L. (Pl. VII, 8)
Profile 4: 1 nutlet in 1 sample

Size: 1·9 × 1·7 mm.

Stachys cf. *palustris* L. (Pl. XII, 6)
Profile 4: 1 nutlet in 1 sample
Size: 2·0×1·5 mm.

Thymus sp.
Profile 4: 1 nutlet in 1 sample
Profile 11: 1 nutlet in 1 sample
Size: 0·6×0·6 mm.

Labiatae indeterminatae
Profile 4: 8 nutlets in 6 samples
Profile 11: 5 nutlets in 4 samples

Linaceae
Linum catharticum L. (Pl. V, 15)
Profile 4: 10 seeds in 6 samples
Profile 11: 10 seeds in 4 samples
Size of 10 seeds: 1·08 (1·0–1·2) mm ×0·62 (0·5–0·7) mm.

Linum usitatissimum L. (Pl. V, 16)
Profile 4: 15 seeds in 8 samples
Profile 11: 1 seed in 1 sample
Size of 10 seeds: 3·9 (3·3–4·4)×2·3 (2·1–2·6) mm.

Lythraceae
Lythrum cf. *salicaria* L. (Pl. VII, 9)
Profile 4: 74 seeds in 11 samples
Profile 11: 18 seeds in 4 samples

Seed surface slightly lustrous, covered with narrow cells arranged in not very regular longitudinal rows. During the process of fossilization these cells bulge in some specimens and form tubercles. A similar phenomenon is observed in contemporary seeds after their being boiled in 10% KOH. Fossil specimens with the outer layer of the testa destroyed have their surface covered with a fine reticulum of somewhat elongated meshes.

Out of the three species occurring in Poland, *L. hyssopifolia* L. has seeds considerably shorter and more roundish than those of *L. salicaria*. The seeds of *L. virgatum* L. are very much like the seeds of *L. salicaria*, but this species occurs in this country very rarely. Size of 10 seeds: 0·97 (0·9–1·0)×0·46 (0·3–0·5) mm.

Malvaceae
Malva silvestris L. (Pl. X, 1)
Profile 4: 1 mericarp in 1 sample
Diameter: 2·4×2·5 mm.

Moraceae
Ficus carica L. (Pl. X, 3)
Profile 4: 10 fruits in 8 samples
Profile 11: 8 fruits in 3 samples

Fruits fairly variable in outline, from roundish-oval to obovate. Broadly rounded and thick at one end and more or less narrowed and flattened at the other. The sharp edge begins more or less halfway along the dorsal side and passes over the narrowed end of the fruit to the round attachment scar on the ventral side. The broadened fruit end has no edge. Surface smooth, slightly shiny or dull. Size of 10 seeds: 1·39 (1·2–1·6) × 1·08 (0·7–1·35) mm.

Similar fruits occur in *Morus alba* L., but these are larger, usually slightly narrowed at both ends, their hilum being more elongate and the edge on the dorsal side less distinct.

The first finding of fig seeds in Poland.

Oenotheraceae

Epilobium sp. (Pl. X, 2)

Profile 4: 2 seeds in 2 samples

Size: 0·8 × 0·4 mm, 0·8 × 0·4 mm.

Papaveraceae

Papaver argemone L. (Pl. VII, 10)

Profile 4: 1 seed in 1 sample

Seed narrow reniform in outline. On the ventral side there is a shallow but long (about one-half of seed length) depression, with raphe running lengthwise across the middle. Surface covered by reticulum of relatively large rectangular meshes elongated transversally to the seed length. Size: 0·8 × 0·4 mm.

This species has not hitherto been described from archaeological localities in Poland.

Papaver somniferum L. (Pl. VII, 11)

Profile 11: 2 seeds in 2 samples

Size: 1·3 × 0·9 mm, 1·1 × 0·8 mm.

Papaver sp.

Profile 4: 6 seeds in 5 samples

Papilionaceae indeterminatae (Pl. VII, 12)

Profile 4: 2 seeds in 2 samples (seed from sample 4*o* charred)

Size: 1·4 × 1·4 mm, 1·4 × 1·2 mm.

Pinaceae

Abies alba Mill. (Pl. X, 6)

Profile 4: 11 more or less complete needles and 1 fragment in 4 samples

Picea excelsa (Lam) Lk. (*P. abies* (L.) Karsten ssp. *abies*, Pl. X, 5)

Profile 4: 1 fragment of needle in 1 sample

Profile 11: 1 fragment of needle (base) in 1 sample

Plantaginaceae

Plantago cf. *indica* L. (*P. arenaria* Waldst. & Kit., Pl. VII, 15).

Profile 11: 1 seed in 1 sample (probably charred)

Seed boat-shaped, ± elliptical in outline. The edges inrolled, form a slightly flattened rim, which narrows distinctly at one end. The inconspicuous oval hilum lies in the centre of the concave ventral side and longitudinal thickenings extend from it to both ends. Dorsal side convex. Size: 1·9 × 0·9 × 0·6 mm.

This species has not hitherto been described from archaeological localities in Poland.

The very similar seeds of *P. lanceolata* L. have their marginal rim uniformly broad for all the circumference and unflattened, and the hilum on the ventral side somewhat raised and more elongated. The longitudinal thickening most often runs only in one direction from the hilum. The dorsal side is less convex.

Plantago maior L. (Pl. VII, 16)

Profile 4: 6 seeds in 4 samples

Profile 11: 1 seed in 1 sample

Size of 5 seeds: 1·18 (1·1–1·3) × 0·68 (0·6–0·8) mm.

Plantago pauciflora Gilib. (*P. major* L. subsp. *intermedia* (DC.) Arcangeli, Pl. VII, 14)

Profile 4: 2 seeds in 2 samples

Profile 11: 2 seeds in 2 samples

Seeds smaller and thicker than in *P. maior*, their breadth almost equal to thickness. Sculpture of wavy striae somewhat higher than in *P. maior*, but similarly arranged. Size: 0·8 × 0·55 mm, 0·75 × 0·4 mm, 0·9 × 0·45 mm.

Polygonaceae

Polygonum aviculare L. s. l. (Pl. VIII, 1)

Profile 4: 63 complete fruits and 10 fragments in 12 samples

Profile 11: 23 complete fruits and 2 fragments in 6 samples

Size of 10 fruits: 2·5 (2·1–3·0) × 1·5 (1·2–1·7) mm.

Polygonum convolvulus L. (*Bilderdykia convolvulus* (L.) Dumort, Pl. VIII, 2)

Profile 4: 20 complete fruits and 21 fragments in 13 samples

Profile 11: 2 complete fruits and 7 fragments in 3 samples

Size of 8 fruits: 3·08 (2·5–3·6) × 2·08 (1·9–2·3) mm.

Polygonum hydropiper L. (Pl. VIII, 3)

Profile 4: 1 complete fruit and 2 fragments in 3 samples

Profile 11: 2 complete fruits and 3 fragments in 3 samples

Size: 2·9 × 2·1 mm, 2·6 × 1·7 mm.

Polygonum minus Huds. (Pl. VIII, 7)

Profile 4: 4 complete fruits in 4 samples

Profile 11: 1 complete fruit in 1 sample

Size of 3 fruits: 1·7 × 1·1 mm, 1·6 × 1·1 mm, 1·9 × 1·2 mm.

Polygonum nodosum Pers. (Pl. VIII, 4)

Profile 4: 12 complete fruits and 4 halves in 8 samples

Profile 11: 1 and a half fruits in 1 sample

Size of 5 fruits with remnants of perianth at base: 2·38 (2·2–2·6) × 1·61 (1·35–1·9) mm. Size of 5 fruits without remnants of perianth at base: 2·1 (2·0–2·2) × 1·62 (1·5–1·7) mm.

Polygonum tomentosum Schrk. (Pl. VIII, 6)

Profile 4: 44 complete fruits and 4 halves (1 specimen charred, in sample 4*c*) in 14 samples

Profile 11: 6 fruits in 3 samples

Size of 10 fruits with remnants of perianth at base: 2·58 (2·0–2·9)×1·92 (1·8–2·1) mm. Size of 10 fruits without remnants of perianth at base: 2·38 (2·0–2·9)×2·11 (1·7–2·4) mm.

Polygonum lapathifolium L. s. l. (Pl. VIII, 5)

Profile 4: 29 complete fruits and 6 halves in 10 samples

Profile 11: 14 complete fruits, 3 halves and 1 fragment in 5 samples

Fruits intermediate in shape between *Polygonum nodosum* and *P. tomentosum* are included here. Size of 5 fruits with remnants of perianth at base: 2·36 (2·2–2·5)×1·74 (1·6–1·8) mm. Size of 10 fruits without remnants of perianth at base: 2·27 (2·0–2·7)×1·85 (1·5–2·1) mm.

Polygonum persicaria L. (Pl. VIII, 8)

Profile 4: 49 complete fruits, 5 halves and 6 fragments in 15 samples

Profile 11: 10 complete fruits, 1 half and 2 fragments in 4 samples

Size of 5 fruits with remnants of perianth at base: 2·58 (2·2–2·9)×1·82 (1·4–2·1) mm. Size of 10 fruits without remnants of perianth at base: 2·45 (2·0–2·8)×1·86 (1·6–2·0) mm.

Polygonum sp.

Profile 4: 39 complete fruits, 1 half, 40 fragments and a leaf of perianth in 10 samples

Profile 11: 13 complete fruits and 1 fragment and 2 leaves of perianth in 4 samples

Rumex acetosa L. (Pl. IX, 1)

Profile 4: 1 fruit in 1 sample

Size: 1·3×0·8 mm.

Rumex acetosella L. s. l. (Pl. IX, 2–3)

Profile 4: 229 complete fruits and 1 fragment in 14 samples

Profile 11: 48 fruits in 6 samples

Size of 100 fossil specimens from different samples: 1·08 (0·8–1·4)×0·77 (0·5–1·0) mm. Fruits are longer than broad, which makes it possible to exclude *Rumex angiocarpus* Murb. (Rechinger 1964). Judging by their size, (Fig. 6),

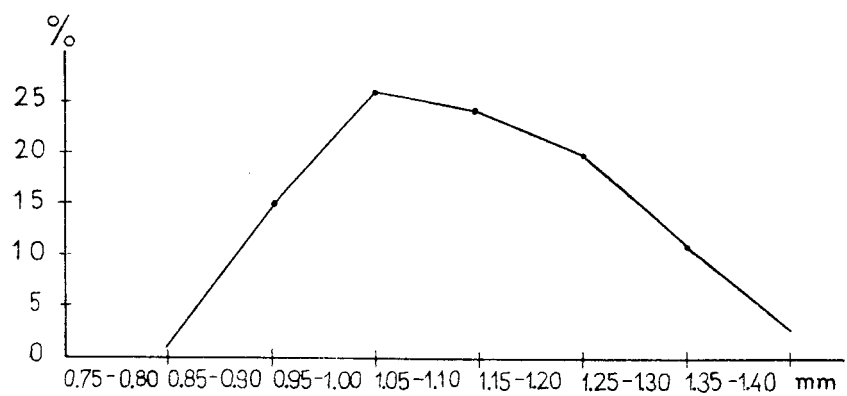

Fig. 6. Length of 100 fossil fruits of *Rumex acetosella* L. s. l.

Ryc. 6. Długość 100 owoców kopalnych *Rumex acetosella* L. s. l.

we may assume that most of fossil fruits belong to *R. tenuifolius* (Wallr.) A. Löve. The presence of *R. acetosella* L. s. str. emend. A. Löve is not excluded, the more so since the dried subfossil specimens are usually somewhat smaller than extant material. Fruits longer than 1·3 mm (about 14% of those measured) might belong to this species. Rechinger (1964) gives the length of 0·9–1·3 mm for contemporary fruits of *R. tenuifolius* and 1·3–1·5 mm for those of *R. acetosella* s. str.

Rumex crispus L. (Pl. IX, 4)
Profile 4: 13 fruits without perianth, 1 with perianth and 1 fragment of perianth leaf in 7 samples

Nutlets trigonous, pyriform, edges sharp, clearly delimited from the walls all along their length. In contradistinction to *R. obtusifolius* L., the walls are slightly convex. Size of 10 fruits: 1·83 (1·6–2·0)×1·24 (1·0–1·5) mm.

Rumex obtusifolius L. (Pl. IX, 5)
Profile 4: 5 fruits in 3 samples

Nutlets similar to *R. crispus*. Edges sharp, but not delimited from the walls. Walls flat with an inconspicuous longitudinal depression in the middle (these characteristics are best seen when the fruits are looked at from the base). Size: 1·85×1·3 mm, 2·0×1·2 mm, 2·0×1·2 mm.

Rumex sp.
Profile 4: 16 fruits in 8 samples
Profile 11: 5 complete fruits and 2 fragments in 4 samples

Portulacaceae
Portulaca oleracea L. (*P. oleracea* L. ssp. *oleracea*, Pl. VII, 13)
Profile 4: 1 seed in 1 sample

Size: 0·9×0·7 mm. The seeds of *P. oleracea* differ from those of *P. sativa* Haw. chiefly in size. Their length in *P. sativa* Haw. (*P. oleracea* L. ssp. *sativa* (Haw.) Celak) always exceeds 1 mm and in *P. oleracea* is 0·5–1·0 mm (Kowal 1961).

Portulaca sp.
Profile 4: 1 damaged seed in 1 sample

Primulaceae
Anagallis arvensis L. (Pl. VII, 17)
Profile 4: 6 seeds in 5 samples
Profile 11: 2 seeds in 1 sample

Size of 5 seeds: 1·16 (1·0–1·2)×0·83 (0·8–0·9); height 0·74 (0·6–0·8) mm.

Lysimachia vulgaris L. (Pl. VII, 18)
Profile 4: 3 seeds in 3 samples
Profile 11: 1 seed in 1 sample

Size of 3 seeds (length × breadth × height): 1·4×1·2×0·5 mm, 1·1× ×0·9×0·5 mm, 1·1×1·0×0·6 mm.

Primulaceae indeterminatae
Profile 4: 4 seeds in 3 samples

Ranunculaceae
Caltha sp. (Pl. IX, 6)
Profile 4: 2 seeds in 2 samples
Size: 1·75 × 0·7 mm, 1·4 × 0·5 mm.

Ranunculus acer L. (*R. acris* L., Pl. IX, 7)
Profile 4: 28 achenes in 13 samples
Profile 11: 13 achenes and a half in 4 samples

Lateral side covered with a fine, pitted reticulum, the meshes of which are larger in the central part and decrease peripherally (this characteristic is well seen on recent specimens when the epidermis is removed). The edges are flattened, almost winged. The size of fruits of this species varies within a wide range. Size of 10 fruits: 1·77 (1·4–2·2) × 1·45 (1·0–1·7) mm.

The similar fruits of *R. lanuginosus* L. are somewhat larger, with a considerably longer beak, distinctly bent towards the dorsal side.

Ranunculus flammula L. (Pl. IX, 8)
Profile 4: 2 achenes in 2 samples
Profile 11: 3 achenes and a half in 2 samples
Size of 5 fruits: 1·23 (1·1–1·4) × 0·89 (0·7–1·1) mm.

Ranunculus repens L. (Pl. IX, 9)
Profile 4: 58 complete achenes and 8 fragments in 14 samples
Profile 11: 13 complete achenes and 2 fragments in 3 samples
Size of 10 fruits: 2·46 (2·0–2·85) × 1·9 (1·5–2·3) mm.

Ranunculus sardous Cr. (Pl. IX, 11)
Profile 11: 1 achene in 1 sample

Fruit obovate in outline, much resembling fruits of *R. repens* L. in shape and size. Sculpture of surface also nearly identical, reticulate and pitted, but with an addition of sparse and pronounced tubercles characteristic of this species. Size: 1·9 × 1·7 mm.

This species has not hitherto been described from archaeological localities in Poland.

Ranunculus sceleratus L. (Pl. IX, 10)
Profile 4: 6 achenes and a half in 6 samples
Profile 11: 1 achene in 1 sample
Size of 6 fruits: 0·97 (0·9–1·1) × 0·78 (0·7–0·9) mm.

Ranunculus sp.
Profile 4: 42 complete achenes, 8 halves and 1 fragment in 10 samples
Profile 11: 22 complete achenes and 5 halves in 5 samples

Thalictrum cf. *flavum* L. (Pl. IX, 12)
Profile 4: 1 achene in 1 sample
Size: 1·85 × 1·1 mm.

Ranunculaceae indeterminatae
Profile 4: 1 achene in 1 sample
Profile 11: 1 achene in 1 sample

Rosaceae
Agrimonia eupatoria L. (Pl. X, 8)
Profile 4: a half of hypanthium in 1 sample
Profile 11: a half of hypanthium in 1 sample
Size: 3·3 × 3·0 mm, 3·4 × 3·1 mm.
Aphanes arvensis L. (Pl. X, 9)
Profile 11: 1 achene in 1 sample
Size: 1·2 × 0·8 mm.
Cerasus sp.
Profile 4: 1 half of fruit-stone and 19 fragments in 8 samples
Profile 11: 2 halves of fruit-stones and 7 fragments in 3 samples
Comarum palustre L. (*Potentilla palustris* (L.) Scop., Pl. X, 11)
Profile 4: 1 achene in 1 sample
Size: 1·5 × 1·25 mm.
Filipendula ulmaria (L.) Maxim. (Pl. X, 7)
Profile 4: 8 achenes in 3 samples
Profile 11: 3 achenes in 3 samples
Size of 6 fruits: 2·38 (1·9–3·0) × 0·97 (0·6–1·4) mm.
Fragaria vesca L. (Pl. X, 13)
Profile 4: 41 complete achenes and 1 half in 10 samples
Profile 11: 24 complete achenes and 1 half in 5 samples
On the dorsal side a well-defined edge runs from the beak more or less halfway along the fruit and further disappears gradually. Size of 10 fruits: 1·06 (1·0–1·1) × 0·81 (0·7–0·9) mm.
Fragaria viridis Duch. (Pl. X, 12)
Profile 4: 1 achene in 1 sample
Fruit more convex at broadened and rounded end than that of *F. vesca*. Narrowing of other end less distinct, beak less prominent, undercut a little on ventral side. The well-marked dorsal edge runs from the beak throughout the dorsal side down to the attachment scar. Size: 1·3 × 1·0 mm.
Fragaria sp.
Profile 4: 10 achenes in 5 samples
Fragaria sp. or *Potentilla* sp.
Profile 4: 4 achenes in 4 samples (1 specimen, in sample 4*p*, seems charred)
Profile 11: 1 achene in 1 sample
Pirus sp. or *Malus* sp.
Profile 4: 1 seed without testa in 1 sample
Potentilla cf. *argentea* L. (Pl. X, 10)
Profile 4: 22 achenes in 8 samples
Profile 11: 3 achenes in 3 samples
Fruits slightly obliquely ovate. Ventral side flattened, dorsal side convex, with gently marked dorsal edge. Surface smooth or with ridges running nearly parallel to circumference. Size of 10 fruits: 0·75 (0·65–0·9) × 0·52 (0·45–0·6) mm.
Similar fruits occur in *P. norvegica* L. In nearly all species of *Potentilla*

small fruits of almost the same size and shape (unripe?) may be found occasionally and for this reason the determination of the specimens from the Main Market Square is not quite reliable.

Potentilla erecta (L.) Raeusch (Pl. X, 15)
Profile 4: 43 complete achenes and 1 half in 11 samples
Profile 11: 11 complete achenes and 1 half in 5 samples

Fruits very characteristic, fairly large, with flattened ventral side. Dorsal side arcuately rounded with longitudinal ridge along the back. Ridges forming V-shaped pattern on lateral sides. Size of 10 fruits: 1·36 (1·2–1·7) × 0·82 (0·65–1·0) mm.

Potentilla norvegica L. (Pl. X, 14)
Profile 4: 3 achenes in 2 samples

Fruits broadly obliquely ovate, clearly broader in relation to length than in *P. argentea* (sometimes almost roundish), with their dorsal edge not very sharp. Thick arched ridges on lateral surfaces, almost invisible on some fossil specimens. Size: 0·8 × 0·6 mm, 0·7 × 0·6 mm, 0·7 × 0·6 mm.

Potentilla sp.
Profile 4: 61 complete achenes and 6 fragments in 13 samples
Profile 11: 30 achenes in 5 samples

Prunus sp.
Profile 4: 3 fragments of fruit-stones in 2 samples

Rubus caesius L. (Pl. X, 16)
Profile 4: 3 fruit-stones in 3 samples

Size: 3·4 × 1·8 mm, 3·1 × 2·0 mm.

Rubus idaeus L. (Pl. X, 17)
Profile 4: 31 fruit-stones in 13 samples
Profile 11: 7 fruit-stones in 5 samples

Size of 10 fruits: 2·03 (1·6–2·2) × 1·18 (1·0–1·4) mm.

Rubus plicatus W. et N. type (Pl. X, 18)
Profile 4: 3 fruit-stones in 2 samples

Fruits of this type occur in many species, of which *R. plicatus* and *R. suberectus* Anders. are the most frequent in Poland. In subfossil materials the fruits of this shape were often described as *Rubus fruticosus* L. Size: 2·5 × 1·55 mm, 2·5 × 1·7 mm, 2·3 × 2·0 mm.

Rubus sp.
Profile 4: 7 complete fruit-stones and 6 fragments in 8 samples
Profile 11: 4 complete fruit-stones and 2 fragments in 3 samples

Rosaceae indeterminatae
Profile 4: 9 fragments of fruit-stones in 3 samples
Profile 11: 6 fragments of fruit-stones in 1 sample

Rubiaceae

Galium cf. *boreale* L. (Pl. IX, 13)
Profile 4: 1 mericarp in 1 sample

Lateral outline narrow-reniform, ventral side concave with longitudinal

depression. Elongate, not very regular verrucae on surface. Hairs not preserved. The sculpture under the damaged outer layer of pericarp has the form of a reticulum of fine polygonal meshes. Size: 2·0 × 0·6 mm.

The similar fruits of *G. pumilum* Murr. and *G. saxatile* L. are somewhat smaller and covered with round verrucae. The fruits of *G. verum* L. are more circular in outline. The fruits of *G. vernum* Scop., most similar in shape and size, have transversely elongated cells under the outer layer of the pericarp.

This species has not hitherto been described from archaeological localities in Poland.

Galium elongatum Presl. (Pl. IX, 14)
Profile 4: 1 mericarp in 1 sample
Profile 11: 1 mericarp in 1 sample
Size: diameter — 1·5 and 1·9 mm.

Galium cf. *mollugo* L. (Pl. IX, 15)
Profile 4: 1 mericarp in 1 sample
Size: 0·9 × 0·7 mm.

Galium palustre L. (Pl. IX, 16)
Profile 4: 1 mericarp in 1 sample
Fruit identical with that of *G. elongatum* as regards shape but smaller. Size: 1·25 × 1·0 mm.

Galium spurium L. (Pl. IX, 17)
Profile 11: 1 mericarp (charred) in 1 sample
Size: 1·8 × 1·4 mm.

Galium spurium L. or *G. tricorne* Stock.
Profile 4: 7 complete pericarps and 1 fragment in 7 samples
Profile 11: 1 complete pericarp and 1 fragment in 1 sample

Some macerated coats (inner layer of pericarp or testa), with isodiametric cells seen on their surface, are preserved in these samples. The sculpture of this type occurs in the fruits of *G. spurium* and *G. tricorne*. The subfossil specimens are crushed and damaged to the extent that their original shape cannot be reconstructed.

Galium sp.
Profile 4: 1 complete mericarp and a fragment in 2 samples
Profile 11: 1 mericarp in 1 sample

Salicaceae

Salix sp. (Pl. XI, 6)
Profile 4: 7 buds in 6 samples

Scrophulariaceae

Linaria vulgaris (L.) Mill. (Pl. XI, 1)
Profile 4: 16 seeds in 8 samples
Profile 11: 3 seeds in 2 samples

Size of 10 seeds: diameter including wing — 1·8 (1·3–2·2) mm diameter without wing — 0·97 (0·65–1·2) mm.

Scrophularia alata Gilib. (*S. umbrosa* Dumort.) or *S. nodosa* L. (Pl. XI, 2–3)
Profile 4: 8 seeds in 5 samples
Profile 11: 1 seed in 1 sample

Seeds ± cylindrical, rounded or truncated at ends. About 8 longitudinal, undulately dentate ribs on surface. In the grooves between the ribs there are thin transverse ridges in groups of 2–3; depressions between these ridges are with a small pit in the middle each. Size of 9 seeds: 0·71 (0·65–0·8) × 0·43 (0·3–0·55) mm.

The seeds of *S. scopolii* Hoppe have thicker and blunter ribs and better marked pits.

Verbascum sp. (Pl. XI, 4–5)
Profile 4: 2 seeds in 1 sample
Size: 0·9 × 0·6 mm, 0·6 × 0·45 mm.

Veronica sp.
Profile 4: 11 seeds in 5 samples

Solanaceae

Hyoscyamus niger L. (Pl. XI, 8)
Profile 4: 5 complete seeds and 4 fragments in 5 samples
Profile 11: 7 complete seeds and 1 fragment in 2 samples
Size of 7 seeds: 1·41 (1·35–1·6) × 1·4 (1·1–1·5) mm.

Solanum nigrum L. (Pl. XI, 7)
Profile 4: 13 seeds in 9 samples
Profile 11: 3 seeds in 3 samples
Size of 10 seeds: 1·72 (1·3–1·9) × 1·35 (1·1–1·7) mm.

Solanaceae indeterminatae
Profile 4: 1 fragment of seed in 1 sample

Typhaceae

Typha sp. (Pl. XII, 7)
Profile 4: 3 seeds in 2 samples
Size of 2 seeds without opercle: 0·9 × 0·25 mm.

Umbelliferae

Bupleurum rotundifolium L. (Pl. XI, 9)
Profile 4: 3 mericarps in 3 samples
Size: 2·8 × 1·4 mm, 2·4 × 1·3 mm, 3·3 × 1·7 mm.

Daucus carota L. (Pl. XI, 10)
Profile 4: 16 mericarps in 8 samples
Profile 11: 4 complete mericarps and 2 fragments in 3 samples
Size of 10 fruits: 2·13 (1·8–2·4) × 1·24 (1·1–1·4) mm.

Heracleum sphondylium L. s. l. (Pl. XII, 2)
Profile 4: 1 mericarp in 1 sample

Fruit heavily damaged. On the ventral side the middle ridge is seen and 2 vittae broadened at one end in a club-like manner, characteristic of this species and extending from the top at the most halfway along the fruit. Size: length — above 3·8 mm, breadth — about 3·1 mm.

H. sibiricum L. has very similar fruits but occurs chiefly in the north and east of this country (Gawłowska 1957). The fruits of *Pastinaca* and *Peucedanum* have ventral vittae narrower and longer.

Peucedanum cervaria (L.) Lap. (Pl. XI. 11)

Profile 4: 1 mericarp in 1 sample

Fruit broadly elliptical, strongly flattened, narrowly winged. On dorsal side 4 dark vittae extending nearly down to fruit base. Ventral side with two vittae, fairly broad, running more or less parallel to each other without reaching fruit base (Kowal & Wojterska 1973). Size: length — about 4·5 mm, breadth — about 3·0 mm.

This species has not hitherto been described from archaeological localities in Poland.

Umbelliferae indeterminatae

Profile 4: 1 complete mericarp and 3 fragments in 3 samples

Urticaceae

Urtica dioica L. (Pl. XI, 15)

Profile 4: 36 fruits in 12 samples

Profile 11: 8 fruits in 5 samples

Size of 10 fruits: 1·05 (0·9–1·2) × 0·73 (0·6–0·85) mm.

Urtica urens L. (Pl. XI, 14)

Profile 4: 2 fruits in 2 samples

Size: 1·7 × 1·2 mm.

Valerianaceae

Valeriana cf. *officinalis* L. (Pl. XI, 12)

Profile 4: 9 fruits in 6 samples

Profile 11: 6 fruits in 4 samples

Size of 7 fruits: 2·21 (2·0–2·4) × 0·95 (0·8–1·15) mm.

Valerianella dentata (L.) Poll. (Pl. XI, 16)

Profile 4: 7 complete fruits and 1 fragment in 2 samples

Profile 11: 1 half of fruit in 1 sample

Size of 7 fruits: 2·04 (1·8–2·3) × 1·24 (1·1–1·4) mm.

Verbenaceae

Verbena officinalis L. (Pl. XI, 13)

Profile 4: 4 nutlets in 3 samples

Size: 1·7 × 0·65 mm, 1·6 × 0·5 mm, 1·3 × 0·5 mm.

Violaceae

Viola arvensis Murr. or *V. tricolor* L. (Pl. XI, 17)

Profile 4: 17 complete seeds and 3 fragments in 7 samples

Profile 11: 1 seed in 1 sample

Size of 10 seeds: 1·35 (1·2–1·5) × 0·76 (0·7–0·8) mm.

Viola silvestris Rchb. type (*V. reichenbachiana* Jordan type, Pl. XI, 18)

Profile 4: 3 complete seeds and 1 half in 2 samples

Profile 11: 1 seed in 1 sample

Seeds resembling those of *Viola arvensis* Murr. and *V. tricolor* L. in shape

but larger. Similar seeds occur in *V. palustris* L., whereas the seeds of *V. canina* Rchb., being the same length, are much broader. Other species have not been checked. Size of 4 specimens: 1·7 × 0·9 mm, 1·6 × 1·0 mm, 1·7 × 0·9 mm, 1·6 × × 0·9 mm.

Vitaceae

Vitis vinifera L. ssp. *vinifera* (Pl. XI, 19)

Profile 11: 1 complete seed, 1 half and 1 fragment in 1 sample

Seed pyriform in outline, basal beak narrowed, strongly elongated. Lustrous surface, very finely punctated. Length of complete seed — 3·5 mm, breadth — 1·7 mm. The preserved half of another seed is much larger: length without beak — 6·0 mm, half breadth — 3·2 mm.

DESCRIPTION OF VEGETATION

In the Middle Ages the natural vegetation of the area of today's Cracow was characterized by great diversity conditioned by the morphology of the terrain and the great differentiation of habitats. On the basis of the knowledge of modern plant communities occurring in the environs of Cracov, Kornaś and Medwecka-Kornaś (1974) worked out a map of the potential natural vegetation of the town area, in which they distinguished 6 divisions referred to as community complexes. On this map the largest area is occupied by the complexes of riverside forests on low-lying valley terraces and oak-hornbeam forests on higher terraces and some slopes. The Main Market Square is situated in the region of oak-hornbeam forest habitats. The other complexes, which occupy smaller areas, are those of xerothermic brushwoods on southern rocky slopes, beechwoods on northern rocky slopes, mixed forests on the upland and hill summits and pine forests in sandy places. Following this scheme of community complexes, Trzcińska-Tacik (Trzcińska-Tacik & Wieserowa 1976) made the first attempt to characterize the flora of Cracow in the early and late Middle Ages (10th–15th c.) on the basis of macroscopic remains from different archaeological excavations in the town area. In this compilation she also included materials from the Main Market Square. It has appeared that in both phases of the Middle Ages the largest number of species came from the communities of the oak-hornbeam forest complex and that in the late Middle Ages the total number of forest species decreased in favour of the meadow ones and there was an increase in the number of species of wet habitats.

The present attempt at phytosociological characterization is based exclusively on the material from the Main Market Square, but in addition to macroscopic remains it includes also sporomorphs identified by Koperowa (unpubl.). All the species have been taken into account and only these forms identified to generic level which could have been counted in definite phytosociological units with a certain degree of probability. Less precise determinations have been omitted. Phytosociological classification was accepted according to the Szata

roślinna Polski (Vegetation of Poland, Medwecka-Kornaś *et al.* 1972) and, in several cases, according to Ellenberg (1974). Species included in a given syntaxonomic unit are those characteristic of this unit and also of lower units and the species most commonly occurring in the associations of this unit in the Cracow region now, no matter what their natural habitats might be (H. Trzcińska-Tacik, oral communication). Lists of species are given in Tables 2–8. Samples of the same age from the two profiles are presented jointly in these tables. The first column — the early Middle Ages from the middle of the 11th century to the middle of the 13th — contains all the early medieval samples, i.e. 11 macroscopic and 5 pollen samples except those from the levelling and Gothic layers in profile 4, which are given separately. One macroscopic and 1 pollen samples were examined from the levelling layer (column 2) and 2 macroscopic and 1 pollen samples from the Gothic layer (column 3). The older phase of the late Middle Ages, from the middle of the 13th century throughout the 14th, is represented by 11 macroscopic and 5 pollen samples (column 4). The younger phase from the 15th century, found exclusively in profile 11, has 2 macroscopic and 1 pollen samples (column 5). Sample 11 *h* from the levelling layer has been omitted in the tables. One macroscopic and 2 pollen samples from the modern layers are given in column 6. The serial numbers of samples included in particular groups can be found in Table 1. The last two columns of Tables 2–8 provide information about the frequency of occurrence of macroscopic remains of particular species and their total numbers.

Aquatic, bog and reedswamp plants

The identified species belong at present to the classes *Potametea*, *Phragmitetea* and *Scheuchzerio-Caricetea fuscae* (Table 2, Fig. 7 — is under the cover).

As regards the aquatic plants (*Potametea*), only 2 genera were found, represented by single pollen grains: *Potamogeton* and *Nuphar*.

Seven characteristic and one additional species are numbered in reedswamp communities (*Phragmitetea*), growing at the edge of eutrophic stagnant and slow-running waters. They were all found in small numbers. *Sagittaria sagittifolia*, *Scutellaria galericulata*, *Galium elongatum* and *G. palustre* occurred in only one sample each. *Heleocharis* cf. *palustris*, present in the late medieval layers and in the modern sample, was one of the commonest forms.

The peatbog communities of the class *Scheuchzerio-Caricetea fuscae* are represented by 4 characteristic species, occurring in small numbers — two of them only in pollen.

These groups of plants play a minor role in the material from the Market Square, especially as far as the number of specimens is concerned. The species of all these three classes together form 6·6% of the total number of species (Table 9).

Aquatics and plants of natural moist habitats — Table 2.

Rośliny wodne i rośliny naturalnych siedlisk wilgotnych — Tabela 2.

Plant communities Zbiorowiska roślinne	Characteristic species Cechunki charakterystyczne	Early medieval time Wczesne średniowiecze			Late medieval time - Późne średniowiecze		Modern time Czasy nowożytne	Fruits or seeds Owoce lub nasiona	
		Middle of XI to the middle of XIII century Od połowy XI do połowy XIII w.	Ca. the middle of XIII century Only in profile 4 Około poł. XIII w. Tylko w profilu 4		Middle of XIII to the end of XIV century Od połowy XIII do końca XIV w.	XV cent XV wiek		Total of samples Suma prób	Total of specimens Suma okazów
			Levelling layer - War. niwelacyjna	Gothic layer - Warstwa gotycka					
Potametea									
Nuphar sp.		(+)							
Potamogeton sp.					(+)		(+)		
Phragmitetea									
Alisma plantago-aquatica	ch			+	+	+		5	6
Alisma sp.		(+)			(+)	(+)			
Calium elongatum	ch				+	+		2	2
G. palustre	ch						+	1	1
Heleocharis cf. palustris	ch				+	+	+	9	10
Sagittaria sagittifolia	ch	+						1	1
Scutellaria galericulata	ch				+			1	1
Typha latifolia	ch	(+)	(+)		(+)				
T. sp.		+	+					2	3
T. angustifolia / Sparganium sp.							(+)		
Isoëto-Nanojuncetea									
Cyperus fuscus	ch	+		+		+		3	3
Gypsophila muralis	ch				+			1	2
Plantago paucifiora	ch	+	(+)		+	+		4	4
Scheuchzerio-Caricetea fuscae									
Comarum palustre	ch	(+)			+		(+)	1	1
Menyanthes trifoliata	ch				(+)				
Parnasia palustris	ch		(+)	(+)		(+)	(+)		
Ranunculus flammula	ch				+	+		5	6
Bidentetalia									
Bidens tripartitus	ch				+	+		2	3
B. cernuus	ch				+			1	1
Chenopodium glaucum	ch				+			1	1
Polygonum hydropiper	ch			+	+	+		6	8
P. nodosum	ch	+		+	+		+	9	17
Ranunculus sceleratus	ch	+	+		+	+		7	8
Potentilla norvegica				+	+			2	3

(+) - sporomorphs, + - macroscopic remains. Other explanations in the text.

(+) - sporomorfy, + - szczątki makroskopowe. Pozostałe objaśnienia w tekście.

Plants of meadows, pastures and xerothermic grassland

This group consists of meadow communities and epilithic grasslands, developing on soils varying in moisture content.

The wettest habitats were occupied by meadows similar to the present-day communities of *Molinietalia coeruleae* (Table 3, Fig. 7). Fourteen characteristic and 1 additional species have been numbered in this order, three of them determined on the basis of pollen only (*Gentiana pneumonanthe* type, *Sanguisorba officinalis*, *Succisa pratensis*). The macroscopic remains of *Scirpus silvaticus*, *Lythrum salicaria* and *Ranunculus repens* were the most numerous and present

in nearly all samples from both profiles. There are two culminations in the histograms of these plants from profile 4, one at the top of the early-medieval layer and in the lower sample of the Gothic layer and the other in the final phase of the late Middle Ages. Another group of species, namely, *Thalictrum flavum*, *Iris sibirica*, *Filipendula ulmaria* and *Lysimachia vulgaris*, do not appear below the Gothic layer and the bottom of the late medieval layer. At the top of this last there are, in addition, remains of *Galium* cf. *boreale* and *Stachys* cf. *palustris*. Fruits of *Caltha* sp. (probably *C. palustris*) also appear, but the pollen of this genus was noted throughout the profile.

The order *Arrhenatheretalia* (Table 3) comprises communities of fresh meadows, which occur chiefly where the ground-water table as a rule never reaches the very surface of the ground. Only in river valleys they are periodically inundated. This order includes fresh hay-meadows and pastures. In the material from the Main Market Square these communities are represented by 5 characteristic and 6 additional species. *Daucus carota* and *Hypericum perforatum* occurred in most samples in both profiles, *Cerastium vulgatum* and *Chrysanthemum leucanthemum* being also frequent. The plant represented by the greatest number of specimens is *Stellaria graminea*, which occurred only in the late-medieval layers and in the modern sample. *Galium* cf. *mollugo*, *Achillea* cf. *millefolium* and *Ranunculus sardous* did not appear until the late Middle Ages and *Heracleum sphondylium* was present in the sample from modern times.

The species which now equally often grow in wet meadows (*Molinietalia*) and in fresh meadows (*Arrhenatheretalia*) have been combined into a group *Molinio-Arrhenatheretea*, numbering 7 species characteristic of the class and 4 additional ones. Macroscopic remains of *Prunella vulgaris*, *Ranunculus acer*, *Hypericum* cf. *maculatum* and *Luzula multiflora* and pollen of *Centaurea jacea*, *Plantago lanceolata*, *Polygonum* cf. *bistorta*, *Rumex acetosa* and *Trifolium pratense* type occurred in the early- and late-medieval layers. Moreover, seeds and pollen of *Linum catharticum* were found in the layers from both these periods and fruits of *Centaurea jacea* and *Rumex acetosa* in those of the late Middle Ages. Among the macroscopic remains *Prunella vulgaris* is represented most numerously and has its maxima in the late phase of the Middle Ages and in modern times. *Glechoma hederacea* and *Luzula multiflora* are rarely encountered forms.

The communities of poor meadows and heathlands of the class *Nardo-Callunetea* are represented by only 3 species (Table 4, Fig. 7). Only remains of *Potentilla erecta* are preserved among the macrofossils, its fruits being fairly abundant in many samples. There is also a large amount of pollen of *Calluna vulgaris* and, in one sample few spores of *Lycopodium clavatum* were found.

Five characteristic species have been numbered in the class *Sedo-Scleranthetea* (Table 4, Fig. 7), which contains the communities of sand grassland, occasionally grazed, and acidophilous epilithic grassland. *Rumex acetosella* s. l. is distinguished by the greatest number of specimens found in nearly all samples of both profiles. Its largest numbers were noted in the late-medieval layer, notably in its top portion and in the modern sample of profile 4. As can be seen from the measure-

Plants of moist and fresh meadows — Table 3.

Rośliny łąk wilgotnych i świeżych — Tabela 3.

Plant communities Zbiorowiska roślinne	Characteristic species Gatunki charakterystyczne	Early medieval time Wczesne średniowiecze			Late medieval time – Późne średniowiecze		Modern time Czasy nowożytne	Fruits or seeds Owoce lub nasiona	
		Middle of XI to the middle of XIII century Od połowy XI do połowy XIII w.	Ca. the middle of XIII century. Only in profile 4 Około poł. XIII w. tylko w profilu 4		Middle of XIII to the end of XIV century Od połowy XIII do końca XIV w.	XV century XV wiek		Total of samples Suma prób	Total of specimens Suma okazów
			Levelling layer – Warstwa niwelacyjna	Gothic layer – Warstwa gotycka					
Molinietalia									
Caltha sp.	ch	(+)	(+)	(+)	+(+)	(+)		2	2
Filipendula ulmaria	ch				+	+	+	6	13
Galium boreale	ch				+			1	1
Gentiana pneumonanthe type	ch	(+)			(+)				
Hypericum cf. acutum	ch	+			+			2	4
Iris sibirica	ch			+	+			2	2
Lychnis flos-cuculi	ch	+			+	+	+	12	28
Lysimachia vulgaris	ch				+	+		4	4
Lythrum salicaria	ch	+		+	+	+	+	15	32
Sanguisorba officinalis	ch	(+)	(+)	(+)	(+)	(+)	(+)		
Scirpus silvaticus	ch	+		+	+	+	+	14	35
Stachys cf. palustris	ch				+			1	1
Succisa pratensis	ch	(+)	(+)	(+)	(+)		(+)		
Thalictrum cf. flavum	ch			+				1	1
Ranunculus repens		+	+	+	+	+	+	17	74
Arrhenatheretalia									
Achillea cf. millefolium	ch				+			1	2
Chrysanthemum leucanthemum	ch	+			+		+	6	9
Daucus carota	ch	+		+	+	+		11	24
Heracleum sphondylium	ch						+	1	1
Ranunculus sardous	ch					+		1	1
Betonica officinalis			+		+			3	3
Cerastium vulgatum		+		+	+	+		7	19
Galium cf. mollugo					+			1	1
Hypericum perforatum		+	+	+	+	+	+	15	43
Knautia arvensis						+		1	1
K. sp.		(+)	(+)	(+)	(+)	(+)			
Stellaria graminea					+	+	+	13	54
Molinio-Arrhenatheretea									
Centaurea jacea	ch	(+)	(+)	(+)	+(+)	(+)	+(+)	4	4
Plantago lanceolata	ch	(+)	(+)	(+)	(+)	(+)	(+)		
Polygonum s. bistorta	ch	(+)		(+)	(+)	(+)	(+)		
Prunella vulgaris	ch	+		+	+	+	+	18	172
Ranunculus acer	ch	+		+	+	+	+	17	42
Rumex acetosa type	ch	(+)	(+)	(+)	+(+)	(+)	(+)	1	1
Trifolium pratense type	ch	(+)	(+)	(+)	(+)	(+)			
Glechoma hederacea					+			1	1
Hypericum cf. maculatum		+		+	+			5	7
Linum catharticum				+(+)	+(+)	+	+	10	20
Luzula multiflora		+			+			4	4

(+) – sporomorphs, + – macroscopic remains. Other explanations in the text.

(+) – sporomorfy, + – szczątki makroskopowe. Pozostałe objaśnienia w tekście.

ments of the nutlets (cf. p. 168), a great many of them belong to *R. tenuifolius*, the characteristic species of the class being discussed. Both, *R. acetosella* and *R. tenuifolius* may have occurred in natural habitats in sand grassland in the Middle Ages but they may as well have grown as weeds in cultivated fields. Nowadays *R. acetosella* often occurs abundantly in the associations of cereal weeds on sandy and acid soils, especially those bordering upon sand grasslands. The presence of this species in the Main Marker Square should be explained, at

Xerothermic grassland, sand grassland and poor pastures — Table 4.
Murawy kserotermiczne, murawy piaskowe i ubogie pastwiska — Tabela 4.

Plant communities Zbiorowiska roślinne	Characteristic species Gatunki charakterystyczne	Early medieval time Wczesne średniowiecze			Late medieval time – Późne średniowiecze		Modern time Czasy nowożytne	Fruits or seeds Owoce lub nasiona	
		Middle of XI to the middle of XIII century Od połowy XI do połowy XIII w.	Ca. the middle of XIII century Only in profile 4 Około poł. XIII w. Tylko w profilu 4		Middle of XIII to the end of XIV century Od połowy XIII do końca XIV w.	XV century XV wiek		Total of samples Suma prób	Total of specimens Suma okazów
			Levelling layer – warstwa niwelacyjna	Gothic layer – warstwa gotycka					
Festuco - Brometea									
Agrimonia eupatoria	ch				+			2	2
Anthemis tinctoria	ch				+			5	11
Calamintha acinos	ch				+		+	3	3
Centaurea scabiosa	ch	(+)	(+)	(+)	(+)	(+)	(+)		
Origanum vulgare	ch	+		+	+	+	+	16	40
Plantago media	ch			(+)	(+)	(+)	(+)		
Salvia cf. *nemorosa*	ch			+				1	1
S. verticillata	ch				+			2	2
Arenaria serpyllifolia		+			+	+	+	7	14
Cerinthe sp.		(+)	(+)	(+)	(+)	(+)	(+)		
Fragaria viridis		+						1	1
Kepeta nuda					+			1	1
Picris hieracioides					+		+	2	2
Viscaria vulgaris				+	+			3	3
Sedo - Scleranthetea									
Potentilla cf. *argentea*	ch	+		+	+	+	+	10	24
Plantago cf. *indica*	ch	+						1	1
Jasione montana	ch	(+)	(+)	(+)	(+)	(+)	(+)		
Trifolium t. *arvense*	ch	(+)	(+)	(+)	(+)	(+)	(+)		
Rumex acetosella	ch	+(+)	+(+)	+(+)	+(+)	+(+)	+(+)	19	277
Nardo - Callunetea									
Calluna vulgaris	ch	(+)	(+)	(+)	(+)	(+)	(+)		
Lycopodium clavatum	ch					(+)			
Potentilla erecta		+		+	+	+	+	16	56

(+) – sporomorphs, + – macroscopic remains. Other explanations in the text.
(+) – sporomorfy, + – szczątki makroskopowe. Pozostałe objaśnienia w tekście.

least in part, by its occurrence in the communities of weeds of cultivated fields of the order *Secali-Violetalia arvensis*.

Out of the remaining species of the class *Sedo-Scleranthetea*, fruits of *Potentilla* cf. *argentea* and pollen of *Jasione montana* and *Trifolium pratense* type occurred in nearly all layers. Only one seed of *Plantago* cf. *indica* was found in the early-medieval layer of profile 11.

The class *Festuco-Brometea* (Table 4, Fig. 7) which includes the associations of xerothermic grassland, developing on a substratum rich in calcium carbonate, is represented by 8 characteristic and 6 additional species. *Origanum vulgare* and *Arenaria serpyllifolia*, diaspores of which occurred in the early- and late-medieval layers and in the modern sample, belong to the commonest forms. Also the pollen of *Centaurea scabiosa* and *Cerinthe* sp. (presumably *C. minor*) was found in nearly all layers. *Fragaria viridis* was represented only in the early-medieval layer and a fruit of *Salvia* cf. *nemorosa* was present in the Gothic layer alone. Another six species appeared in the late Middle Ages, *Anthemis*

tinctoria being the most abundant of them. This phase was marked by the largest number of species of xerothermic grassland. As regards the number of specimens, there are two well-marked peaks, one in the three lowest samples of the late Middle Ages and the other in the three upmost ones.

A comparison of the numbers of species from various meadow communities (Table 9) shows that the species of wet and fresh meadows, *Molinio-Arrhenatheretea* (37 species, 17·7%) constitute the greatest group, in which the *Molinietalia* are represented by more species (15, 7·2% of the total of species) than are the *Arrhenatheretalia* (11, 5·3%). The xerothermic-grassland species of the class *Festuco-Brometea* are also numerous (14, 6·7%).

Rüderal plants

In addition to the typical synanthropic communities (*Onopordetalia*), which occur exclusively in habitats altered by man, the communities that may grow both in secondary habitats and in natural ones (*Isoëto-Nanojuncetea*, *Potentillo-Polygonetalia* and *Bidentetalia*) are numbered among the ruderal plants in these considerations.

Short-lived associations of the class *Isoëto-Nanojuncetea* (Table 2) grow as natural communities in places which emerge periodically at the edge of stagnant waters and, as anthropogenic communities, on wet roads, in field furrows and damp stubble-fields. In the diagram from the Market Square these communities are represented by only 3 characteristic species found in small numbers of specimens.

The order *Potentillo-Polygonetalia* (Table 5, Fig. 8 — is under the cover) consists of natural nitrophilous communities, chiefly of low creeping plants. They occur in river valleys on places flooded in winter, and as synanthropic communities in trodden places along roads and paths, in squares and yards, etc. Five characteristic species have been counted in this group. *Polygonum aviculare* occurs in greatest numbers; its fruits appeared towards the end of the early Middle Ages, but were most numerous in the late Middle Ages and in the sample from modern times. The pollen of this species was present throughout the profile. Also the pollen of *Rumex crispus* and *Plantago maior* was found in all layers but the fruits and seeds of these plants did not occur below the Gothic layer. *Sagina procumbens* and *Rorippa* cf. *silvestris* belong to rare forms in this material. Presumably, at least some of these species, e. g. *Polygonum aviculare* and *Plantago maior*, grew in situ, for they are characteristic of the associations appearing in trodden squares and paths, in which, sure enough, the Market Square was not lacking.

The species included in the order *Bidentetalia tripartitae* (Table 2, Fig. 8) — 6 characteristic and 1 additional — represent nitrophilous communities which late in summer and in autumn develop on the periodically flooded muddy margins of lakes and ponds, in drying-up pools, ditches, marshes and pastures. In the Middle Ages they had natural habitats in river valleys, but other, secondary, habitats were also possible (e. g. road ditches). Some of the species found, like

Ruderal plants — Table 5.

Rośliny ruderalne — Tabela 5.

Plant communities / Zbiorowiska roślinne	Characteristic species / Gatunki charakterystyczne	Early medieval time / Wczesne średniowiecze			Late medieval time – Późne średniowiecze		Modern time / Czasy nowożytne	Fruits or seeds / Owoce lub nasiona	
		Middle of XI to the middle of XIII century / Od połowy XI do połowy XIII w.	Ca. the middle of XIII century. Only in profile 4 / Około poł. XIII w. Tylko w profilu 4: Levelling layer – War. niwelacyjna	Gothic layer – Warstwa gotycka	Middle of XIII to the end of XIV century / Od połowy XIII do końca XIV w.	XV century / XV wiek		Total of samples / Suma prób	Total of specimens / Suma okazów
Onopordion + Sisymbrion									
Anchusa sp.	ch	(+)	(+)		(+)	(+)	(+)		
Chenopodium cf. opulifolium	ch	+			+			5	9
Descurainia sophia	ch				+			1	1
Echium sp.	ch	(+)		(+)	(+)	(+)			
Hyoscyamus niger	ch	+			+			8	15
Urtica urens	ch	+(+)	(+)	(+)	(+)	(+)	+(+)	2	2
Arction									
Arctium cf. lappa	ch					+		1	1
Chenopodium hybridum	ch	+			+			4	5
Malva silvestris	ch			+				1	1
Nepeta cataria	ch				+			1	1
Onopordetalia									
Anthemis cotula	ch				+	+		8	10
Galeopsis pubescens	ch	+			+	+		4	4
Linaria vulgaris	ch	+		+	+	+	+	10	19
Rumex obtusifolius	ch			+	+			3	5
Verbena officinalis	ch			+	+			3	4
Chenopodium ficifolium		+			+		+	7	8
C. cf. urbicum		+			+			5	5
C. viride		+	+		+	+	+	7	10
C. cf. vulvaria				+	+			2	3
Cichorium intybus					+	+		3	3
Solanum nigrum		+		+	+	+	+	12	16
Urtica dioica		+(+)	(+)	+(+)	+(+)	+(+)	+(+)	17	44
Amaranthus sp.							+	1	2
Carduus sp.					+		+	3	4
Potentillo – Polygonetalia									
Polygonum aviculare	ch	+(+)	+(+)	+(+)	+(+)	+(+)	+(+)	17	87
Plantago maior	ch	(+)	(+)	+(+)	+(+)	+(+)	(+)	5	7
Rorippa cf. silvestris	ch						+	1	1
Rumex crispus	ch	(+)	(+)	+(+)	+(+)	(+)	+(+)	7	15
Sagina cf. procumbens	ch				+			1	1

(+) – sporomorphs, + – macroscopic remains. Other explanations in the text.

(+) – sporomorfy, + – szczątki makroskopowe. Pozostałe objaśnienia w tekście.

Bidens cernuus, *B. tripartitus*, *Ranunculus sceleratus* and *Polygonum hydropiper*, occur today in the natural association *Polygono-Bidentetum*. Only 2 species of the material from the Market Square namely, *Polygonum nodosum* and *Ranunculus sceleratus*, occurred in a fairly large number of samples, *Polygonum hydropiper* being also rather frequent, whereas the remaining forms were found in 1 or 2 samples. The older layer of the late Middle Ages contained the largest number of species (7 species, 3·9% — Table 9) and the number of specimens reached its maximum at the bottom of this layer.

The *Onopordetalia* (Table 5, Fig. 8) constitute the most numerous group of ruderal plants, represented by 24 species (11·5%), of which 15 are characteristic.

Field weeds

Chwasty uprawowe

Table 6.

Tabela 6.

Plant communities Zbiorowiska roślinne	Characteristic species Gatunki charakterystyczne	Early medieval time Wczesne średniowiecze			Late medieval time - Późne średniowiecze		Modern time Czasy nowożytne	Fruits or seeds Owoce lub nasiona	
		Middle of XI to the middle of XIII century Od połowy XI do połowy XIII w.	Ca. the middle of XIII century Only in profile 4 - Około poł. XIII w. - tylko w profilu 4 Levelling layer - Warstwa niwelacyjna	Ca. the middle of XIII century Only in profile 4 - Około poł. XIII w. - tylko w profilu 4 Gothic layer - Warstwa gotycka	Middle of XIII to the end of XIV century Od połowy XIII do końca XIV w.	XV century XV wiek		Total of samples Suma prób	Total of specimens Suma okazów
Polygono-Chenopodietalia									
Chenopodium polyspermum	ch				+		+	7	13
Digitaria sanguinalis	ch	+						1	1
Echinochloa crus-galli	ch	+			+	+	+	9	18
Euphorbia helioscopia	ch				+			1	1
Polygonum minus	ch	+		+	+		+	5	5
P. tomentosum	ch	+	+	+	+	+	+	17	54
Setaria glauca	ch	+	+	+	+	+	+	23	219
S. viridis / S. verticillata	ch	+		+	+	+	+	6	13
Sonchus asper	ch	+						1	1
Centauretalia cyani - Caucalidion									
Bupleurum rotundifolium	ch	+			+			3	3
Consolida regalis	ch	(+)	(+)	(+)	(+)		(+)		
Melandrium nootiflorum	ch	+			+	+		8	18
Neslia paniculata	ch	+		+	+	+	+	14	24
Nigella arvensis	ch	(+)	(+)		(+)	(+)	(+)		
Ranunculus arvensis	ch	(+)			(+)				
Stachys annua	ch				+			1	1
Valerianella dentata	ch				+			3	9
Centauretalia cyani - Aperion									
Aphanes arvensis	ch				+			1	1
Papaver argemone	ch				+			1	1
Scleranthus cf. annuus	ch	(+)	(+)	(+)	+(+)	+(+)	+(+)	11	31
Centauretalia cyani - Linion									
Galium spurium	ch	+						1	1
Centauretalia cyani									
Agrostemma githago	ch	+	+	+	+	+	+	21	68
Anthemis arvensis	ch	+		+	+	+	+	16	150
Centaurea cyanus	ch	+(+)	(+)	+(+)	+(+)	+(+)	+(+)	13	26
Galium spurium / G. tricorne	ch			+	+	+	+	8	10
Lithospermum arvense	ch		+		+			2	2
Secali-Violetalia arvensis									
Anagallis arvensis	ch				+	+	+	6	8
Lapsana communis	ch			+	+		+	5	8
Polygonum convolvulus	ch	+(+)	+(+)	+(+)	+(+)	+	+(+)	17	33
Silene gallica	ch					+		1	2
Sinapis arvensis	ch				+	+	+	7	14
Sonchus arvensis	ch				+			1	1
Spergula arvensis	ch			+	+	+	+	9	28
Thlaspi arvense	ch	+		+	+		+	11	15
Viola arvensis / V. tricolor	ch	+		+	+			8	19
Galeopsis cf. ladanum				+	+			3	6
G. tetrahit					+			3	3
Myosotis arvensis type						+		1	1
Rudero - Secalietea									
Atriplex patulum	ch				+			2	2
Capsella bursa-pastoris	ch				+	+	+	6	11
Chenopodium album s.str. and Ch. album s.l.	ch	+	+	+	+	+	+	22	324
Convolvulus arvensis	ch	(+)		(+)	(+)		(+)		
Galeopsis speciosa	ch				+			3	4
Galeopsis tetrahit type	ch		+	+	+	+		8	20
Melandrium album	ch	+			+			3	4
Polygonum lapathifolium s.l.	ch		+	+	+	+	+	15	51
Polygonum persicaria	ch	+(+)	+(+)	+(+)	+(+)	+(+)	+	19	69
Stellaria media	ch	+	+	+	+	+		11	23

(+) - sporomorphs, + - macroscopic remains. Other explanations in the text.

(+) - sporomorfy, + - szczątki makroskopowe. Pozostałe objaśnienia w tekście.

On the basis of the number of species characteristic of the present-day alliances of this order (Tables 4 and 9) it may be supposed that the aggregations of pioneer ruderals resembling modern communities of the alliance *Sisymbrion*, developing on, e. g. fresh rubbish heaps, and the communities similar to associations of the alliance *Onopordion acanthii*, growing in warmer and drier habitats, played a more important role than communities resembling those of the alliance *Arction lappae*. The alliances *Sisymbrion* and *Onopordion* are both together represented by 6 characteristic species, the pollen and macroscopic ramains of which were found in 16 samples. Only 4 characteristic species found in 7 samples belong to the alliance *Arction*. A large number of species of the *Onopordetalia* appeared in the early-medieval layers (13 species); their number decreased in the levelling and Gothic layers to rise again in the late-medieval layers (21 species), in which many new forms occurred. If, however, the percentage occurrence of the species of this order in the total of species is taken into account, it presents itself the same for the early and late Middle Ages (about 11%, Table 9). A fall in the percentage occurrence is marked only in the modern sample (7·8%).

The only *Onopordetalia* species whose specimens were present in fairly large numbers in many samples from all the periods is *Urtica dioica*, a forest plant by nature, secondarily growing in synanthropic communities. Moreover, *Solanum nigrum* and *Linaria vulgaris* in profile 4 and *Hyoscyamus niger* in the early- and late-medieval layers in profile 11 occurred in large numbers but only in several samples of the Gothic and late-medieval layers.

Weeds of cultivated fields

The communities of field weeds of the order *Secali-Violetalia arvensis* are most numerously represented in respect of both the number of species and that of specimens in the material from the Market Square (Table 6, Fig. 8). Here they number 38 species, including 35 characteristic ones, which forms 18·2% of the total of species (Table 9).

The communities of root-crop weeds of *Polygono-Chenopodietalia* are represented by 9 characteristic species determined on the basis of macroscopic remains only. *Setaria glauca* occurred most abundantly in all the layers of both profiles. The fruits of *Polygonum tomentosum* were also numerous. *Echinochloa crus-galli*, *Chenopodium polyspermum*, *Setaria viridis*/*S. verticillata* and *Polygonum minus* were less abundant. The remaining species, i. e. *Sonchus asper*, *Euphorbia helioscopia* and *Digitaria sanguinalis* appeared in only single samples.

Seventeen characteristic species, of which 8 characteristic of the alliance *Caucalidion*, 3 of *Aperion* and 1 of *Linion* belong to the communities of cereal weeds of *Centauretalia*.

The associations of weeds of the alliance *Caucalidion* grow on heavier soils rich in calcium carbonate and are rather rare in this country now. In the material

from the Main Market Square fruits of *Neslia paniculata*, *Melandrium noctiflorum* and *Bupleurum rotundifolium* and pollen of *Consolida regalis*, *Nigella arvensis* and *Ranunculus arvensis* were found in the samples of the early and late Middle Ages. Fruits of *Stachys annua* and *Valerianella dentata* appeared only in the late-medieval layers. *Neslia paniculata* and *Melandrium noctiflorum* were the most frequent among the macroscopic remains.

The associations of the alliance *Aperion* which develop on lighter soils, acid or poor in calcium carbonate, are considerably less numerously represented in the material from the Market Square. Out of the three characteristic species, only *Scleranthus* cf. *annuus* occurred in larger numbers, its fruits and pollen being found in all layers. There were single specimens of the other two species, *Papaver argemone* and *Aphanes arvensis* only in the late-medieval layers. *Rumex acetosella* s. l., which has been numbered in the class *Sedo-Scleranthetea* on account of its natural occurrence, may also have grown in communities of this alliance.

The communities of flax-crop weeds of *Linion* are represented by only one weakly characteristic species, *Galium spurium*, which occurred merely in one sample from the early Middle Ages.

The species given in Table 5 as characteristic of the *Centauretalia cyani* may have occurred in communities resembling various associations of this suborder. *Agrostemma githago* and *Anthemis arvensis* were the most abundant of them, while *Centaurea cyanus*, determined on the basis of fruits and pollen, occurred somewhat less numerously but also in all layers. The species that can grow in cereal and root crops are given as characteristic and additional species of the order *Secali-Violetalia arvensis* (Table 5). Out of them, *Polygonum convolvulus*, *Viola arvensis/V. tricolor* and *Thlaspi arvense* were present in the early- and late-medieval layers. *Polygonum convolvulus*, with its fruits and pollen preserved, was the commonest. *Galeopsis terahit* appeared in the levelling layer (4*h*) to persist in younger layers. Three species, *Lapsana communis*, *Spergula arvensis* and *Galeopsis* cf. *ladanum*, occurred starting from the bottom of the Gothic layer. *Sonchus arvensis*, *Myosotis arvensis* type and *Silene gallica* were found in single samples from the late Middle Ages.

It may be stated, in general, that the communities of weeds of cultivated fields are well represented in all the settlement layers of the Main Market Square. Twenty-one species or 17·6% of the total of identified species were encountered in the early-medieval layers. In the older portion of the late--medieval layers (from the mid-13th c. throughout the 14th c.) the absolute number of species rises to 33, which forms 18·2%. A fall to 18 species and 16·2% is observed in the 15th-century layer and a re-rise to 20 species and 19·2% in the modern sample (Table 9). As far as the number of specimens is concerned, the highest absolute and percentage values occurred in the late-medieval layers of the 13th–14th c. In both the phases of the Middle Ages the cereal weeds of the *Centauretalia cyani* predominated over the root-crop weeds of the *Polygono--Chenopodietalia* in respect of the number of species. In the settlement layer

distinguished the percentage occurrence of the *Centaurelia* species ranges from 6·9 to 9·4% and that of the *Polygono-Chenopodietalia* species from 3·1 to 5·9%. Both groups of species are relatively most numerous in the early Middle Ages. The *Centauretalia* persist at more or less the same level in the late Middle Ages throughout the 14th c. (8·8%) and their occurrence decreases somewhat as late as the 15th c. (7·2%). On the other hand, the percentage contribution of the *Polygono-Chenopodietalia* decreased as early as the older phase of the late Middle Ages (3·9%) to increase again in the modern sample (5·8%, Table 9). The decrease in the importance of *Polygono-Chenopodietalia* as compared to *Centauretalia cyani* in the late Middle Ages manifests itself also when the absolute totals of fruits and seeds of the two suborders are compared. There are more *Polygono-Chenopodietalia* (53 specimens) than *Centauretalia* (30) in the early Middle Ages and more *Centauretalia* (256 specimens) than *Polygono-Chenopodietalia* (204) in the late Middle Ages.

Some of the species characteristic of the class *Rudero-Secalietea* may occur as segetal weeds and ruderal plants. Here we can number *Chenopodium album*, which in the Market Place was present in largest numbers of specimens in all the layers and nearly all the samples in both profiles. The seeds of this species were most numerous in the layer referred to the period from the mid-13th c. throughout the 14th c., notably in its upper part. *Polygonum persicaria* and *Stellaria media* also occurred in the early and late Middle Ages though in smaller numbers and there were very few specimens of *Melandrium album*. *Galeopsis speciosa*, *Capsella bursa-pastoris* and *Atriplex patula* did not appear before the late Middle Ages.

Cultivated plants

Only few charred caryopses of four cereal species, *Panicum miliaceum*, *Secale cereale*, *Triticum aestivum* and *Avena* sp. were preserved in the material (Table 7, Fig. 8). The millet *Panicum miliaceum* occurred chiefly in the Gothic and late-medieval layers in profile 4, where 1–4 grains were found in particular samples. Only 3 grains in 2 samples were found in the early-medieval layers. Single grains of the rye *Secale cereale* were present in 1 early-medieval sample, in the Gothic layer and in 4 late-medieval samples. The oat *Avena* sp. was met with in 1 sample of the Gothic layer and 2 samples from the late-medieval layers. The bread wheat *Triticum aestivum* was represented by several grains only in the early-medieval layer of profile 11.

All the above-mentioned cereal genera except *Panicum miliaceum* have also been demonstrated by pollen analysis. The pollen grains of wheat occurred in large numbers and in all the layers of both profiles, and those of rye in somewhat smaller numbers. Single pollen grains of oat were found only in the late-medieval layer of profile 4. In the pollen spectra there were also pollen grains of 2 other cereals, not represented among macroscopic remains. These were the barley

Hordeum sp., present in all the layers of profile 4, and in the 15th-century layer of profile 11, and several pollen grains of *Fagopyrum* sp. only in 1 sample from the late Middle Ages (15th c.) in profile 11 (Koperowa, unpubl.).

The oil-yielding species form a fairly large group of the cultivated plants. They are *Brassica campestris, B. napus, B. nigra, Linum usitatissimum, Cannabis sativa* and *Papaver somniferum* (Table 7).

The seeds of the three *Brassica* species occurred mainly in the late-medieval layer of profile 4. *Brassica campestris*, the seeds of which may come from forms that turned wild and grew as weeds or ruderal plants, or from the cultivated forms, occurred most abundantly, being present in all the samples of that layer and in one early-medieval sample. Wild and cultivated forms cannot be discerned from each other on the basis of subfossil seeds, and neither can the oil-yielding varieties from those producing edible tubers. It is generally supposed that the

Cultivated plants — Table 7.

Rośliny uprawne — Tabela 7.

Plant communities / Zbiorowiska roślinne	Characteristic species / Gatunki charakterystyczne	Early medieval time / Wczesne średniowiecze			Late medieval time – Późne średniowiecze		Modern time / Czasy nowożytne	Fruits or seeds / Owoce lub nasiona	
		Middle of XI to the middle of XIII century / Od połowy XI do połowy XIII w.	Ca. the middle of XIII century. Only in profile 4 / Około poł. XIII w. Tylko w profilu 4		Middle of XIII to the end of XIV century / Od połowy XIII do końca XIV w.	XV century / XV wiek		Total of samples / Suma prób	Total of specimens / Suma okazów
			Levelling layer – War. niwelacyjna	Gothic layer. – Warstwa gotycka					
Cereals – Zboża									
Avena sp.				+	+(+)			3	4
Hordeum sp.		(+)	(+)	(+)	(+)	(+)	(+)		
Fagopyrum sp.						(+)			
Panicum miliaceum		+		+	+		+	12	21
Secale cereale		+(+)	(+)	+(+)	+(+)	(+)	(+)	6	9
Triticum aestivum		+						2	8
Triticum sp.		(+)	(+)	(+)	(+)	(+)	(+)		
Oil, fiber plants, legumes / Rośliny oleiste, włókniste, warzywa									
Brassica campestris		+			+			10	14
Brassica napus					+	+		8	11
Brassica nigra					+		+	5	8
Brassica oleracea				+				1	2
Brassica sp.			+	+	+	+		6	9
Cannabis sativa		+(+)	(+)	+(+)	+(+)	(+)	(+)	7	7
Linum usitatissimum		+		+(+)	+(+)	+		9	16
Papaver somniferum						+		1	1
Portulaca oleracea					+			1	1
Fruit trees and shrubs / Drzewa i krzewy owocowe									
Ficus carica				+	+	+	+	11	18
Juglans regia					+(+)	(+)	(+)	1	1
Vitis vinifera						+		1	2
Prunus sp.					+			2	2
Others – Inne									
Calamintha officinalis						+	+	2	3
Nigella sativa		(+)	(+)	(+)	(+)	(+)			

(+) – sporomorphs, + – macroscopic remains. Other explanations in the text.

(+) – sporomorfy, + – szczątki makroskopowe. Pozostałe objaśnienia w tekście.

oil-yielding variety is older (Nowiński 1970) but, as can be seen from written sources, both forms were probably cultivated in the Middle Ages (Nowiński 1970; Kuźmiński 1975).

Brassica napus was also present in many samples, but only late-medieval ones. This species is known exclusively as a cultivated plant and, like the previous species, has varieties producing oil or edible tubers. Its oil-yielding varieties are also older. It was not grown on a large scale in Europe before the 16th century (Nowiński 1970). It is hard to fix the beginnings of cultivation of both *Brassica campestris* and *B. napus* exactly, the more so because their seeds resemble each other very much, which makes the reliable identification of subfossil material difficult.

In Poland seeds of *B. campestris* have been described from 2 localities of the Hallstatt period (Biskupin, Jaroń 1938; Słupca, Moldenhawer 1958), 3 localities of the early Middle Ages (Szczecin and Biskupin, Klichowska, 1972; Cracow-Wawel, Wasylikowa 1978) and 1 late-medieval locality (Cracow-Kazimierz, Wasylikowa 1958). *Brassica napus* has not been found hitherto.

Neither does the third species, *Brassica nigra*, belong to the native flora of Poland, but grows here as naturalized in various habitats and as a cultivated plant. It is grown as an oil-yielding plant and a condiment used in making mustard. Some specimens of this species were found in the late-medieval layer and in the modern sample. In Poland seeds of *B. nigra* have been reported from 2 early-medieval localities (Gniezno, Jaroń 1939; Cracow-Wawel, Wasylikowa 1978) and 1 late-medieval locality (Cracow-Kazimierz, Wasylikowa 1958).

The poppy (*Papaver somniferum*) was found only in the upper portion of the late-medieval layers in profile 11 (levelling and 15th-century layers).

The hemp (*Cannabis sativa*) and flax (*Linum usitatissimum*) were represented in many early- and late-medieval samples. Both plants not only provided oil but were also grown for their fibres.

It is difficult to demonstrate the presence of vegetables in subfossil materials, since the edible parts of these plants, i. e. leaves or tubers, readily undergo decay and are preserved only in exceptional cases. Their seeds were rarely gathered in large quantities and had little chance to get into culture layers. In the material from the Main Market Square *Brassica campestris* and *B. napus* may have served as root vegetables, but their main use probably consisted in providing oil. *B. oleracea* was consumed as a leaf vegetable. It occurs in Poland only as a cultivated plant. *B. oleracea* was represented in 1 sample of the Gothic layer. Otherwise it has not been recorded from Poland. It may well be that *Portulaca oleracea* found in 1 sample of the late Middle Ages and in the modern sample (*Portulaca sp.*) also served as vegetable. It may have been grown, but it is also possible that even then it already occurred as a weed. In Poland it has been recorded from the 13th-century layers of Wrocław (Kosina 1974, 1975).

Calamintha officinalis, present in the 15th-century sample and in the modern one, is also included among the cultivated plants. The main range of *C. officinalis* in Europe covers the Mediterranean and Atlantic countries (Hegi

1964). In medieval Poland it may have been grown in gardens as a medicinal plant.

Nigella sativa, the pollen of which was found in the early-medieval and Gothic layers in profile 4 and in the late-medieval layers in profile 11 may have been grown as a condiment (Koperowa, unpubl.), but it may have occurred as a weed, as well.

Among trees and shrubs cultivated for edible fruits, there appeared plum-tree *Prunus* sp., walnut-tree *Juglans regia* and vine *Vitis vinifera* (Table 7). Their fruit-stones were preserved in small numbers and only in the late-medieval layer. The walnut was, in addition, represented by pollen in the late-medieval layer and in the modern sample. Apple- and pear-tree may also have been grown or their fruits gathered from wild trees. One fruit-stone which we failed to determine closely was found in the Gothic layer.

An interesting fact is the presence of seeds of the fig-tree *Ficus carica*. This is the first find of seeds of this species in the Polish excavations. They were found in a number of samples of both profiles, being present in the Gothic and late-medieval layers and in the modern sample. Nowaday the fig-tree is cultivated in the Mediterranean; in Central Europe, north of the Alps, it can ripen only if protected against severe frost (Knörzer 1966). It is difficult to determine the derivation of the fig fruits found in the Main Market Square. Their local cultivation cannot be excluded, since there are records of fig houses existing in the Cracow environs (Balice, Prądnik Biały and Łobzów) in the 16th–18th centuries in the descriptions of palace gardens (Ciołek 1954; Stępniewska 1977). We may however be concerned here with the import of dried fruits.

Plants of forests and brushwoods

In the material from the Main Market Square there were several species which provide edible fruits gathered from wild plants growing in different forest communities. In Table 8 these species are given in appropriate phytosociological units and in the diagram (Fig. 7) they are combined into one group on account of the mode of their utilization. The fruit-stones of the raspberry *Rubus idaeus*, strawberry *Fragaria vesca*, and blackberry *Rubus* sp. and *R. plicatus* type occurred in the largest numbers in both early and late Middle Ages. They may have grown in the nitrophilous communities of the order *Atropetalia*, which develop in forest clearings and places left by uprooted trees. The elder *Sambucus* sp. may also have occurred among them. The remaining species of this group given in the diagram, like *Corylus avellana*, *Cerasus* sp., *Pirus* sp./*Malus* sp. and *Vaccinium* sp., occur in other forest communities.

A fairly large group of forest plants consists of species associated with forests and brushwoods which developed on the lower terraces of the river valleys. These are above all the species of the alliance *Salicion*, which represent willow and willow-poplar riverside forests growing on periodically flooded warp

Plants of forest and brushwoods — Table 8.

Rośliny leśne i zaroślowe — Tabela 8.

Plant communities Zbiorowiska roślinne	Characteristic species Gatunki charakterystyczne	Early medieval time Wczesne średniowiecze			Late medieval time – Późne średniowiecze		Modern time Czasy nowożytne	Fruits or seeds Owoce lub nasiona	
		Middle of XI to the middle of XIII century Od połowy XI do połowy XIII w.	Ca. the middle of XIII century Only in profile 4 Około poł. XIII w. – tylko w profilu 4		Middle of XIII to the end of XIV century Od połowy XIII do końca XIV w.	XV century XV wiek		Total of samples Suma prób	Total of specimens Suma okazów
			Levelling layer – War. niwelacyjna	Gothic layer Warstwa gotycka					
Alnetea glutinosae									
Lycopus europaeus	ch	+			+	+	+	8	14
Osmunda regalis	ch	(+)		(+)	(+)		(+)		
Salicion									
Humulus lupulus	ch	+(+)	+(+)	+(+)	+(+)	+(+)	+(+)	18	46
Rubus caesius	ch				+			3	3
Eupatorium cannabinum					+			1	1
Malachium aquaticum					+			1	1
Mentha cf. arvensis				+	+			4	4
Valeriana officinalis		+		+	+	+	+	10	15
Salix sp.		+(+)	(+)	(+)	+(+)	(+)	+(+)	6	7
Alno - Padion									
Alnus incana	ch				+			1	1
A. sp.		(+)	(+)	(+)	(+)	(+)	(+)		
Fraxinus excelsior		(+)				(+)	(+)		
Stellaria nemorum		+		+	+	+		7	9
Ulmus sp.		(+)	(+)	(+)	(+)	(+)	(+)		
Viburnum sp.					(+)	(+)			
Carpinion									
Carpinus betulus	ch	(+)	(+)	(+)	(+)	(+)	(+)		
Tilia cordata	ch	(+)	(+)	(+)	(+)	(+)	(+)		
T. platyphyllos	ch	(+)	(+)	(+)	(+)	(+)	(+)		
Ajuga reptans							+	1	1
Hedera helix		(+)		(+)	(+)	(+)	(+)		
Myosotis silvatica					+			1	1
Cerasus sp.		+(+)	(+)	+(+)	+(+)	+(+)		11	15
Pirus sp./Malus sp.				+				1	1
Quercetalia pubescentis									
Calamintha vulgaris	ch						+	1	1
Campanula persicifolia	ch					+		1	1
Peucedanum cervaria	ch				+			1	1
Querco - Fagetea									
Corylus avellana	ch	+(+)	(+)	+(+)	+(+)	+(+)	+(+)	14	20
Cornus sanguinea	ch	(+)							
Fagus silvatica		(+)	(+)	(+)	(+)	(+)	(+)		
Acer sp.		(+)	(+)	(+)	(+)	(+)	(+)		
Vaccinio - Piceetea									
Lycopodium annotinum	ch	(+)			(+)				
L. complanatum	ch						(+)		
Pteridium aquilinum	ch	(+)	(+)	(+)	(+)	(+)	(+)		
Picea excelsa	ch	(+)	(+)	(+)	+(+)		(+)	2	2
Vaccinium sp.	ch		(+)		+	(+)		1	1
Others - Różne lasy i zarośla									
Abies alba		(+)	(+)	+(+)	+(+)	+(+)	+(+)	7	16
Betula cf. verrucosa					+			1	1
Frangula alnus		(+)			(+)				
Juniperus communis					+			1	1
Pinus silvestris		(+)	(+)	(+)	(+)	(+)	(+)		
Polypodium vulgare		(+)		(+)	(+)		(+)		
Betula sp.		(+)	(+)	(+)	(+)	(+)	(+)		
Populus sp.		(+)			(+)		(+)		
Quercus sp.		(+)	(+)	(+)	(+)	(+)	(+)		
Ribes sp.					(+)				
Sorbus sp.		(+)	(+)	(+)	(+)				
Atropetalia									
Fragaria vesca	ch	+		+	+	+	+	14	66
Rubus idaeus	ch	+	+	+	+	+		18	38
R. plicatus type				+	+			2	3
R. sp.		+(+)	(+)	+(+)	+(+)	+(+)	+(+)	11	18
Sambucus sp.		(+)	(+)		+(+)	(+)	(+)	2	3

(+) – sporomorphs, + – macroscopic remains. Other explanations in the text.

(+) – sporomorfy, + – szczątki makroskopowe. Pozostałe objaśnienia w tekście.

soils. Two characteristic and 5 additional species are counted in this group (Table 8, Fig. 7). The hop *Humulus lupulus* was the most abundant, its fruits and pollen being present in all the layers of profile 4 and in the late-medieval layer of

profile 11. *Valeriana officinalis* also occurred in both profiles but in smaller numbers. The other species, i. e. *Rubus caesius*, *Mentha* cf. *arvensis*, *Eupatorium cannabinum* and *Malachium aquaticum*, occurred in few samples, mainly late--medieval ones, and only in profile 4. The pollen of willow *Salix* sp. was found in both profiles and bud scales in the early- and late-medieval layers of profile 4. The riverside forests with alder, ash and elm of the alliance *Alno-Padion* are represented somewhat less numerously (5 species). *Alnus incana*, which occurs chiefly in the Carpathian alderwood *Alnetum incanae* and descends to the lowlands along the river valleys, is weakly characteristic of *Alno-Padion*. One fruit of *Alnus incana* was found in the late-medieval layer. *Stellaria nemorum*, whose seeds were met with in the early- and late-medieval layers, and *Viburnum* sp., identified on the basis of pollen from the late Middle Ages, may have grown in these riverside forests. The wet alderwoods of the alliance *Alnion glutinosae* are represented by two characteristic species, *Lycopus europaeus*, found in macroscopic remains, and *Osmunda regalis*, determined on the basis of pollen grains. Both these species occurred in the early and late Middle Ages.

Among the plants referred to the forest communities of the class *Querco--Fagetea* there were several species which in the environs of Cracow probably most often grew in oak-hornbeam forests (*Tilio-Carpinetum*). They are trees and shrubs, represented only in the pollen material, the hornbeam *Carpinus betulus*, lime *Tilia cordata* and *T. platyphyllos* and ivy *Hedera helix*, probably also the cherry-tree *Cerasus* sp., preserved in the form of fragmentary fruit--stones and pollen grains, and the pear- or apple-tree *Pirus* sp./*Malus* sp. (a fruit-stone). Edible fruits of these trees may have been gathered. The herbs are represented only by single fruits of *Ajuga reptans* and *Myosotis silvatica*. The xerothermic brushwoods (*Peucedano cervariae-Coryletum*) were perhaps the places of occurrence of the hazel *Corylus avellana* (pollen and fruits), the dogwood *Cornus sanguinea* (pollen) and three herb species *Calamintha vulgaris*, *Campanula persicifolia* and *Peucedanum cervaria*, the fruits and seeds of which are preserved in small numbers. The hazel, whose fragmentary nut-shells were found in all the layers, may have grown also in deciduous forests of other types. The fir *Abies alba* (pollen and needles) perhaps occurred in oak-pine or beech forests and the beech *Fagus silvatica*, determined on the basis of pollen only, in beech and oak-hornbeam forests.

The coniferous forests of the class *Vaccinio-Piceetea* are represented by such characteristic species as *Picea excelsa* (pollen and needles), *Pteridium aquilinum* (spores), *Lycopodium annotinum* and *L. complanatum* (spores) and *Vaccinium* sp. (a seed and pollen).

As far as the number of species is concerned, the class *Querco-Fagetea* is represented by 27 species (12·9% of the total), *Vaccinio-Piceetea* by 5 species (2·4%) and *Alnetea glutinosae* by 2 (0·9%). The most species (14—6·7%) fall to the associations of the riverside forest complex (*Salicion*, *Alno-Padion* and *Alnion glutinosae*). Their number ranges from 4 to 12 in particular layers

(6·2–7·2% of the number of species in the given layer), being the highest in the late-medieval layer (13th–14th cc.). The oak-hornbeam forests (*Carpinion*) are represented by 8 species (3·8%) in the material.

BOTANICAL CHARACTERISTICS OF ARCHAEOLOGICAL LAYERS

The description of the settlement layers given in this section is based only on the results of the analysis of macroscopic remains, omitting those of the pollen analysis. As regards the occurrence of fruits and seeds, profile 4 turned out richer than profile 11.

A distinct difference between the early and the late Middle Ages in respect of the number of specimens was marked in both profiles. The early-medieval layers were more sandy, drier, less compact and contained fewer plant remains. The late-medieval layers were more compact, moist, often composed chiefly of vegetable material in the nature of manure. The accumulation of a large amount of organic matter in the late Middle Ages may have been caused by two factors. On the one hand, the more intense human activity connected with the development of settlement in this very place, trade, transport, etc. resulted in an increase in the accumulation of vegetable refuse. On the other hand, the faster formation of settlement layers brought about the production of a bed less pervious to rainfall water, owing to which the vegetable remains were better preserved than in the early Middle Ages.

Seven samples have been examined from the early-medieval layer covering the period from the turn of the 12th to the mid-13th c. in profile 4. Two bottom samples, taken from the sand underlying the culture layers and just above it, were nearly completely void of identifiable macroscopic remains. A few fruits and seeds of 8 species occurred in sample *c* at a depth of 478–483 cm. Samples *d*, *f* and *g* (473–478 and 447–460 cm) from the top of the early-medieval layer were rich in remains, which belonged to 72 species of nearly all plant communities distinguished in the material from the Market Square. Sample *e* (460–470 cm) showed a fall in the number of species to 10, although it did not differ from the neighbouring samples in the type of material. Most species in the samples from the early Middle Ages were represented by single or quite few specimens. Sample *h* from the levelling layer which covers the early-medieval layer had 23 species, i.e. more or less as many as were in the last early-medieval sample (sample *g* — 20 species) and about half the number of species distinguished in the bottom sample of the overlying Gothic layer (sample *i* — 54 species). In respect of the composition of macroscopic remains the Gothic layer is not uniform. In the bottom sample there were 54 species representing nearly all the communities distinguished in the early Middle Ages. In the next sample, *j*, the number of specimens and species shows a decrease (37) and the components of some communities (*Arrhenatheretalia*, *Nardo-Callunetea* and *Sedo-Scleranthetea*) had disappeared completely.

Eight samples were examined from the late-medieval layer (from the mid-13th c. throughout the 14th c.). A distinct increase in the absolute numbers of species (altogether 145 species on the basis of macroscopic remains) took place in this layer. The graph of the macroscopic remains in the late-medieval layer shows two maxima of the absolute numbers of species and specimens, separated by a horizon characterized by the impoverishment of material (sample *n*, depth 370–380 cm). Within the range of the lower maximum sample *k* was the richest; it contained a total of 275 specimens belonging to 74 species. In sample *n* the number of species fell to 26 and that of specimens to 53 and then rose to reach the highest absolute values for one sample in sample *p*: 96 species and 479 specimens. The bipartite character of the late-medieval layer in profile 4 is more or less clearly marked for all plant communities.

The decrease of the number of identifiable plant remains in sample *n* is not connected with any clearly visible change of the type of material taken for analysis and so it may be supposed that the conditions of preservation of plant material were identical in the whole late-medieval layer. The differentiation observed within this layer may rather be interpreted as caused by a change in the use of this part of the Main Market Square, leading to this temporary change in the composition of plants. The macroscopic remains of this sample contained no traces of cereals, flax, hemp, raspberry, blackberry, strawberry, hazel, cherry, species of fresh meadows (*Arrhenatheretalia*), poor pastures (*Nardo-Callunetea*), reeds (*Phragmitetea*) and willow-poplar riverside forests (*Salicion*). There was also a decrease in the absolute numbers of fruits and seeds of many weed species (*Setaria glauca*, *Anthemis arvensis*, total of specimens of all *Secali-Violetalia* species), fruits of *Rumex acetosella* and some meadow species (*Prunella vulgaris*). These are for the most part species the presence of which in the Market Square was directly connected with the economic activity of inhabitants. Some of them were brought deliberately, e. g. cereals, edible fruits, meadow plants brought with hay, others got here accidentally, e. g. weeds or species of the natural communities bordering upon hay-meadows. The two phases were less distinct as regards the occurrence of ruderal plants of the order *Onopordetalia*, which may have grown in the Market Square itself all that time. To be sure, the number of species in sample *n* decreased to three but there was no clear rise in the number of specimens at the bottom and at the top of the late-medieval layer.

In the modern sample the number of taxa diminished in all the distinguished communities. Instead, there appeared species absent from both medieval subperiods: *Ajuga reptans*, *Amaranthus* sp., *Calamintha vulgaris*, *Galium palustre*, *Heracleum sphondylium* and *Rorippa silvestris*.

Four samples from the early Middle Ages (from the mid-11th c. to the mid-13th c.) were examined in profile 11. As in profile 4, two lower samples (329–350 cm) contained no fruits and seeds. There were 12 species represented by small numbers of specimens in the upper samples (296–329 cm).

Six samples were examined in the late-medieval layer, 3 of them (*e*, *f* and *g*

260–280 cm) from the period from the mid-13th c. throughout the 14th c., one sample (*h*) from the levelling layer at a depth of 210–220 cm, and two samples from the 15th c. (*i* and *j* 192–205 cm). With respect to age samples *e–g* corresponded with samples *k–s* of profile 4, samples *h–j* being younger than these last but older than sample *t* from the modern times. Both late-medieval horizons contained remains of species belonging to the same phytosociological units as described from profile 4, but each group of communities was represented here by a smaller number of species. A total of 102 species were described from macroscopic remains in the late-medieval layer (72 in its portion referred to the 13th–14th c., 79 in the layer from the 15th c.). In particular samples the number of species ranged from 7 to 64 and the number of specimens from 13 to 189. The minimum values have been obtained from sample *h* in the levelling layer and the maximum ones from sample *j* from the 15th c.

Out of the interesting species unnoted in profile 4, the vine *Vitis vinifera* appeared in the 15th-century sample.

VEGETATION OF THE EARLY AND LATE MIDDLE AGES — COMPARISON AND GENERAL CHARACTERISTICS

Table 9, constructed from the absolute and percentage numbers of species in plant communities described, has been designed to compare the vegetation from the early and late medieval layers of the Main Market Square in Cracow. In this comparison the samples of the same age from the two profiles under study are treated together as in Tables 2–8 (cf. p. 177).

It will be seen from the data given in the table that there is no essential difference in the nature of vegetation between the early and the late Middle Ages. Nearly all phytosociological units found in the early Middle Ages are also represented in the two phases of the late Middle Ages. The differences in the number of species in particular groups between these periods do not generally exceed 2·5%. The percentage occurrence of the species of *Scheuchzerio-Caricetea*, *Arrhenatheretalia*, *Bidentetalia*, *Salicion*, *Festuco-Brometea* and cultivated plants increased in the older phase of the late Middle Ages as compared with the early Middle Ages. In the layer from the 15th c. the communities of *Scheuchzerio-Caricetea* persisted at more or less the same level, the occurrence of *Bidentetalia*, *Festuco-Brometea* and *Salicion* underwent a decrease and that of *Arrhenatheretalia* and cultivated plants increased. A decrease in the percentage occurrence of species was found in the xerothermic ruderal associations of the *Onopordion* + *Sisymbrion* group at the transition from the early to late Middle Ages, from 4·2% (early Middle Ages) to 2·7% (15th c.). The number of the weeds of root crops (*Polygono-Chenopodietalia*) also decreased from 5·9 to 3·6% and that of the weeds of cereals (*Centauretalia cyani*) from 9·2 to 7·2%. In this last group the decrease in species concerned mainly the alliance *Caucalidion* and was most conspicuous between the older (4·4%) and the younger phase of the late Middle Ages (2·7%). Within *Alno-Padion* the number of species diminished from 3·4%

Table 9.
Tabela 9.

Number of species from described plant communities and vegetation complexes in particular layers of profiles 4 and 11.

Liczba gatunków z wyróżnionych zbiorowisk roślinnych i ich kompleksów w poszczególnych warstwach profilów 4 i 11.

Plant communities Zbiorowiska roślinne	Vegetation complexes Kompleksy zbiorowisk roślinnych	Early medieval time Wczesne średniowiecze						Late medieval time - Późne średniowiecze				Modern time Czasy nowożytne		Total of species Suma gatunków	
		Middle of XI to the middle of XIII century Od połowy XI do połowy XIII w.		Ca. the middle of XIII cent. Only in profile 4 Około poł. XIII w. Tylko w profilu 4				Middle of XIII to the end od XIV century Od połowy XIII do końca XIV w.		XV cent XV wiek					
				Levelling layer Warstwa niwelacyjna		Gothic layer Warstwa gotycka									
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
Potametea	RF	1	0.8	-	-	-	-	1	0.5	-	-	1	1.0	2	0.9
Phragmitetea, total	RF	4	3.4	2	3.1	1	1.0	6	3.3	4	3.6	3	2.9	8	3.8
Magnocaricion		-	-	-	-	-	-	1	0.5	1	0.9	1	1.0	3	1.4
Isoëto-Nanojuncetea	HF	2	1.7	1	1.6	1	1.0	2	1.1	2	1.8	-	-	3	1.4
Scheuchzerio-Caricetea fuscae	RF	1	0.8	1	1.6	1	1.0	3	1.6	2	1.8	2	1.9	4	1.9
Molinio-Arrhenatheretea, total		23	19.3	11	17.2	21	20.6	34	18.8	23	20.7	18	17.3	37	17.7
Molinietalia	HF	9	7.6	4	6.2	8	7.8	14	7.7	8	7.2	7	6.7	15	7.2
Arrhenatheretalia	O-HF	5	4.2	3	4.7	4	3.9	9	5.0	6	5.4	4	3.8	11	5.3
Rudero-Secalietea, total		47	39.5	24	37.5	41	40.2	79	43.6	44	39.6	41	39.4	88	42.1
Bidentetalia	RF	2	1.7	1	1.6	3	2.9	7	3.9	3	2.7	1	1.0	7	3.3
Potentillo-Polygonetalia	RF,O-HF	3	2.5	3	4.7	3	2.9	4	2.2	3	2.7	4	3.8	5	2.4
Onopordetalia, total		13	10.9	4	6.2	9	8.8	21	11.6	11	9.9	8	7.8	24	11.5
Onopordion + Sisymbrion	XB	5	4.2	2	3.1	2	2.0	6	3.3	3	2.7	2	1.9	6	2.9
Aretion	O-HF	1	0.8	-	-	1	1.0	2	1.1	1	0.9	-	-	4	1.9
Atropetalia	O-HF	3	2.5	2	3.1	3	2.9	4	2.2	3	2.7	3	2.9	4	1.9
Secali-Violetalia arvensis, total	O-HF	21	17.6	9	14.1	17	16.7	33	18.2	18	16.2	20	19.2	38	18.2
Polygono-Chenopodietalia.		7	5.9	2	3.1	4	3.9	7	3.9	4	3.6	6	5.8	9	4.3
Centaureatalia cyani, total		11	9.2	6	9.4	7	6.9	16	8.8	8	7.2	8	7.8	17	8.1
Caucalidion		6	5.0	2	3.1	2	2.0	8	4.4	3	2.7	3	2.9	8	3.8
Aperion		1	0.8	1	1.6	1	1.0	3	1.6	1	0.9	1	1.0	3	1.4
Linion		1	0.8	-	-	-	-	-	-	-	-	-	-	1	0.5
Festuco-Brometea	XB	5	4.2	2	3.1	6	5.9	12	6.6	5	4.5	7	6.7	14	6.7
Sedo-Scleranthetea	PF	5	4.2	3	4.7	4	3.9	4	2.2	4	3.6	4	3.8	5	2.4
Nardo-Callunetea	O-PF	2	1.7	1	1.6	2	2.0	2	1.1	3	2.7	2	1.9	3	1.4
Vaccinio-Piceetea	PF,O-PF	3	2.5	3	4.7	2	2.0	4	2.2	2	1.8	3	2.9	5	2.4
Alnetea glutinosae	RF	2	1.7	-	-	1	1.0	2	1.1	1	0.9	2	1.9	2	0.9
Querco-Fagetea, total		16	13.4	11	17.2	16	15.7	21	11.6	17	15.3	15	14.4	27	12.9
Salicion	RF	3	2.5	2	3.1	4	3.9	7	3.9	3	2.7	3	2.9	7	3.3
Fagetalia, total		9	7.3	6	9.4	9	8.8	10	5.5	10	9.0	8	7.7	13	6.2
Alno-Padion	HF	4	3.4	2	3.1	3	2.9	4	2.2	5	4.5	3	2.9	5	2.4
Carpinion	O-HF	5	4.2	4	6.2	6	5.9	6	3.3	5	4.5	5	4.8	8	3.8
Quercetalia pubescentis	XB	-	-	-	-	-	-	1	0.5	1	0.9	1	1.0	3	1.4
Others - Inne		8	6.7	5	7.8	6	5.9	11	6.1	4	3.6	6	5.8	11	5.3
Sum of species (excl. cultivated plants) Suma gatunków bez uprawnych		119		64		102		181		111		104		209	
Cultivated plants - Rośliny uprawne		8	6.3	6	8.6	10	8.9	16	8.1	14	11.2	9	8.0	20	8.7
Cereals - Zboża		4	3.1	3	4.3	5	4.5	5	2.5	4	3.2	4	3.5	6	2.6
Oil, fiber plants, legumes Rośliny oleiste, włókniste, warzywa		3	2.4	2	2.8	3	2.7	7	3.5	5	4.0	2	1.8	8	3.5
Fruit trees and shrubs Drzewa i krzewy owocowe		-	-	-	-	1	0.9	3	1.5	3	2.4	2	1.8	4	1.7
Others - Inne		1	0.8	1	1.4	1	0.9	1	0.5	2	1.6	1	0.9	2	0.9
Total sum of species Suma wszystkich gatunków		127		70		112		197		125		113		229	
Complex of riverside forests Kompleks łęgów		31	26.0	16	25.0	25	24.5	50	27.6	31	27.9	26	25.0	58	27.7
Complex of oak-hornbeam Kompleks grądów		42	35.3	20	31.2	37	36.3	67	37.0	40	36.0	39	37.5	79	37.8
Complex of xerothermic brushwood Kompleks ciepłych zarośli		10	8.4	4	6.2	8	7.8	19	10.5	9	8.0	10	9.6	23	11.0
Complex of pine forests and complex of oak-pine forests Kompleks borów sosnowych i kompleks borów mieszanych		10	8.4	7	10.9	8	7.8	10	5.5	9	8.0	9	8.6	13	6.2

RF - Complex of riverside forests, O-HF - Complex of oak-hornbeam forests, XB - Complex of xerothermic brushwood, O-PF - Complex of oak-pine forests, PF - Complex of pine forests. Percentages are calculated from the sum of species found in a given period, excluding cultivated plants. Percentages of cultivated plants are based on the total sum of species from each period. Other explanations in the text.

RF - kompleks łęgów, O-HF - kompleks grądów, XB - kompleks ciepłych zarośli, O-PF - kompleks borów mieszanych, PF - kompleks borów sosnowych. Procenty obliczone w stosunku do sumy wszystkich gatunków w danym okresie z wyłączeniem roślin uprawnych. Udział procentowy roślin uprawnych podany w stosunku do sumy wszystkich gatunków łącznie z uprawnymi. Pozostałe objaśnienia w tekście.

in the early Middle Ages to 2·2% in the older phase of the late Middle Ages, but increased again to 4·5% in the younger phase.

The percentage occurrence of the species of the phytosociological units described in the whole material is highly variable. The synanthropic communities of the class *Rudero-Secalietea* prevail, their occurrence in the periods being compared ranging from 39·5 to 43·6% of the total number of species. The largest group includes the communities of field weeds of *Secali-Violetalia arvensis* (16·2–18·2%) and ruderal plants of the order *Onopordetalia* (9·9–11·6%), while the occurrence of the remaining communities of this class does not exceed 4%. The *Molinio-Arrhenatheretea* meadow communities (18·8–20·7%) constitute the next group in respect of the number of species. Within this group the wet meadows of the order *Molinietalia* predominate slightly over the fresh meadows of *Arrhenatheretalia* and reach over 7% of the total of species. The species of fresh meadows form only 4·2% in the early Middle Ages and their occurrence rises to 5·4% in the younger period of the late Middle Ages. The vegetation of drier habitats is represented, above all, by xerothermic grasslands of the class *Festuco-Brometea* (6·7% of the total of species). The occurrence of the epilithic and sandy grassland species of the class *Sedo-Scleranthetea* is 2·4% and that of the species of poor meadows of the class *Nardo-Callunetea* 1·4%. The species of reedswamp communities (*Phragmitetea*) came to about 3·8% and the aquatic plants (*Potametea*) to only 0·9% of the total. Among the forest communities the species of the alliance *Salicion* reached 3·3%, the species of *Alno-Padion* 3·8% and those of *Alnetea glutinosae* only 0·9%. The share of cultivated plants was 6·3% in the early Middle Ages and rose to 11·1% of the total of species in the late Middle Ages.

An attempt to indicate which of the species could occur in the Market Square itself and which came from the neighbouring or further districts of the town or from its environs may prove interesting. No doubt, the ruderal plants of the communities included in the orders *Potentillo-Polygonetalia* and *Onopordetalia* could grow in this place. The first of them, e. g. *Polygonum aviculare* and *Plantago maior*, appear in continually trodden places in squares and along roads. The species of the second group grew in habitats rich in nitrogen but not trodden, like refuse heaps, rubble heaps, in the nearness of buildings and fences, e. g. *Arctium lappa*, *Atriplex patulum*, *Capsella bursa-pastoris*, *Chenopodium album*, *C. hybridum*, *Malva sylvestris*, *Nepeta cataria*, *Rumex obtusifolius*, *Urtica dioica*, *U. urens* and others. It seems possible that such nitrophilous terophytes of the order *Bidentetalia* as *Bidens cernuus*. *B. tripartitus*, *Polygonum hydropiper* and *P. nodosum* sometimes appeared along ditches. Perphas in the area of the present Main Market Square or in its vicinity there were some gardens or plots with cultivated plants, e.g. vegetables (*Brassica campestris*, *B. napus*, *B. oleracea* and *Portulaca oleracea*) and medicinal plants (*Calamintha officinalis*, *Mentha*). The weeds of root crops, e. g. *Echinochloa crus-galli*, *Setaria glauca* and *S. viridis*/*S. verticillata*, found in fairly large numbers in the Market Square, may also have grown in these gardens.

Some trees, like the maple (*Acer*), lime (*Tilia cordata*), hornbeam (*Carpinus*) and oak (*Quercus*), found in relatively high percentages mainly on the basis of pollen analysis, were perhaps relicts of the oak-hornbeam forests growing originally in the study area. Out of the shrubs, there may have been the elder (*Sambucus* sp.), preserved in addition in the form of fruit-stones, currant or gooseberry (*Ribes* sp.) and ivy (*Hedera helix*), climbing on trees and walls.

Most of the wild-growing species however reached the Market Square accidentally with corn (field weeds), hay (meadow species) or other products put on the market or were casually brought in various ways by people and animals. These species reflect the vegetation of areas at the periphery of the town and in its environs.

Most species, about 38% of the total, belonged to the communities of the oak-hornbeam forest complex (Kornaś & Medwecka-Kornaś 1974). These were nearly exclusively secondary communities, the development of which had been caused by human activities. They included the associations of fresh meadows (*Arrhenatheretalia*), ruderal plants (*Onopordetalia*), field weeds (*Secali-Violetalia*) and the communities of forest clearings (*Atropetalia*). They found favourable conditions of development on the middle terrace after the destruction of the oak-hornbeam forests (*Carpinion*), which had been the dominant natural community there. The lower-lying flood-plain terrace provided favourable habitats for the communities of the riverside forest complex. In the material from the Market Square 28% of all the species belonged to the communities of this complex. They were mostly primary communities including the aquatic and reedswamp associations (*Potametea* and *Phragmitetea*), out of the forest communities, wet alderwoods (*Alnetea glutinosae*), willow-poplar (*Salicion*) and alder-ash-elm riverside forests (*Alno-Padion*) and also, at least partly, the herb communities of the class *Isoëto-Nanojuncetea* and the orders *Bidentetalia* and *Potentillo-Polygonetalia*. The anthropogenic plant communities were, above all, represented by the species of wet meadows of the order *Molinietalia* and the class *Scheuchzerio-Caricetea*.

The complex of warm brushwoods, represented by 11% of the species, was fairly strongly marked in the material. They belonged to the communities of xerothermic grasslands (*Festuco-Brometea*), thermophilous ruderal associations (*Onopordion*) and xerothermic hazel brushwoods (of *Quercetalia pubescentis*). Only about 6% of the species found were connected with the communities of the pine and pine-oak forest complexes. Nearly 20% of the total were species occurring in various communities and then included in none of the complexes, and cultivated plants.

CONCLUSIONS

The plant remains from two archaeological excavations in the Main Market Square of Cracow, exposing early- and late-medieval layers, have been examined. The early-medieval layers cover the period from the turn of the 11th c. to

the mid-13th c. The late-medieval layers are divided into an older part referred to the second half of the 13th c. and the 14th c. and a younger part from the 15th c.

From modern layers, 1 sample has been examined by macroscopic analysis and 2 samples by the palynological method.

The analysis of the macroscopic remains was made by the author and the palynological study by Dr. W. Koperowa (unpubl.). 340 taxa were distinguished using both these methods, of which 200 determined to specific and 60 to generic level. 149 species were determined by analysis of macroscopic remains, 30 on the basis of sporomorphs and 21 from both types of remains. 60 forms determined to the generic level include 17 identified by macroscopic analysis, 38 by the microscopic method and 5 by using both these methods. Out of the species identified on the basis of macroscopic remains, 17 had never been reported from archaeological localities in Poland before. These are *Brassica napus*, *B. oleracea*, *Calamintha acinos*, *C. officinalis*, *Eupatorium cannabinum*, *Ficus carica*, *Galium* cf. *boreale*, *Glechoma hederacea*, *Origanum vulgare*, *Papaver argemone*, *Peucedanum cervaria*, *Plantago* cf. *indica*, *Ranunculus sardous*, *Sagina procumbens*, *Sagittaria sagittifolia*, *Scrophularia alata/S. nodosa* and *Scutellaria galericulata*. Another 39 species were found only in the material from the Main Market Square and that from the Wawel Hill (Wasylikowa 1978).

The species distinguished in the material from the Main Market Square represent plant communities belonging to the following classes of associations: *Potametea*, *Phragmitetea*, *Isoëto-Nanojuncetea*, *Scheuchzerio-Caricetea fuscae*, *Molinio-Arrhenatheretea* (including orders *Molinietalia coeruleae* and *Arrhenatheretalia*), *Rudero-Secalietea* (including orders *Bidentetalia tripartitae*, *Potentillo-Polygonetalia*, *Onopordetalia acanthii*, *Atropetalia*, *Secali-Violetalia arvensis*), *Festuco-Brometea*, *Sedo-Scleranthetea*, *Nardo-Callunetea*, *Vaccinio-Piceetea*, *Alnetea glutinosae* and *Querco-Fagetea* (including orders *Populetalia albae*, *Fagetalia silvaticae* and *Quercetalia pubescentis*). The cultivated plants form a separate group.

Out of the communities mentioned, the largest number of taxa fall to the class *Rudero-Secalietea* (85 species and 3 genera). Within this class the best represented communities are those of weeds of cultivated fields (*Secali-Violetalia arvensis* — 38 species), among which the cereal weeds (*Centauretalia cyani* — 17 species) prevail over the weeds of root crops (*Polygono-Chenopodietalia* — 9 species). The communities of ruderal plants (*Onopordetalia*) number 24 species. Another group, also numerously represented, are meadow communities of the class *Molinio-Arrhenatheretea* (37 species) in the type of wet meadows (*Molinietalia* — 15 species) and fresh hay-meadows (*Arrhenatheretalia* — 11 species). From among other communities, the deciduous forests and shrubs of the class *Querco-Fagetea* (27 species) and the associations of xerothermic grasslands of *Festuco-Brometea* (14 species) are distinguished for fairly large numbers of species. The number of species in the remaining classes does not exceed 10 in each. The group of cultivated plants includes 20 taxa (16 species and 4 genera), of which 6 species of cereals and 5 of vegetables.

Some species may have grown in the very area of the Market Square. As regards trees and shrubs, these may have been the maple (*Acer*), lime (*Tilia cordata*), oak (*Quercus*) and perhaps hornbeam (*Carpinus betulus*), elm (*Ulmus*), elder (*Sambucus* sp.), currant or gooseberry (*Ribes* sp.) and ivy (*Hedera helix*). Out of the herbs, the ruderal plants, which grow in squares, along trodden paths and roads, in ditches, on refuse or rubble heaps and close to residential and farm buildings, could find suitable habitat conditions here. The cultivated plants, chiefly vegetables and medicinal plants may have been grown in the area of the present Market Square or in its close vicinity. Weeds of root crops appeared among them. Some species were brought to the market place as products designed for sale, e. g. cereals, fruits of wild (strawberries, blackberries, whortleberries, raspberries, pears, apples and hazel-nuts) and cultivated plants (walnuts and grapes). Figs may have been imported. The oil and fibre plants (hemp, flax and poppy) and various medicinal herbs were probably brought in, as well. However, most species distinguished in the material and coming from various plant communities were brought to the market accidentally by people and animals.

The botanical analysis of the material from the Main Market Square has not shown any essential differences between the early and the late Middle Ages as regards the picture of vegetation.

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STRESZCZENIE

Wstęp

Materiał paleobotaniczny wykorzystany w niniejszej pracy zebrany został w czasie badań archeologicznych przeprowadzonych przez Muzeum Archeologiczne m. Krakowa pod kierunkiem Doc. Dr hab. K. Radwańskiego na Rynku Głównym w Krakowie w latach 1961–1963. Próby do badań palinologicznych i karpologicznych pobrała w 1962 r. Doc. Dr hab. K. Wasylikowa z szeregu wykopów zlokalizowanych w różnych częściach Rynku (ryc. 2). Do szczegółowego opracowania wybrano dwa profile, z których Dr W. Koperowa (nie publ.) wykonała analizę pyłkową, a autorka tej pracy analizę szczątków makroskopowych.

Lokalizacja prób

Zbadane profile 4 i 11 pochodzą z dwóch wykopów we wschodniej części Rynku na osi NS.

Profil 4 (ryc. 3) pobrany był w kwartale NE z wykopu I, ściana N i zawierał 19 prób makroskopowych. Próby *a–j* reprezentują warstwy wczesnośredniowieczne obejmujące okres od XII/XIII do połowy XIII w., próby *k–s* pochodzą z warstwy późnośredniowiecznej datowanej na okres od połowy XIII do końca XIV w. Próba *t* pochodzi z warstwy nowożytnej.

Profil 11 (ryc. 4) pobrany był w kwartale SE z wykopu II, ściana N i zawierał 10 prób przeznaczonych do badań karpologicznych. Próby *a–d* pochodzą z warstw wczesnośredniowiecznych od połowy XI do połowy XIII w. Warstwy te są nakryte brukiem nr 4 położonym na Rynku około 1250 r. Próby *e–g* pochodzą z warstw nakrytych brukiem nr 3 z 1391 r. i obejmują starszą fazę późnego średniowiecza, od połowy XIII do końca XIV w. Próba *h* pochodzi z poziomu niwelacyjnego, a próby *i–j* są datowane na wiek XV. Próby datowane są według kryteriów archeologicznych (K. Radwański 1975 i inf. ustne T. Radwańska i A. Wałowy).

Metoda badań

Z każdej badanej próby 200 cm³ materiału gotowano w wodzie z dodatkiem sody Na_2CO_3 lub 10% KOH i szlamowano na sitach o średnicy oczek 0·5 i 0·2 mm. Uzyskany materiał segregowano pod lupą binokularną, a następnie oznaczano przy użyciu lupy binokularnej K. Zeissa z powiększeniami 10–100 ×, lub w miarę potrzeby przy użyciu mikroskopu o większych powiększeniach. Pomiarów dokonywano przy użyciu lupki Brünella z dokładnością do 0·05 mm. Dla oznaczonego materiału sporządzono dokumentację rysunkową (tablice I–XII) oraz opisy szczątków makroskopowych. Wyniki badań przedstawiono w tabelach 1–9 i w 2 diagramach.

Opisy szczątków makroskopowych

Rozdział ten zawiera opisy wszystkich oznaczonych szczątków roślinnych w kolejności alfabetycznej według rodzin. Nazwy gatunków przyjęto według Roślin Polskich (Szafer, Kulczyński & Pawłowski 1953), a w nawiasach podano nazwy obowiązujące według Flora Europaea (1964–1976). Wszystkie taksony oznaczone na podstawie szczątków makroskopowych i sporomorf zestawiono w tabeli 1.

Charakterystyka roślinności

Na podstawie znajomości dzisiejszych zbiorowisk roślinnych występujących w otoczeniu Krakowa J. Kornaś i A. Medwecka-Kornaś (1974) opracowali mapę potencjalnej roślinności naturalnej obszaru miasta. Wyróżnili 6 kompleksów zbiorowiskowych: kompleks łęgowy i kompleks grądów, które zajmowały największe obszary, oraz kompleksy ciepłych zarośli, buczyn, borów mieszanych i borów sosnowych, które zajmowały mniejsze powierzchnie.

Rynek Główny położony jest na obszarze siedlisk grądowych, ale zachowane w badanym materiale szczątki roślinne reprezentują różne zbiorowiska występujące na sąsiadujących z miastem terenach. Rośliny oznaczone na podstawie sporomorf i szczątków makroskopowych ujęto w jednostki fitosocjologiczne scharakteryzowane w Szacie Roślinnej Polski (1972), w niektórych przypadkach według Ellenberga (1974) lub na podstawie informacji ustnej H. Trzcińskiej-Tacik. Zestawienie taksonów według ich przynależności fitosocjologicznej podane zostało w tabelach 2–8, a procentowy udział gatunków w wyróżnionych zbiorowiskach i w kompleksach w tabeli 9. W tabelach 2–9 próby tego samego wieku z obu profilów zostały przedstawione łącznie. Kolumna pierwsza — wczesne średniowiecze od połowy XI do połowy XIII w. — obejmuje wszystkie próby z wczesnego średniowiecza, tzn. 11 prób makroskopowych i 5 prób pyłkowych, z wyjątkiem prób z warstwy niwelacyjnej i gotyckiej z profilu 4. Warstwy te podano w tabelach oddzielnie. Z poziomu niwelacyjnego zbadano 1 próbę makroskopową i 1 pyłkową (kolumna druga), z warstwy gotyckiej 2 próby makroskopowe i 1 pyłkową (kolumna trzecia). Starsza faza późnego średniowiecza od połowy XIII do końca XIV w. — obejmuje 11 prób makroskopowych i 5 prób pyłkowych (kolumna czwarta). Młodsza faza z XV w., stwierdzona tylko w profilu 11, obejmuje 2 próby makroskopowe i 1 pyłkową (kolumna piąta). Próbę 11 *h* z warstwy niwelacyjnej pominięto w tabelach. W kolumnie szóstej podano próby z warstw nowożytnych — 1 makroskopową i 2 pyłkowe. Numery prób zaliczonych do poszczególnych grup można odczytać z tabeli 1. Dwie ostatnie kolumny w tabelach 2–8 pozwalają zorientować się w częstości pojawiania się szczątków makroskopowych poszczególnych gatunków oraz w ich ogólnej liczbie. Ilościowe wyniki analizy szczątków makroskopowych przedstawiono w dwóch diagramach (ryc. 7, 6), których histogramy obrazują bezwzględną liczbę owoców lub nasion w próbach o objętości 200 cm^3.

Rośliny wodne, bagienne i torfowiskowe

Rośliny te reprezentowane są tylko przez 8 gatunków, które wystąpiły w niewielkiej liczbie okazów i należą do zbiorowisk roślinnych z klas *Potametea*, *Phragmitetea* i *Scheuchzerio-Caricetea fuscae* (tabela 2). Niektóre z nich obecne są zarówno we wczesnym, jak i późnym średniowieczu, ale liczniej wystąpiły w warstwie późnośredniowiecznej. Dopiero w późnym średniowieczu i to w większej liczbie prób pojawiły się: *Heleocharis palustris* i *Ranunculus flammula*, natomiast *Alisma plantago-aquatica* wystąpiła już w warstwie gotyckiej, ale obficiej także dopiero w warstwie późnośredniowiecznej.

Rośliny z tej grupy nie odgrywają większej roli, a ich udział procentowy wynosi 6·6% ogólnej liczby gatunków (tabela 9).

Łąki, pastwiska i murawy kserotermiczne

Do tej grupy włączono zbiorowiska łąkowe i murawy naskalne rozwijające się na podłożu o zróżnicowanej wilgotności (tabela 3). Najlepiej są reprezentowane łąki wilgotne i świeże z klasy *Molinio-Arrhenatheretea*, do których zaliczono

37 gatunków (17·7%; tabele 3 i 9). Do łąk trzęślicowych (*Molinietalia*), rozwijających się na terenach wilgotnych i okresowo zalewanych, zaliczono 15 gatunków (7·2%), a do łąk świeżych, kośnych (*Arrhenatheretalia*), które występują na obszarach, gdzie poziom wody gruntowej w zasadzie nie dochodzi nigdy do samej powierzchni, zaliczono 11 gatunków (5·3%). Pozostałych 11 gatunków (5·3%) z tej grupy rośnie obecnie równie często na łąkach wilgotnych, jak i świeżych.

Murawy kserotermiczne (*Festuco-Brometea*), rozwijające się na podłożu zasobnym w węglan wapnia, reprezentuje 14 gatunków (6·7%). Zespoły niekiedy wypasanych muraw piaskowych i acidofilnych muraw naskalnych z klasy *Sedo-Scleranthetea* 5 gatunków (2·4%), a zespoły łąk jałowych i wrzosowisk z klasy *Nardo-Callunetea* tylko 3 gatunki (1·4%; tabela 4 i 9).

Wspomniane zbiorowiska łąk, muraw i pastwisk wystąpiły we wszystkich warstwach z wczesnego i późnego średniowiecza. Łącznie do tej grupy zaliczono 59 gatunków, co stanowi 28·2% ogólnej liczby gatunków (tabela 9).

Rośliny ruderalne

Obok typowych zbiorowisk synantropijnych z rzędu *Onopordetalia*, które występują wyłącznie na siedliskach zmienionych przez człowieka, zaliczono tutaj także zbiorowiska takie, które mogą występować zarówno na siedliskach naturalnych, jak i wtórnych (*Isoëto-Nanojuncetea*, *Bidentetalia* i *Potentillo-Polygonetalia*).

Krótkotrwałe zespoły z klasy *Isoëto-Nanojuncetea*, które jako zbiorowiska naturalne zasiedlają tereny okresowo wynurzające się z wody na brzegach wód stojących, a jako zbiorowiska antropogeniczne pojawiają się na mokrych drogach, bruzdach polnych czy na wilgotnych ścierniskach, reprezentowane są tylko przez 3 gatunki (1·4%; tabele 2, 9), słabo zaznaczające się tak w warstwach wczesnego jak i późnego średniowiecza.

Bidentetalia (tabele 2, 9) obejmują zespoły nitrofilne, rozwijające się późnym latem i jesienią na mulistych, okresowo zalewanych brzegach jezior i stawów, a także w wysychających kałużach, rowach, młakach i pastwiskach. Zaliczono tu 7 gatunków (3·3%), które najliczniej wystąpiły w warstwach późnośredniowiecznych.

Rząd *Potentillo-Polygonetalia* (tabele 5, 9) obejmuje naturalne zbiorowiska nitrofilnych, przeważnie niskich, płożących się roślin, występujące na zalewanych zimą siedliskach dolin rzecznych, i zbiorowiska synantropijne rozwijające się na siedliskach silnie wydeptywanych wzdłuż dróg, ścieżek, na placach, podwórkach itp. Zaliczono tutaj 5 gatunków (2·4%), które pojawiły się we wszystkich badanych warstwach, a najliczniej w późnym średniowieczu.

Zbiorowiska ruderalne z rzędu *Onopordetalia* (tabele 5 i 9) reprezentowane są przez 24 gatunki (11·5%). W ich obrębie wyróżniono grupę pionierskich zespołów ruderalnych rozwijających się na świeżych śmietniskach (*Sisymbrion*) i zespołów rosnących na siedliskach cieplejszych, a suchych (*Onopordion*), do której zaliczono 6 gatunków (2·9%), oraz grupę mezofilnych zespołów ze związku

Arction, gdzie zaliczono 4 gatunki (1·9%). Gatunki z tego rzędu licznie pojawiły się już we wczesnym średniowieczu, a liczba ich wzrosła znacznie w starszym okresie późnego średniowiecza.

Chwasty pól uprawnych

Zespoły chwastów polnych (*Secali-Violetalia arvensis*) są najliczniej reprezentowane w materiale z Rynku (tabela 5). Zaliczono do nich 38 gatunków, co stanowi 18·2% ogólnej liczby gatunków. Wyróżniono grupę chwastów zbożowych z *Centauretalia cyani* (17 gatunków — 8·1%) i chwastów okopowych z *Polygono-Chenopodietalia* (9 gatunków — 4·3%). Wśród chwastów zbożowych wystąpiły gatunki charakterystyczne związków: *Caucalidion* (8 gatunków) i *Aperion* (3 gatunki), których zespoły rozwijają się na różnych glebach, oraz związku *Linion* (1 gatunek) obejmującego zespoły chwastów lnu. Zbiorowiska chwastów polnych są dobrze reprezentowane we wszystkich poziomach osadniczych. We wczesnym średniowieczu stanowią one 17·6%, w starszej części późnego średniowiecza 18·2%, w młodszej 16·2%, a w próbie nowożytnej 19·2% wszystkich gatunków (tabela 9). W obu fazach średniowiecza chwasty zbożowe stanowiły przewagę nad chwastami okopowymi. W wyróżnionych poziomach osadniczych procentowy udział gatunków chwastów zbożowych waha się od 6·9 do 9·4%, a chwastów okopowych od 3·1 do 5·9%. Niektóre gatunki mogły występować jako chwasty segetalne i rośliny ruderalne (*Rudero-Secalietea*, 10 gatunków — 7·8%). Najliczniej pojawiły się one w pierwszym okresie późnego średniowiecza, a wśród nich najobficiej wystąpiła lebioda (*Chenopodium album*), której największą liczbę okazów stwierdzono w profilu 4, w stropie warstwy ze starszej fazy późnego średniowiecza (ryc. 8).

Rośliny uprawne (tabela 7)

Zachowały się tylko nieliczne zwęglone ziarniaki 4 gatunków zbóż: owsa (*Avena* sp.), prosa (*Panicum miliaceum*), żyta (*Secale cereale*) i pszenicy (*Triticum* sp.). Ziarniaki pszenicy wystąpiły tylko w warstwach wczesnośredniowiecznych profilu 11, natomiast pozostałe gatunki zbóż głównie w warstwach późnośredniowiecznych. Wszystkie wymienione rodzaje zbóż, poza prosem, wyróżnione zostały także na podstawie pyłku. Stwierdzono ponadto ziarna pyłku jęczmienia (*Hordeum* sp.) i gryki (*Fagopyrum* sp.), których nie znaleziono wśród szczątków makroskopowych.

Dalszą grupę roślin uprawnych stanowią gatunki, które mogły dostarczyć oleju albo włókien. Do roślin olejodajnych zaliczyć można 2 gatunki z rodzaju *Brassica*, tj. kapustę polną (*Brassica campestris*) i kapustę rzepak (*Brassica napus*) oraz mak lekarski (*Papaver somniferum*). Konopie (*Cannabis sativa*) i len (*Linum usitatissimum*) mogły dostarczać oleju i włókien. Wymienione wyżej gatunki kapusty służyć mogły także jako warzywa korzeniowe, a jako warzywa liściowe kapusta warzywna (*Brassica oleracea*) i portulaka (*Portulaca oleracea*). Dla celów przyprawowych mogły być hodowane kapusta czarna (*Brassica nigra*) używana do wyrobu musztardy i wyróżniona tylko w pyłku

czarnuszka (*Nigella sativa*). Większość gatunków z tej grupy, a zwłaszcza kapusty, wystąpiły głównie w warstwach późnośredniowiecznych. Dla celów leczniczych uprawiana mogła być czyścica lekarska (*Calamintha officinalis*).

Wśród roślin uprawnych nieliczną grupę stanowią drzewa i krzewy hodowane dla jadalnych owoców, a mianowicie orzech włoski (*Juglans regia*), śliwy (*Prunus* sp.) i winorośl (*Vitis vinifera* ssp. *vinifera*), które pojawiły się tylko w późnym średniowieczu.

Interesująca jest obecność w materiale z Rynku nasion figi jadalnej (*Ficus carica*). Nasiona tego gatunku w wykopaliskach z Polski znaleziono po raz pierwszy. Stwierdzono je w szeregu prób w obydwu profilach. Wystąpiły one w warstwie gotyckiej, w późnym średniowieczu i w próbie nowożytnej. Dzisiaj figa uprawiana jest w obszarze śródziemnomorskim, a w Europie na północ od Alp może dojrzewać tylko pod warunkiem zabezpieczenia jej przed silnymi mrozami (Knörzer 1966). Trudno rozstrzygnąć, jakie było pochodzenie owoców figi znalezionych na Rynku. Nie można wykluczyć miejscowej hodowli, ponieważ wzmianki o figarniach istniejących w okolicy Krakowa (Balice, Prądnik Biały, Łobzów) w XVI, XVII i XVIII w. znajdujemy w opisach ogrodów pałacowych (Ciołek 1954; Stępniewska 1977). Być może jednak, że mamy do czynienia z importem owoców suszonych.

Ogółem stwierdzono 20 gatunków roślin uprawnych, co stanowi 8·7% ogólnej liczby gatunków (tabele 7 i 9). W tej liczbie na zboża przypada 6 gatunków (2·6%), na rośliny oleiste, włókniste i warzywa 8 gatunków (3·5%), na drzewa i krzewy owocowe 4 gatunki (1·7%) oraz na inne 2 gatunki (0·9%).

Rośliny lasów i zarośli

Wśród roślin, które swoje naturalne siedliska mają w różnych zbiorowiskach leśnych, zachowało się kilka gatunków, które dostarczają jadalnych owoców zbieranych z roślin dziko rosnących. Najliczniej, tak we wczesnym, jak i późnym średniowieczu, wystąpiły pestki maliny (*Rubus idaeus*) i jeżyny (*Rubus* t. *plicatus* i *Rubus* sp.). Gatunki te mogły rosnąć w zespołach rzędu *Atropetalia*, które rozwijają się na zrębach i wykrociskach leśnych. Do tego rzędu zaliczono 4 gatunki, co stanowi 1·9% ogólnej liczby gatunków (tabele 8 i 9).

Z innych roślin leśnych dość dużą grupę tworzą gatunki, które rozwijały się w dolinach rzek na okresowo zalewanych madach nadrzecznych, reprezentujące łęgi wierzbowe i wierzbowo-topolowe ze związku *Salicion* (7 gatunków — 3·3%). W największej liczbie okazów wystąpił tutaj chmiel (*Humulus lupulus*). Grupa ta najlepiej reprezentowana jest w warstwach późnośredniowiecznych. Nieco słabiej reprezentowane są lasy łęgowe z olszą, jesionem i wiązem ze związku *Alno-Padion* (5 gatunków — 2·4%). Olszę szarą (*Alnus incana*) i gwiazdnicę gajową (*Stellaria nemorum*) znaleziono w szczątkach makroskopowych, a pozostałe gatunki wystąpiły tylko w pyłku. Olesy ze związku *Alnion glutinosae* reprezentowane są przez 2 gatunki charakterystyczne (0·9%), z których w większej liczbie prób i okazów wystąpił stwierdzony w szczątkach makroskopowych karbieniec polny (*Lycopus europaeus*).

Z roślin związanych z lasami grądowymi (*Tilio-Carpinetum*) tylko w pyłku zachowały się grab (*Carpinus betulus*), lipy (*Tilia cordata* i *T. platyphyllos*) i bluszcz (*Hedera helix*). Poza tym znaleziono ułamki pestek czereśni lub wiśni (*Cerasus* sp.) i gruszę lub jabłoń (*Pirus* sp. lub *Malus* sp.) oraz owocki dwu gatunków roślin zielnych. W sumie ten typ lasów reprezentuje 8 gatunków (3·8%).

Ciepłe zarośla kserotermiczne z rzędu *Quercetalia pubescentis* reprezentowane są przez 3 gatunki charakterystyczne (1·4%), które wystąpiły tylko w warstwie późnośredniowiecznej. W zaroślach tych mogły występować również dereń (*Cornus sanguineus*) i leszczyna (*Corylus avellana*), które rosną także w innych zbiorowiskach leśnych.

Omówione zbiorowiska leśne z klasy *Querco-Fagetea* reprezentuje w sumie 27 gatunków (12·9%), a w ich liczbie najwięcej, bo 14 gatunków (6·7%) przypada na zespoły leśne kompleksu łęgowego (tabela 9).

Bory szpilkowe z klasy *Vaccinio-Piceetea* reprezentuje 5 gatunków (2·4%), z których świerk (*Picea excelsa*) i borówka (*Vaccinium* sp.) były stwierdzone na podstawie szczątków makroskopowych i pyłku, a orlica (*Pteridium aquilinum*) i widłaki (*Lycopodium* sp.) zachowały się tylko w postaci zarodników.

Charakterystyka botaniczna warstw archeologicznych

Przedstawiony w tym rozdziale opis warstw osadniczych opiera się tylko na wynikach analizy szczątków makroskopowych. Pod względem zawartości owoców i nasion profil 4 jest znacznie bogatszy od profilu 11. W obu profilach zaznaczyła się różnica w liczbie okazów pomiędzy wczesnym a późnym średniowieczem. Warstwy wczesnośredniowieczne, bardziej piaszczyste i suche, zawierały mniej szczątków roślinnych, natomiast warstwy późnośredniowieczne, bardziej zbite, wilgotne, często o typie mierzwy, zawierały większe ilości materiału roślinnego. W dalszej części rozdziału przeprowadzono szczegółową analizę jakościowego i ilościowego składu prób z obu profilów na podstawie wykresów owocowo-nasiennych (ryc. 7 i 8).

Porównanie roślinności wczesnego i późnego średniowiecza

Ogólna charakterystyka roślinności

Dla przeprowadzenia tego porównania posłużono się tabelą 9, która przedstawia bezwzględną i procentową liczbę gatunków z wyróżnionych zbiorowisk roślinnych. W tabeli próby tego samego wieku z obu profilów zgrupowano razem. Do analizy porównawczej wzięto pod uwagę warstwę wczesnośredniowieczną (bez warstwy niwelacyjnej i gotyckiej) oraz starszą i młodszą warstwę z późnego średniowiecza.

Z danych zestawionych w tabeli wynika, że nie ma zasadniczej różnicy w składzie roślinności wczesnego i późnego średniowiecza. Prawie wszystkie zbiorowiska roślinne wyróżnione we wczesnym średniowieczu reprezentowane są

także w obu fazach późnego średniowiecza. Różnice w liczbie gatunków z poszczególnych grup pomiędzy porównywanymi okresami na ogół nie przekraczają 2·5%.

Na podstawie analizy udziału procentowego gatunków w całości materiału można stwierdzić, że dominują rośliny zbiorowisk synantropijnych. Udział ich w porównywanych okresach waha się od 39·5% do 43·6%, w tym na chwasty polne przypada 16·2 do 18·2%, a na rośliny ruderalne 9·9 do 11·6%. Duże grupy tworzą gatunki zbiorowisk łąkowych (18·8–20·7%) i roślin uprawnych (11·6 do 15·3%). Udział procentowy gatunków z pozostałych zbiorowisk w całości materiału nie dochodzi do 10% (tabela 9).

W dalszej części rozdziału wydzielono gatunki, które mogły rosnąć na samym Rynku, oraz gatunki pochodzące z bliższych i dalszych okolic. Na samym Rynku mogły rosnąć przede wszystkim rośliny ruderalne z rzędu *Potentillo-Polygonetalia*, które rozwijają się przy drogach i na silnie wydeptywanych miejscach, takie jak rdest ptasi (*Polygonum aviculare*) i babka zwyczajna (*Plantago maior*) oraz z rzędu *Onopordetalia* występujące na siedliskach wzbogaconych w azot na śmietniskach, gruzowiskach, przy zabudowaniach i płotach: łopian większy (*Arctium lappa*), łoboda rozłożysta (*Atriplex patulum*), tasznik pospolity (*Capsella bursa-pastoris*), lebioda, czyli komosa biała (*Chenopodium album*) i komosa wielkolistna (*C. hybridum*), ślaz dziki (*Malva silvestris*), kocimiętka właściwa (*Nepeta cataria*), szczaw tępolistny (*Rumex obtusifolius*), pokrzywa zwyczajna (*Urtica dioica*) i pokrzywa żegawka (*U. urens*). Wzdłuż rowów i ścieków mogły pojawiać się czasami nitrofilne terofity z rzędu *Bidentetalia*, np. uczep trójlistkowy (*Bidens tripartitus*) i uczep uwisły (*B. cernuus*) oraz rdest kolankowy (*Polygonum nodosum*) i rdest ostrogorzki (*P. hydropiper*). Nie jest wykluczone, że w ogrodach czy na małych poletkach, jakie mogły znajdować się w obrębie dzisiejszego Rynku, hodowano niektóre rośliny użytkowe, zwłaszcza jarzyny, takie jak kapusta warzywna (*Brassica oleracea*), rzepak (*B. napus*), kapusta polna (rzepa — *Brassica campestris*) i portulaka pospolita (*Portulaca oleracea*), a także rośliny lecznicze, np. mięta (*Mentha* sp.) i czyścica lekarska (*Calamintha officinalis*). W ogrodach tych rozwijały się przypuszczalnie niektóre chwasty upraw okopowych np. chwastnica jednostronna (*Echinochloa crus-galli*), czy włośnica zielona (*Setaria viridis*) lub włośnica sina (*S. glauca*), których owoce znaleziono w większej liczbie okazów. Z drzew, jako pozostałość po naturalnych lasach, mogły rosnąć na rynku klon (*Acer* sp.), lipy (*Tilia cordata*, *T. platyphyllos*), grab (*Carpinus betulus*) i dąb (*Quercus* sp.) stwierdzone tylko w pyłku, ale w stosunkowo wysokim procencie, a z krzewów dziki bez (*Sambucus* sp.), zachowany także w postaci pestek, oraz porzeczka lub agrest (*Ribes* sp.), a z pnączy bluszcz (*Hedera helix*). Większość dziko rosnących gatunków, przede wszystkim chwasty polne i gatunki łąkowe, dostała się na Rynek wraz ze zbożem czy sianem, lub też została zawleczona przypadkowo przez ludzi i zwierzęta z dalszych terenów miasta lub jego okolic.

Jeśli chodzi o siedliska, z których mogły pochodzić gatunki znalezione w warstwach osadniczych, to największa liczba gatunków (ponad 39% — tabela 9) reprezentuje zbiorowiska wtórne, które rozwinęły się dzięki działalności

człowieka w obrębie kompleksu dębowo-grabowego (Kornaś & Medwecka-Kornaś 1974). Należą tu zespoły świeżych łąk (*Arrhenatheretalia*), rośliny ruderalne z rzędu *Onopordetalia*, chwasty polne (*Secali-Violetalia arvensis*) i zbiorowiska zrębów leśnych (*Atropetalia*). Drugie miejsce pod względem liczby gatunków zajmują zbiorowiska kompleksu łęgowego (ponad 27%). Są to przeważnie pierwotne zbiorowiska roślinne, do których należą zespoły wodne i szuwarowe, łęgi wierzbowo-topolowe, łęgi olszowe z jesionem i wiązem, a także częściowo pierwotne, a częściowo antropogeniczne zbiorowiska roślin zielnych z *Bidentetalia*, *Potentillo-Polygonetalia* i *Isoëto-Nanojuncetea*. Ze zbiorowisk wtórnych w obrębie tego kompleksu rozwijały się wilgotne łąki z rzędu *Molinietalia*. Kompleks ciepłych zarośli (około 11 gatunków) reprezentowany jest przez gatunki muraw kserotermicznych, ciepłolubnych zespołów ruderalnych (*Onopordion*) oraz kserotermicznych zarośli leszczynowych. Ze zbiorowiskami kompleksów sosnowego i sosnowo-dębowego związanych jest około 6% gatunków. Prawie 20% ogólnej liczby gatunków przypada na gatunki występujące w zbiorowiskach z różnych kompleksów oraz na rośliny uprawne.

Podsumowanie wyników

Opracowane szczątki roślinne pochodzą z dwu wykopów archeologicznych z Rynku Głównego w Krakowie, z okresów wczesnego średniowiecza (od połowy XI do połowy XIII w.), późnego średniowiecza (od połowy XIII do końca XIV i XV w.) i z czasów nowożytnych. Na podstawie wyników analizy szczątków makroskopowych i analizy pyłkowej wyodrębniono 340 taksonów, w tym 200 oznaczonych do gatunku i 60 do rodzaju. Wśród 200 gatunków 149 opisanych zostało tylko na podstawie szczątków makroskopowych, 30 tylko na podstawie sporomorf, a 21 na podstawie obu typów szczątków. Wśród szczątków makroskopowych stwierdzono 17 gatunków, które dotychczas nie były podawane z innych stanowisk archeologicznych w Polsce. Oznaczone gatunki reprezentują zbiorowiska roślinne należące do 10 klas zespołów. Największa liczba taksonów reprezentuje klasę *Rudero-Secalietea* (88 gatunków), dużą grupę stanowią także gatunki zbiorowisk łąkowych z klasy *Molinio-Arrhenatheretea* (37 gatunków). Zbiorowiska leśne i zaroślowe z klasy *Querco-Fagetea* reprezentuje 27 gatunków, zespoły muraw kserotermicznych z *Festuco-Brometea* 14 gatunków. Liczba gatunków w pozostałych zespołach nie przekracza 10. Grupa roślin uprawnych obejmuje 20 gatunków, w tym 6 gatunków zbóż i 5 gatunków warzyw.

Niektóre gatunki mogły znaleźć odpowiednie warunki do rozwoju na samym Rynku, przede wszystkim rośliny ruderalne, większość jednak była zawleczona przypadkowo przez ludzi i zwierzęta lub przywożona na Rynek celowo jako produkty handlowe przeznaczone dla celów konsumpcyjnych (zboża, jadalne owoce roślin dzikich i hodowanych, rośliny oleiste i włókniste, zioła lecznicze).

Analiza botaniczna materiału z Rynku nie wykazała zasadniczej różnicy w składzie roślinności z wczesnego i późnego średniowiecza.

PLATES

TABLICE

Plate I
Tablica I

1. *Alisma plantago-aquatica*, a — fruit, b — seed (a — owoc, b — nasienie)
2. *Sagittaria sagittifolia*
3. *Alnus incana*
4. *Betula* cf. *verrucosa*
5. *Myosotis arvensis* type
6. *Myosotis silvatica* or (lub) *M. palustris*
7. *Arenaria serpyllifolia*
8. *Lychnis flos-cuculi*
9. *Cerastium vulgatum*
10. *Agrostemma githago*
11. *Malachium aquaticum*
12. *Melandrium album*, one seed: a — from lateral side, b — from ventral side, showing hilum (jedno nasienie: a — z boku, b — od strony brzusznej widoczny znaczek)
13. *Melandrium noctiflorum*, one seed: a — from lateral side, b — from ventral side, showing hilum (jedno nasienie: a — z boku, b — od strony brzusznej widoczny znaczek)
14. *Gypsophila muralis*
15. *Stellaria media*
16. *Stellaria graminea*
17. *Stellaria nemorum*
18. *Scleranthus* cf. *annuus*
19. *Silene gallica*
20. *Viscaria vulgaris*
21. *Spergula arvensis* var. *arvensis*

Each scale line equals 1 mm (Skala oznacza 1 mm)

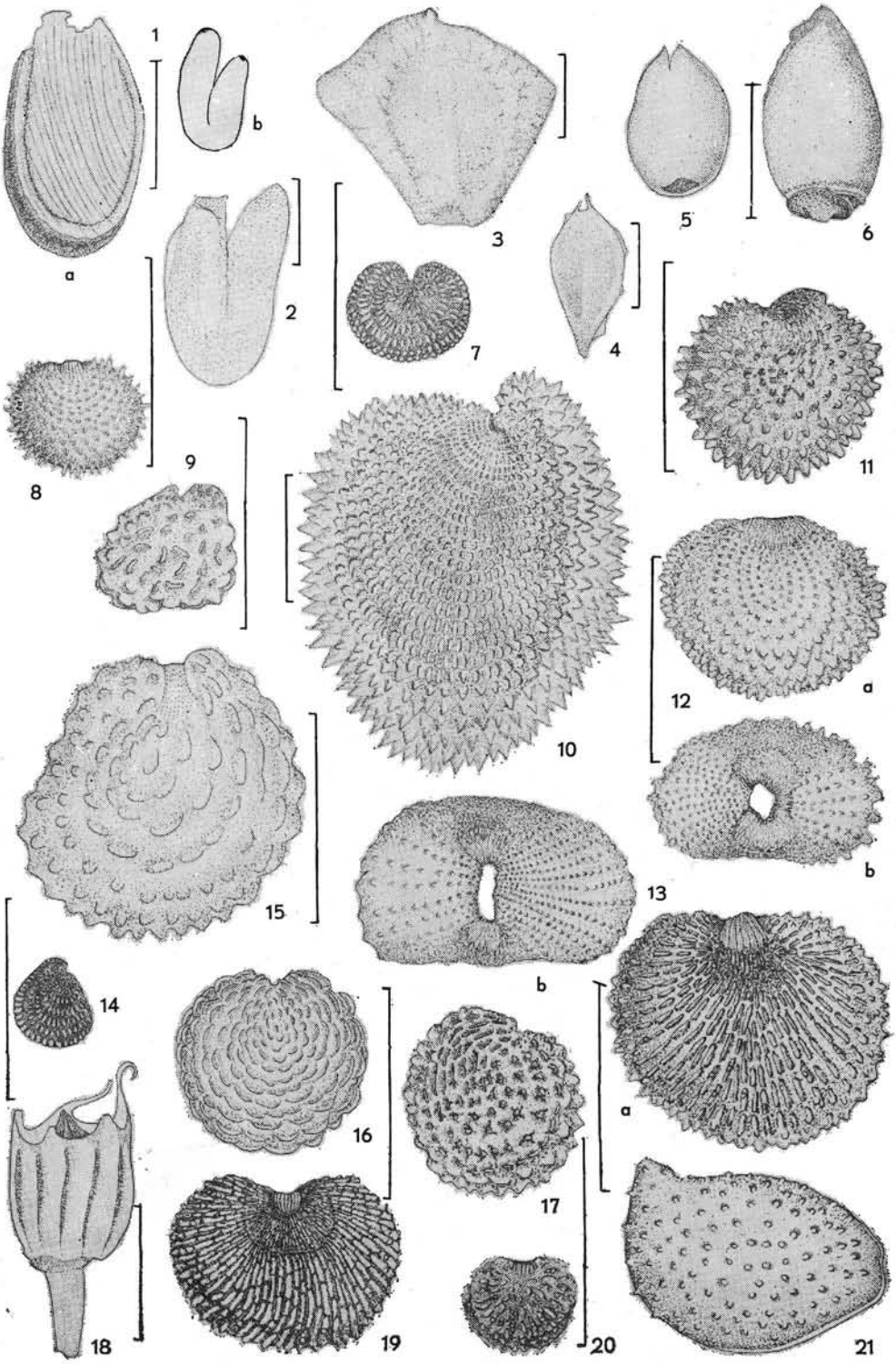
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Plate II
Tablica II

1. *Cannabis sativa*
2. *Humulus lupulus*
3. *Campanula persicifolia*
4. *Atriplex patulum*, one seed: a — from lateral side, b — from edge (jedno nasienie: a — z boku, b — od strony brzeżnej)
5. *Chenopodium album*, one seed: a — from lower side, b — from upper side, c — in cross section (jedno nasienie: a — od strony dolnej, b — od strony górnej, c — przekrój poprzeczny)
6. *Chenopodium hybridum*
7. *Chenopodium glaucum*
8. *Chenopodium* cf. *opulifolium*, one seed: a — from lower side, b — from upper side, c — in cross section (jedno nasienie: a — od strony dolnej, b — od strony górnej, c — przekrój poprzeczny)
9. *Chenopodium polyspermum*
10. *Chenopodium ficifolium*, one seed: a — from lower side, b — from upper side (jedno nasienie: a — od strony dolnej, b — od strony górnej)
11. *Chenopodium* cf. *urbicum*, one seed: a — from lower side, b — from upper side (jedno nasienie: a — od strony dolnej, b — od strony górnej)
12. *Chenopodium* cf. *vulvaria*
13. *Chenopodium* cf. *viride*, one seed: a — from lower side, b — from upper side, c — in cross section (jedno nasienie: a — od strony dolnej, b — od strony górnej, c — przekrój poprzeczny)
14. *Euphorbia helioscopia*
15. *Cuscuta* sp., seed soaked with glycerine (nasienie nasycone gliceryną)

Each scale line equals 1 mm (Skala oznacza 1 mm)

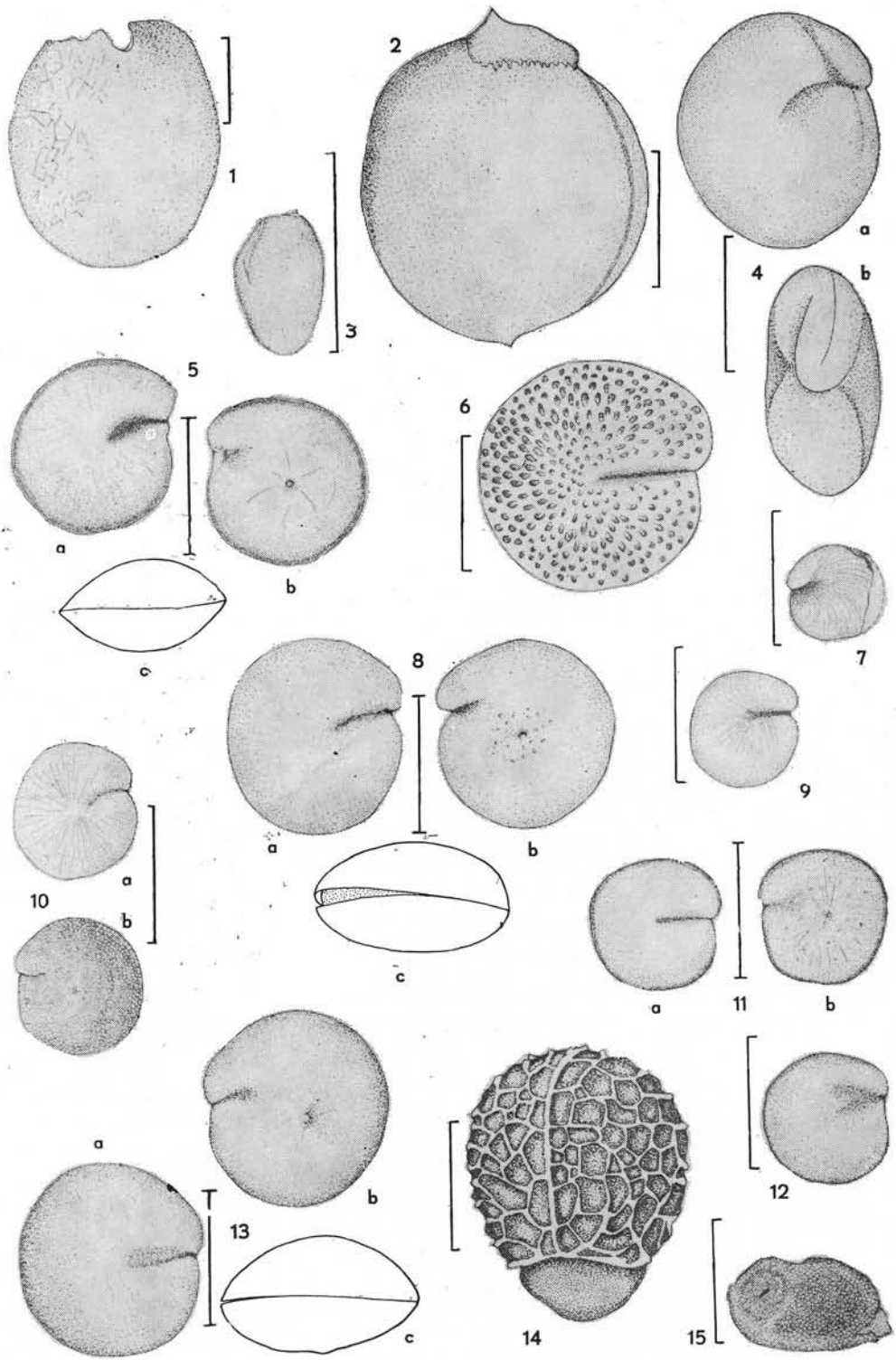

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Plate III
Tablica III

1–4. *Anthemis arvensis*, 1, 2 — central fruits, 3 — marginal fruit, 4 — longitudinal section of a central fruit (1, 2 — owoce środkowe, 3 — owoc brzeżny, 4 — przekrój podłużny owocu środkowego)

5. *Anthemis cotula*

6–7. *Anthemis tinctoria*, two fruits from different places of capitulum: 6 — central fruit, 7 — marginal fruit (dwa owoce z różnych miejsc koszyczka: 6 — owoc środkowy, 7 — owoc brzeżny)

8. *Achillea* cf. *millefolium*

9. *Cichorium intybus*

10. *Arctium* cf. *lappa*

11. *Centaurea cyanus*

12. *Centaurea jacea*

13. *Eupatorium cannabinum*, one achene: a — from lateral side, b — in cross section (jedna niełupka: a — z boku, b — przekrój poprzeczny)

14. *Bidens cernuus*

15. *Bidens tripartitus*

16. *Carduus* sp.

17. *Cirsium* sp.

18. *Lapsana communis*

19. *Hieracium* sp.

20. *Chrysanthemum leucanthemum*, one achene: a — from lateral side, b — from the apex (jedna niełupka: a — z boku, b — z góry)

Each scale line equals 1 mm (Skala oznacza 1 mm)

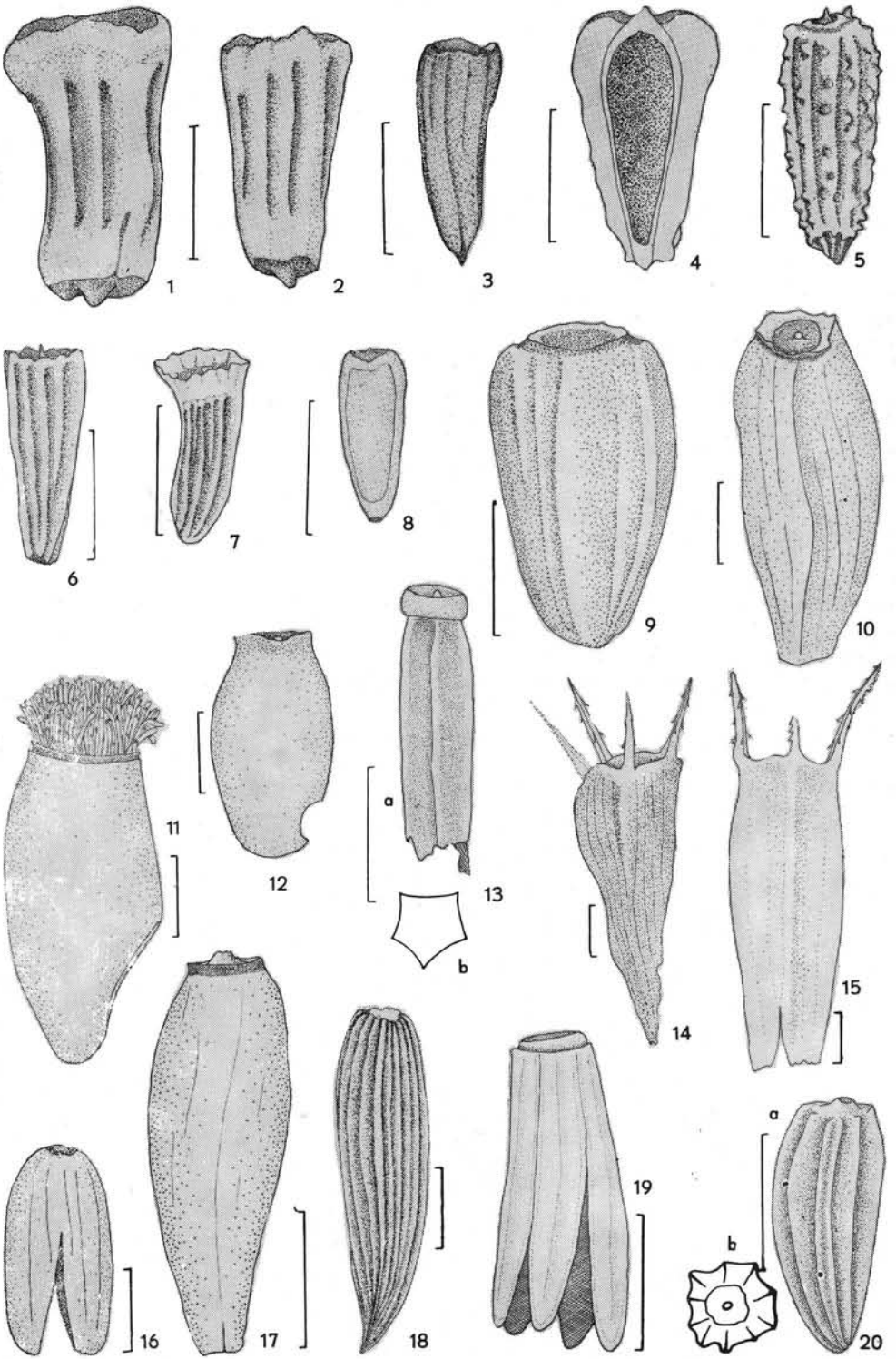
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Plate IV
Tablica IV

1. *Picris hieracioides*
2. *Sonchus arvensis*
3. *Sonchus asper*
4. *Brassica campestris*
5. *Brassica napus*
6. *Barbarea* sp.
7. *Capsella bursa-pastoris*
8. *Brassica nigra*
9. *Brassica oleracea*
10. *Descurainia sophia*
11. *Neslia paniculata*
12. *Rorippa* cf. *silvestris*
13. *Sinapis arvensis*
14. *Thlaspi arvense*
15. *Vaccinium* sp.
16. *Scirpus silvaticus*, one fruit: a — from lateral side, b — cross section (jeden owoc: a — z boku, b — przekrój poprzeczny)
17. *Cyperus fuscus*, one fruit: a — from lateral side, b — cross section (jeden owoc: a — z boku, b — przekrój poprzeczny)
18. *Heleocharis* cf. *palustris*

Each scale line equals 1 mm (Skala oznacza 1 mm)

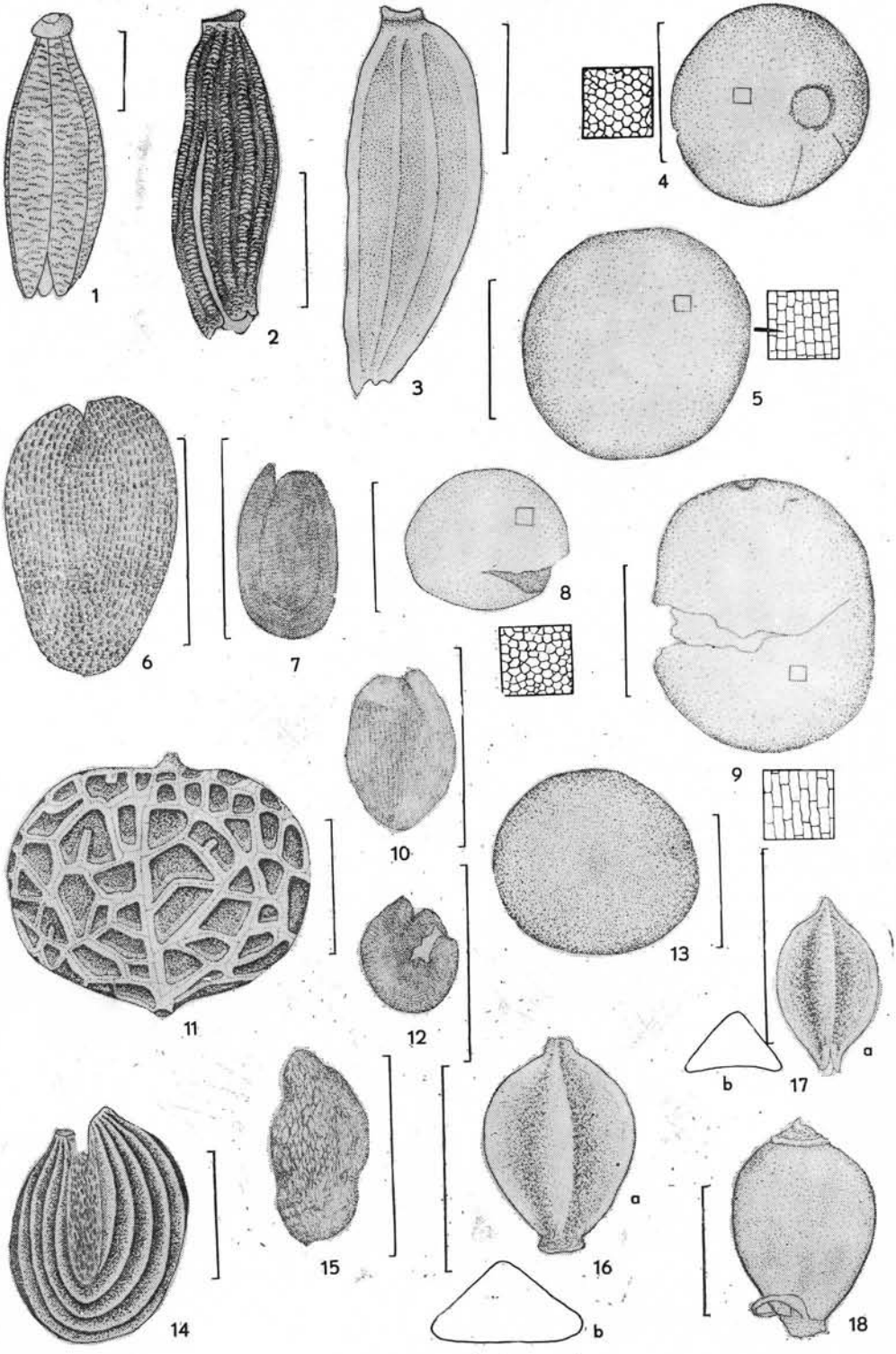

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Plate V
Tablica V

1. *Lolium* sp., one caryopsis: a — from dorsal side, b — from ventral side (jeden ziarniak: a — od strony grzbietowej, b — od strony brzusznej)
2. *Digitaria sanguinalis*, one caryopsis: a — from dorsal side, b — from ventral side (jeden ziarniak: a — od strony grzbietowej, b — od strony brzusznej)
3. *Echinochloa crus-galli*, naked caryopsis from dorsal side (jeden nagi ziarniak od strony grzbietowej)
4. *Setaria viridis* or *S. verticillata*, naked caryopsis from dorsal side (nagi ziarniak od strony grzbietowej)

5–6. *Secale cereale*, 5a, b and 6a, b — two fragments of ear rachis shown from two sides, 6c — fragment of keel of the lemma (5a, b oraz 6a, b — dwa fragmenty osadki kłosa z dwu stron, 6c — fragment kila plewki dolnej)

7. *Setaria glauca*, naked caryopsis from dorsal side (nagi ziarniak od strony grzbietowej)
8. *Hypericum* cf. *acutum*
9. *Hypericum* cf. *maculatum*
10. *Hypericum perforatum*
11. *Juniperus communis*
12. *Iris sibirica*, seed with the outer layer of testa (nasienie z zewnętrzną warstwą łupiny nasiennej)
13. *Luzula* sp.
14. *Luzula multiflora*
15. *Linum catharticum*
16. *Linum usitatissimum*

Each scale line equals 1 mm (Skala oznacza 1 mm)

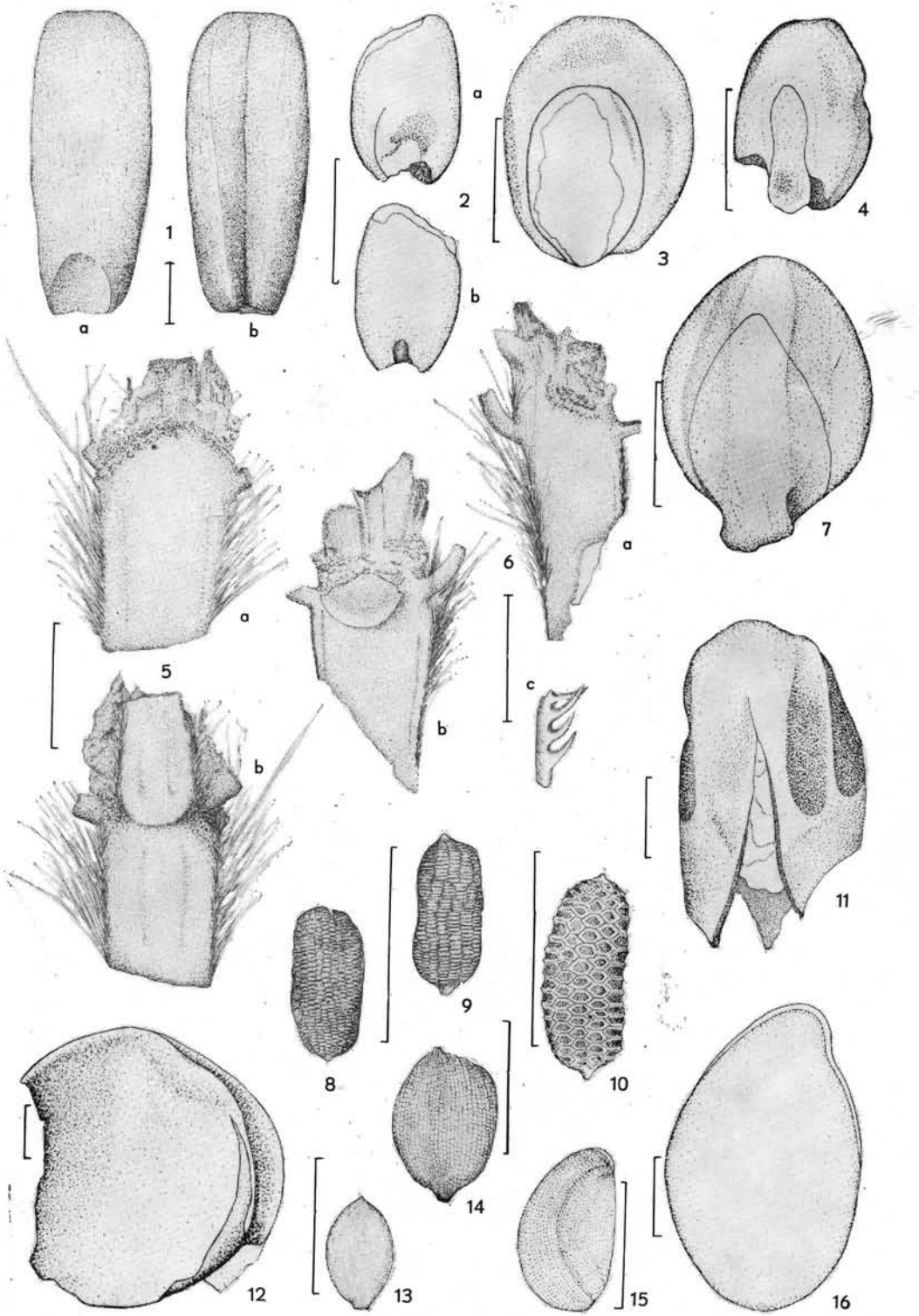
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Plate VI
Tablica VI

1. *Ajuga reptans*, one fruit: a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
2. *Betonica officinalis*, one fruit: a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
3. *Calamintha acinos*, one fruit: a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
4. *Galeopsis* cf. *ladanum*, one fruit: a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
5. *Calamintha officinalis*, one fruit: a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
6. *Galeopsis pubescens*, one fruit: a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
7. *Galeopsis tetrahit*, one fruit: a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
8. *Galeopsis speciosa*, one fruit: a — from dorsal side, b — from lateral side (jeden owoc: a — od strony grzbietowej, b — z boku)
9. *Calamintha vulgaris*, one fruit: a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
10. *Glechoma hederacea*

Each scale line equals 1 mm (Skala oznacza 1 mm)

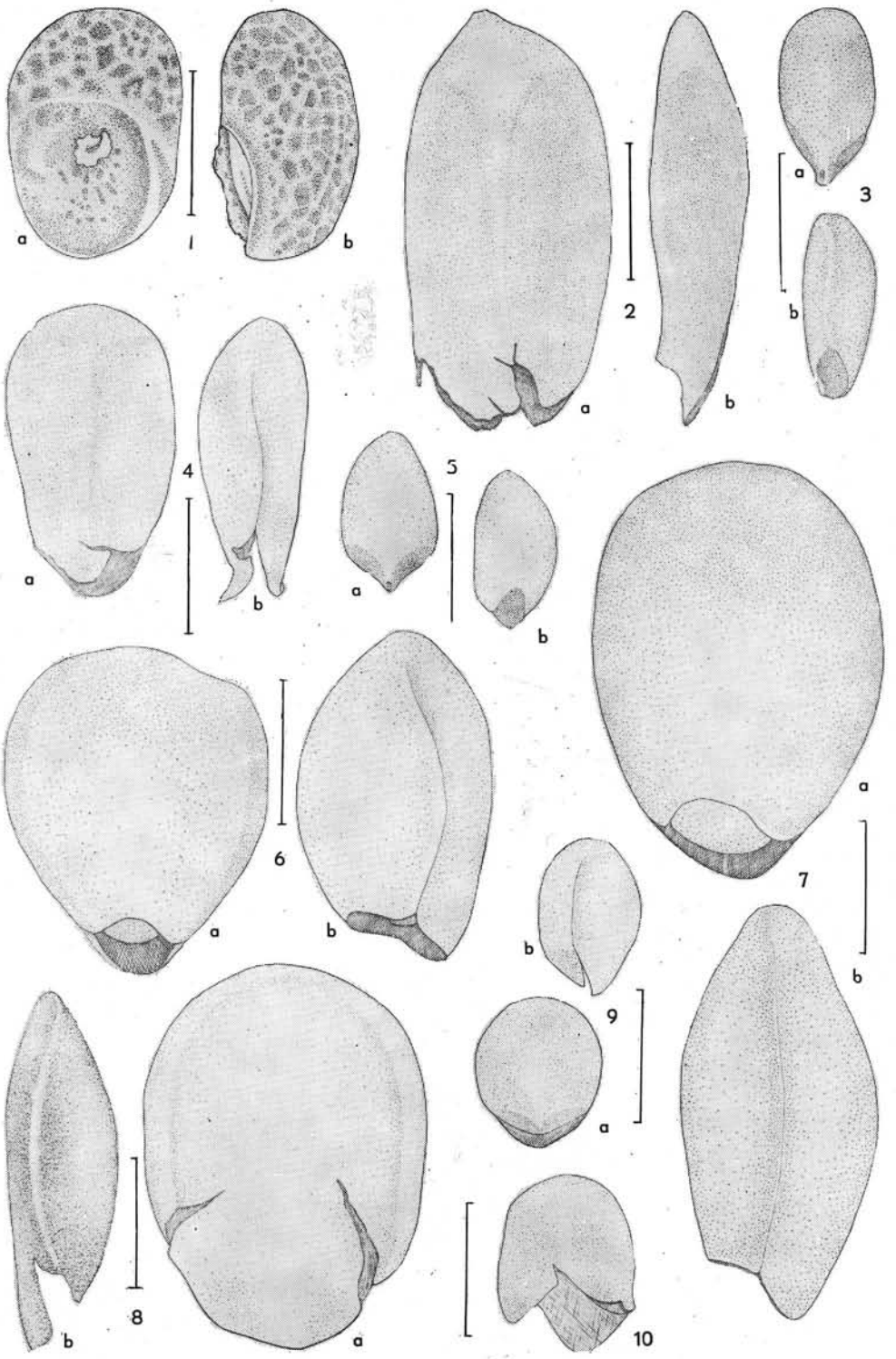

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Plate VII
Tablica VII

1. *Lycopus europaeus*, a — complete fruit from ventral side, b — fruit with partly destroyed marginal ridge (a — cały owoc od strony brzusznej, b — owoc z częściowo uszkodzonym wałeczkowatym zgrubieniem brzeżnym)
2. *Mentha* cf. *arvensis*, one fruit: a — from ventral side, b — from dorsal side (jeden owoc: a — od strony brzusznej, b — od strony grzbietowej)
3. *Nepeta cataria*
4. *Nepeta nuda*
5. *Origanum vulgare*, one fruit: a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
6. *Salvia verticillata*, one fruit: a — from ventral side, b — from base (jeden owoc: a — od strony brzusznej, b — od podstawy)
7. *Prunella vulgaris*, a — complete fruit from ventral side, b — fruit without the outer layer of pericarp, dorsal view (a — cały owoc od strony brzusznej, b — owoc bez zewnętrznej warstwy owocni od strony grzbietowej)
8. *Stachys annua*, one fruit: a — from ventral side, b — from the lateral side (jeden owoc: a — od strony brzusznej, b — z boku)
9. *Lythrum salicaria*
10. *Papaver argemone*
11. *Papaver somniferum*
12. *Papilionaceae* indeterminatae
13. *Portulaca oleracea*
14. *Plantago pauciflora*
15. *Plantago* cf. *indica*
16. *Plantago maior*, one seed: a — from ventral side, b — from dorsal side (jedno nasienie: a — od strony brzusznej, b — od strony grzbietowej)
17. *Anagallis arvensis*, one seed: a — from lateral side, b — from ventral side (jedno nasienie: a — z boku, b — od strony brzusznej)
18. *Lysimachia vulgaris*, one seed: a — from lateral side, b — from ventral side (jedno nasienie: a — z boku, b — od strony brzusznej)

Each scale line equals 1 mm (Skala oznacza 1 mm)

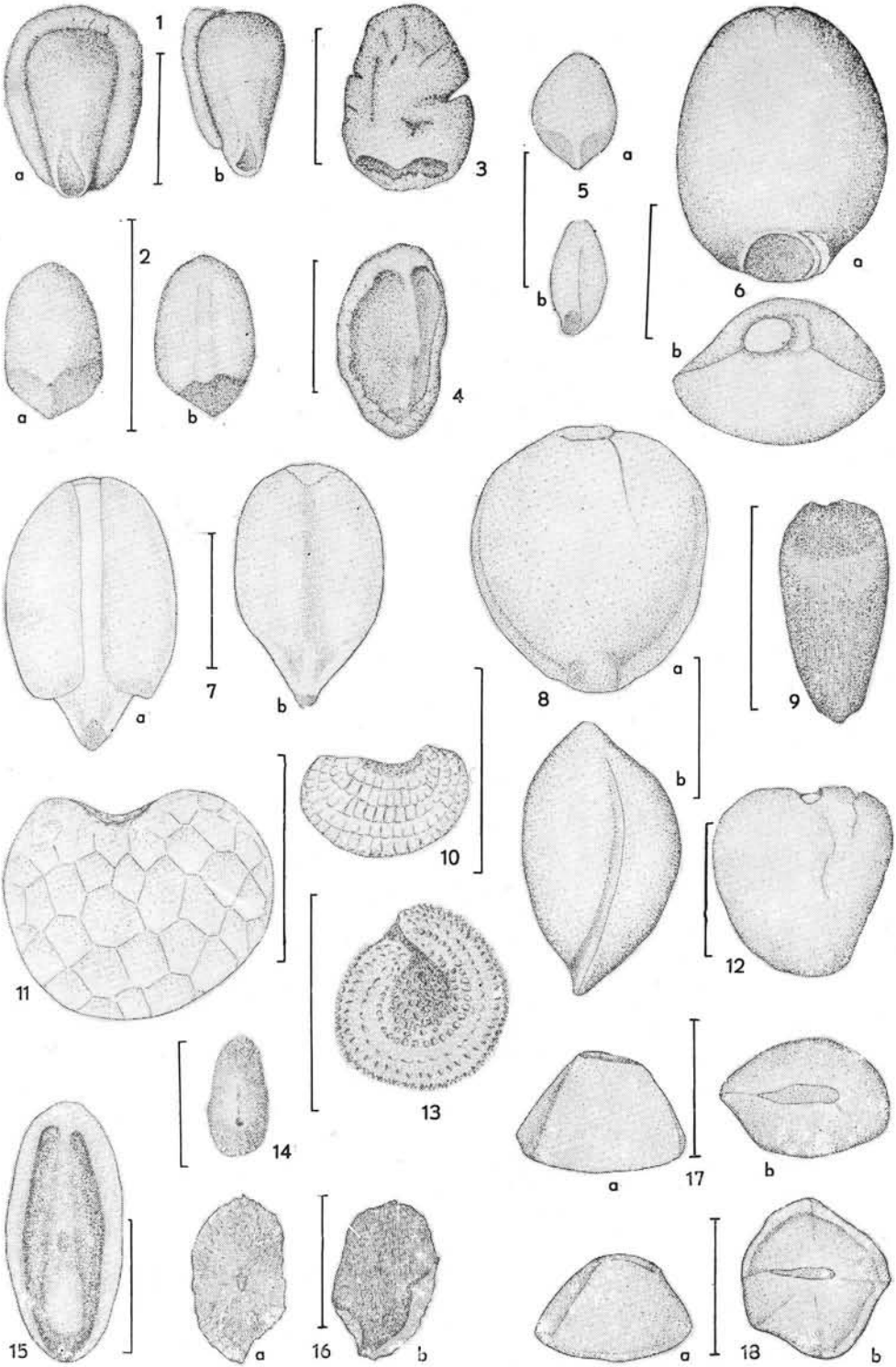

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Plate VIII
Tablica VIII

1. *Polygonum aviculare*
2. *Polygonum convolvulus*
3. *Polygonum hydropiper*, one fruit: a — from lateral side, b — from the apex (jeden owoc: a — od strony bocznej, b — z góry)
4. *Polygonum nodosum*, one fruit: a — from lateral side, b — from the apex (jeden owoc: a — od strony bocznej, b — z góry)
5. *Polygonum lapathifolium*
6. *Polygonum tomentosum*, one fruit: a — from lateral side, b — from the base (jeden owoc: a — od strony bocznej, b — od nasady)
7. *Polygonum minus*, one fruit: a — from lateral side, b — from the base (jeden owoc: a — od strony bocznej, b — od nasady)
8. *Polygonum persicaria*, one fruit: a — from lateral side, b — from the base (jeden owoc: a — od strony bocznej, b — od nasady)

Each scale line equals 1 mm (Skala oznacza 1 mm)

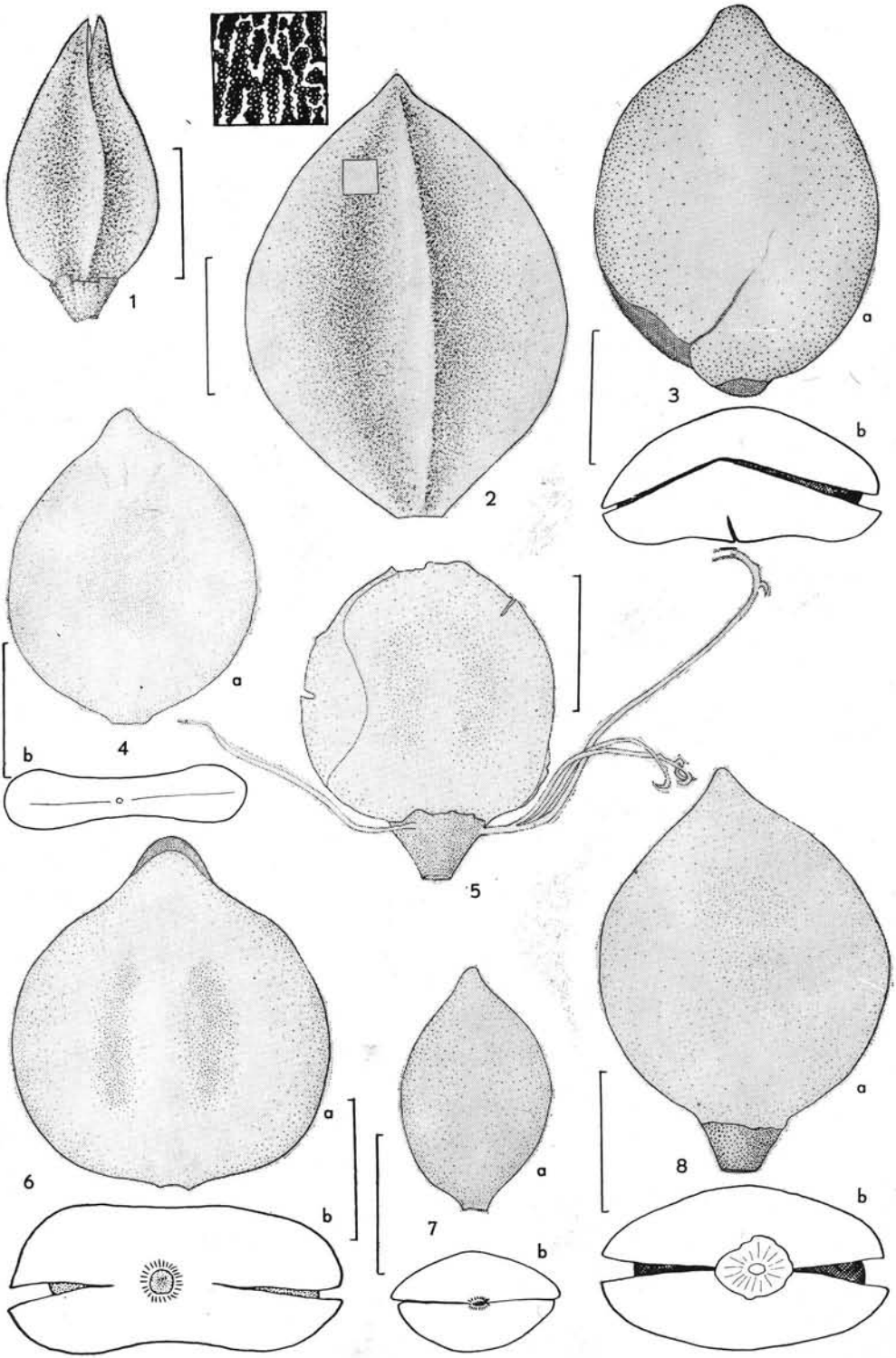

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Plate IX
Tablica IX

1. *Rumex acetosa*, one fruit: a — from lateral side, b — from the apex (jeden owoc: a — od strony bocznej, b — z góry)
2. *Rumex acetosella*, one trigonous fruit: a — from lateral side, b — from the apex (jeden owoc trójgraniasty: a — od strony bocznej, b — z góry)
3. *Rumex acetosella*, one biconvex fruit: a — from lateral side, b — from the apex (jeden owoc dwuboczny: a — od strony bocznej, b — z góry)
4. *Rumex crispus*, one fruit: a — from lateral side, b — from the base (jeden owoc: a — od strony bocznej, b — od nasady)
5. *Rumex obtusifolius*, one fruit: a — from lateral side, b — from the base (jeden owoc: a — od strony bocznej, b — od nasady)
6. *Caltha* sp.
7. *Ranunculus acer*, one fruit: a — lateral view, b — cross section (jeden owoc: a — z boku, b — przekrój poprzeczny)
8. *Ranunculus flammula*
9. *Ranunculus repens*, one fruit: a — lateral view, b — cross section (jeden owoc: a — z boku, b — przekrój poprzeczny)
10. *Ranunculus sceleratus*
11. *Ranunculus sardous*
12. *Thalictrum* cf. *flavum*
13. *Galium boreale*
14. *Galium elongatum*
15. *Galium* cf. *mollugo*
16. *Galium palustre*
17. *Galium spurium*

Each scale line equals 1 mm (Skala oznacza 1 mm)

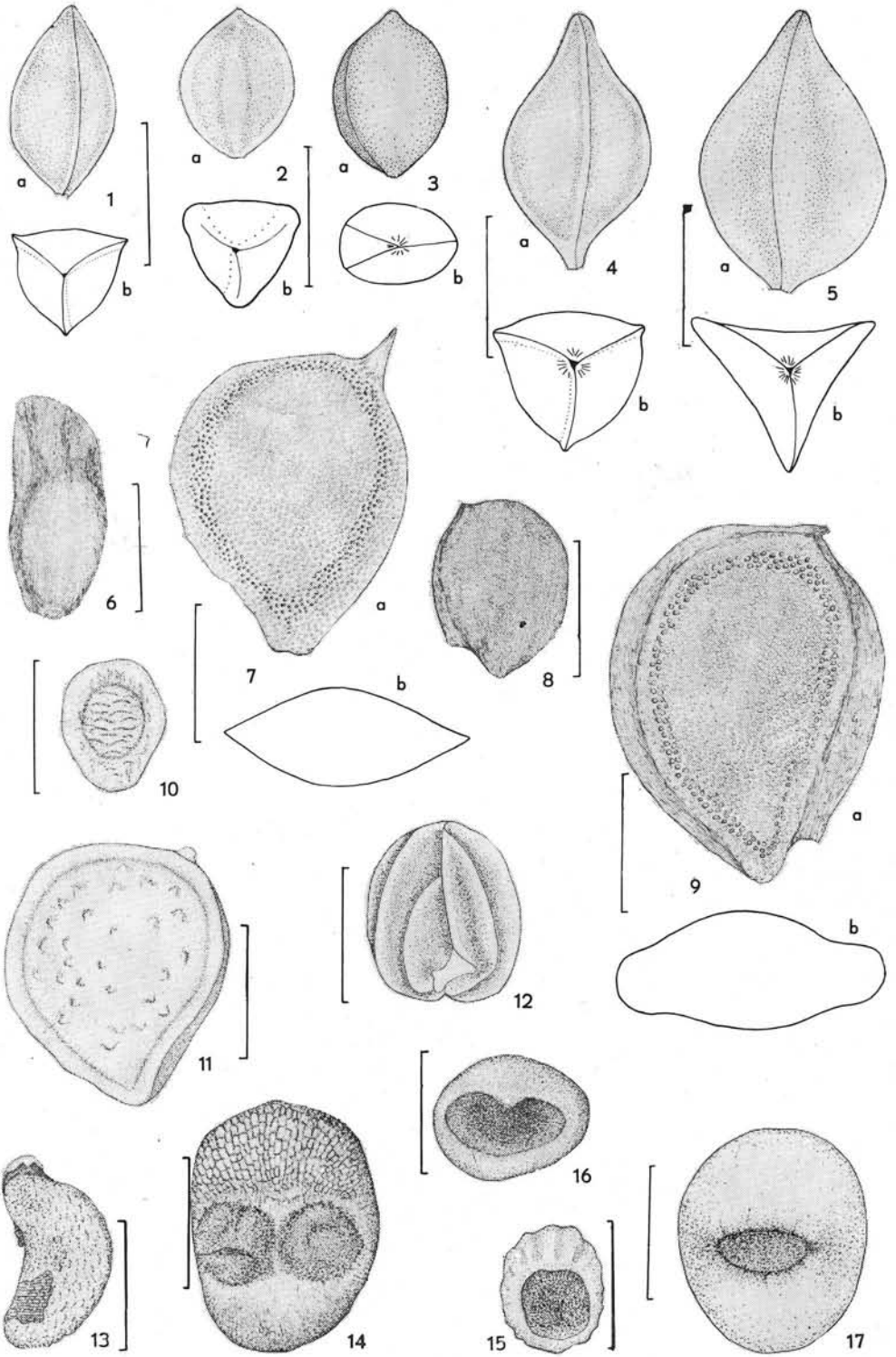
a
1
b
a
2
b
a
3
b
a
4
b
a
5
b
6
7
a
b
8
10
a
9
b
11
12
16
13
14
15
17

Plate X
Tablica X

1. *Malva silvestris*
2. *Epilobium* sp.
3. *Ficus carica*, one seed: a — from lateral side, b — from ventral side, showing hilum (jedno nasienie: a — z boku, b — od strony brzusznej, widoczny znaczek)
4. *Knautia arvensis*, half of a fruit (połowa owocu)
5. *Picea excelsa*, basal part of a needle (część nasadowa szpilki)
6. *Abies alba*, needle (szpilka)
7. *Filipendula ulmaria*
8. *Agrimonia eupatoria*
9. *Aphanes arvensis*
10. *Potentilla* cf. *argentea*
11. *Comarum palustre*
12. *Fragaria viridis*
13. *Fragaria vesca*
14. *Potentilla norvegica*
15. *Potentilla erecta*
16. *Rubus caesius*
17. *Rubus idaeus*
18. *Rubus plicatus* type

Each scale line equals 1 mm (Skala oznacza 1 mm)

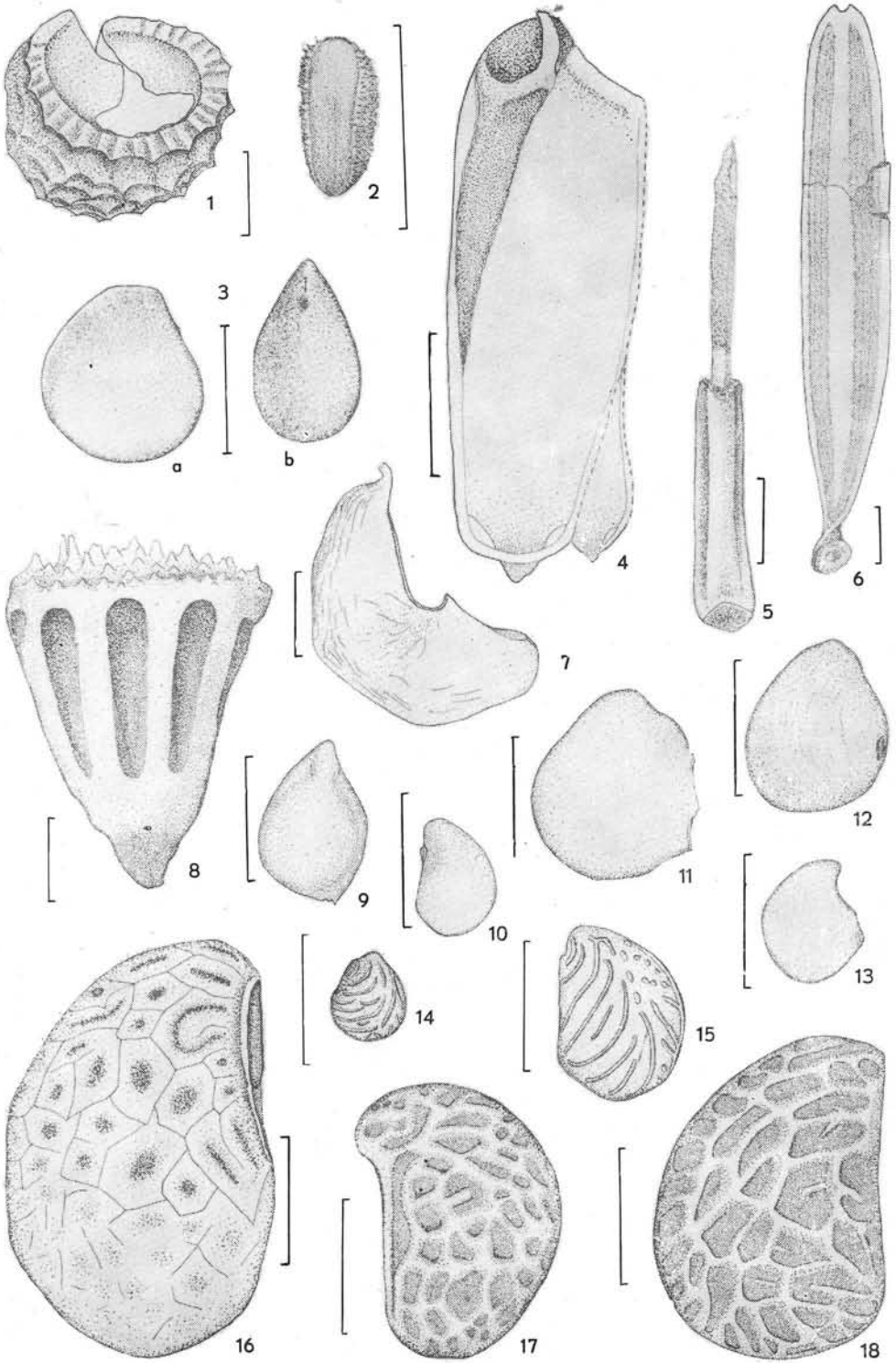
1
2
3
a
b
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Plate XI
Tablica XI

1. *Linaria vulgaris*
2–3. *Scrophularia alata* or (lub) *S. nodosa*
4–5. *Verbascum* sp.
6. *Salix* sp., bud-scale (łuska pączkowa)
7. *Solanum nigrum*
8. *Hyoscyamus niger*
9. *Bupleurum rotundifolium*
10. *Daucus carota*
11. *Peucedanum cervaria*
12. *Valeriana* cf. *officinalis*
13. *Verbena officinalis*
14. *Urtica urens*
15. *Urtica dioica*
16. *Valerianella dentata*
17. *Viola arvensis* or (lub) *V. tricolor*
18. *Viola silvestris* type
19. *Vitis vinifera* ssp. *vinifera*, one fruit-stone: a — from dorsal side, b — from ventral side (jedna pestka: a — od strony grzbietowej, b — od strony brzusznej)

Each scale line equals 1 mm (Skala oznacza 1 mm)

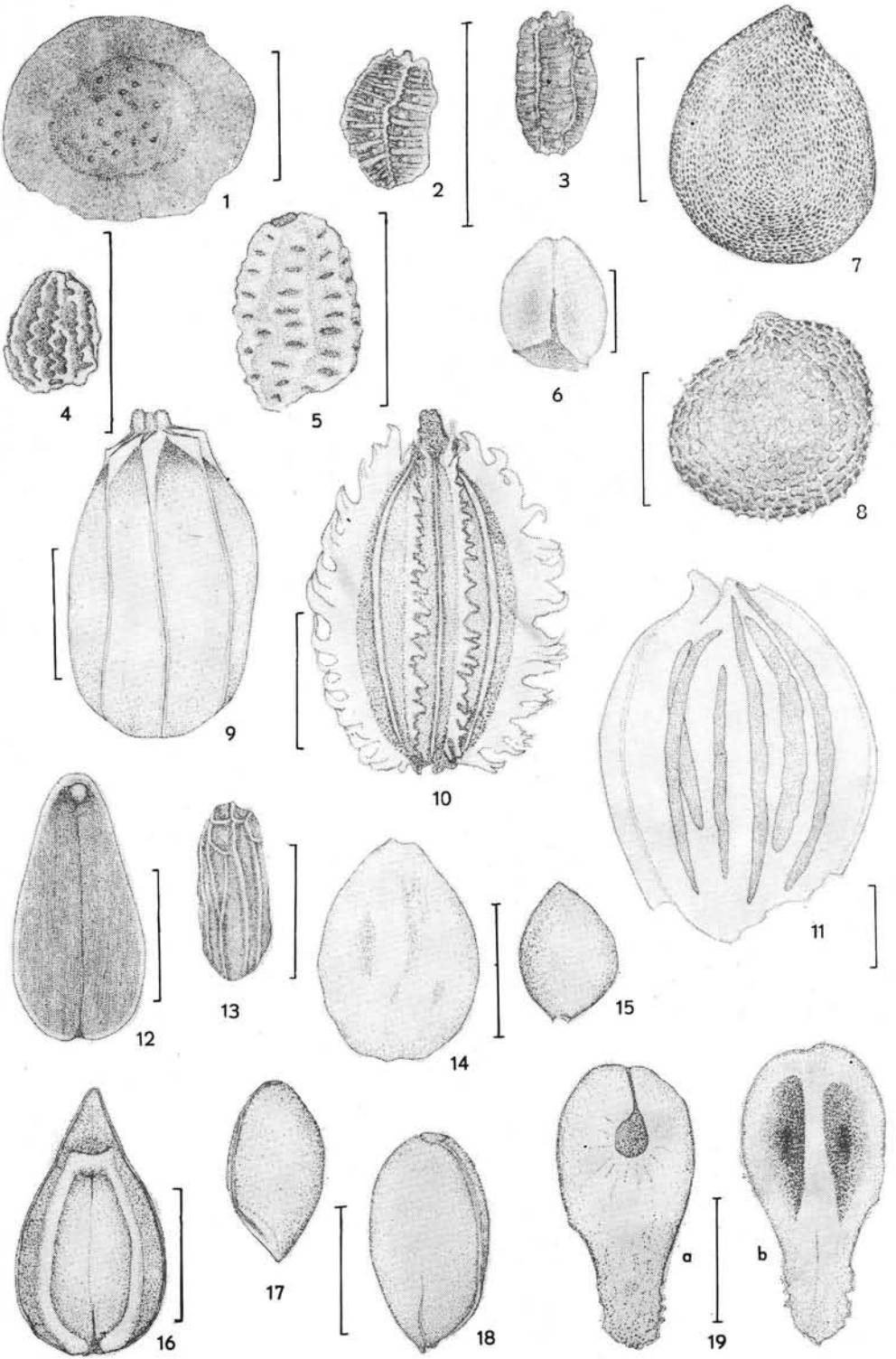

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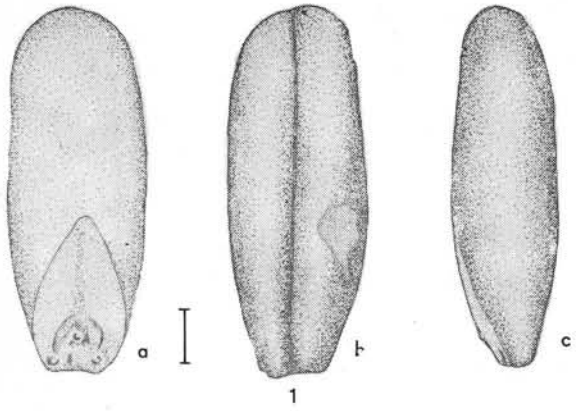
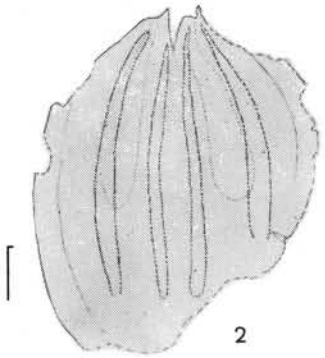
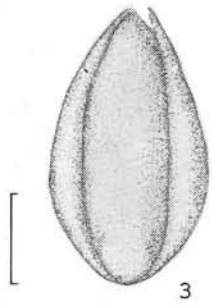
Plate XII
Tablica XII

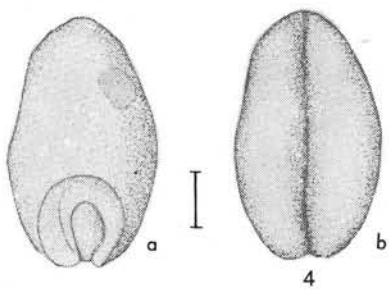
1. *Avena* sp., one carbonized caryopsis: a — from dorsal side, b — from ventral side, c — from lateral side (jeden ziarniak zwęglony: a — od strony grzbietowej, b — od strony brzusznej, c — z boku)
2. *Heracleum sphondylium*
3. *Panicum miliaceum*, uncharred spikelet from ventral side (kłosek nie zwęglony od strony brzusznej).
4. *Triticum aestivum*, one carbonized caryopsis: a — from dorsal side, b — from ventral side, c — from lateral side (jeden ziarniak zwęglony: a — od strony grzbietowej, b — od strony brzusznej, c — z boku).
5. *Salvia* cf. *nemorosa*
6. *Stachys* cf. *palustris*, one fruit; a — from ventral side, b — from lateral side (jeden owoc: a — od strony brzusznej, b — z boku).
7. *Typha* sp.

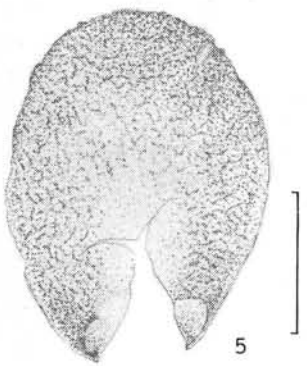
Each scale line equals 1 mm (Skala oznacza 1 mm)


a
b
c
1


2


3


a
b
4
c


5

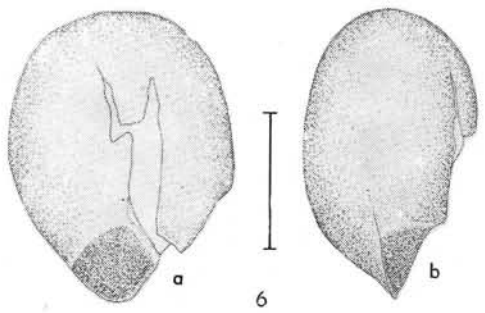

a
6
b
7

Table 1.
Tabela 1.

List of plants from early and late medieval times from the Main Market Square in Cracow identified on the basis of macrofossils and sporomorphs

Lista roślin z wczesnego i późnego średniowiecza z Rynku Głównego w Krakowie oznaczonych na podstawie szczątków makroskopowych i sporomorf

Location – Lokalizacja	NE quarter, excavation I. N wall, profile 4 Kwartał NE, wykop I, ściana N, profil 4																		SE quarter, excavation II, N wall, profile 11 Kwartał SE, wykop II, ściana N, profil 11									
	Early medieval time Wczesne średniowiecze										Late medieval time Późne średniowiecze							Modern time Czasy nowożytne	Early medieval time Wczesne średniowiecze			Late medieval time Późne średniowiecze					Modern time Czasy nowożytne	
Century A.D. Wiek n.e.	From XII/XIII to the middle of XIII century Od XII/XIII do połowy XIII wieku							Ca. the middle of XIII century Około połowy XIII wieku			From the middle of XIII to the end of XIV century Od połowy XIII do końca XIV wieku								From the middle of XI to the middle of XIII century Od połowy XI do połowy XIII wieku			From the middle of XIII to the end of XIV century Od połowy XIII do końca XIV w.			Levelling layer Warstwa niwelacyjna	XV century XV wiek			
								Levelling layer – warstwa niwelacyjna	Gothic layer – Warstwa gotycka																				
Pollen sample No. – Próby palinologiczne Nr			65		68	72		76		79	82			88			94			175		178	181		184		190		192	195
Depth in cm – Głębokość w cm			480,5		470	453		435		420	405			375			345			331		305	275		260		204		190	170
Macrofossil sample No. – Próby makroskopowe Nr	4a	4b	4c	4d	4e	4f	4g	4h	4i	4j	4k	4l	4m	4n	4o	4p	4r	4s	4t	11a	11b	11c	11d	11e	11f	11g	11h	11i	11j		
Depth in cm – Głębokość w cm	492-502	483-490	478-483	473-478	460-470	450-460	447-450	430-447	420-430	410-420	400-410	390-400	380-390	370-380	360-370	350-360	340-350	338-340	215-225	335-350	329-335	320-329	296-310	270-280	260-270	250-260	210-220	200-205	192-200		
Hepaticae																															
Anthoceros sp.			+			+		+			+			+									+				+		+	+
Musci																															
Sphagnum sp.			+																												
Pteridophyta																															
Equisetaceae																															
Equisetum sp.			+		+	+				+	+			+			+						+				+			+
Lycopodiaceae																															
Lycopodium annotinum L.											+						+						+								
L. clavatum L.																												+			
L. complanatum L.																															+
Osmundaceae																															
Osmunda regalis L.					+	+				+	+			+										+					+		
Polypodiaceae indet.			+		+	+		+			+			+			+				+		+	+				+		+	+
Phegopteris sp.																															+
Polypodium vulgare L.										+				+			+						+								+
Pteridium aquilinum (L.) Kuhn			+		+	+		+		+	+						+						+	+			+			+	+
Gymnospermae																															
Cupressaceae																															
Juniperus communis L.																1s															
Pinaceae																															
Abies alba Miller			+		+	+		+	2n	+	+ 2n			+		3n	+		1n				+	+		2 (1) n		+ 3n	(2) n	+	+
Picea excelsa (Lam.) Lk.			+		+	+		+		+	+			+		(1) n							+			(1) n				+	+
Pinus silvestris L.			+		+	+		+		+	+			+			+				+		+	+		+		+			+
Angiospermae																															
Aceraceae																															
Acer sp.			+		+	+		+		+	+			+			+						+				+		+	+
Alismataceae																															
Alisma plantago-aquatica L.									1s	1f		1f																	1f	1s	
A. sp.			+		+	+											+											+			
Sagittaria sagittifolia L.				1s																											
Amaranthaceae																															
Amaranthus sp.																			2s												
Araliaceae																															
Hedera helix L.			+		+					+				+			+											+		+	+
Balsaminaceae																															
Impatiens sp.											+						+							+							
Betulaceae																															
Alnus incana (L.) Mnch.																			1f												
A. sp.			+		+	+		+		+	+			+			+				+		+	+		+		+		+	+
Betula cf. verrucosa Ehrh.																			1f												
B. sp.			+		+	+		+		+	+			+			+						+	+				+		+	+
Carpinus betulus L.			+		+	+		+		+	+			+			+						+	+				+		+	+
Corylus avellana L.			+	(2) f	+	+	(1) f	+		+ (1) f	+ (2) f	(2) f	(1) f	+	(1) f	(7) f	+ (2) f	(3) f	(7) f					+		(10) f	(3) f		+ (3) f			
Boraginaceae																															
Anchusa sp.								+			+			+									+					+			
Cerinthe sp.			+		+	+		+		+	+			+										+		+		+		+	
Echium sp.			+		+	+		+		+	+			+			+							+				+			
Lithospermum arvense L.								1s						1s														1s			
Myosotis arvensis (L.) Hill. type																															
M. silvatica (Ehrh.) Hoffm. / M. palustris (L.) Nathorst											1s																				
M. sp.										1s																					
Campanulaceae																															
Campanula persicifolia L.																													1s		
C. sp.			+		+	+		+		+	+			+			+						+					+		+	+
Jasione montana L.			+		+	+		+		+	+												+					+		+	+
Phyteuma sp.			+		+	+		+		+	+			+									+					+		+	+
Cannabaceae																															
Cannabis sativa L.			+	(1) s	+	+ (1) sp		+	(1) s	+	+	(2) s		+		(1) s	+ (1) s	(1) s					+					+		+	+
Humulus lupulus L.			+	1 (1) s	+ 1s	+	2s	+ 1s	4s	+ 2s	+ 4 (3) s	2 (2) s	1s	+	1 (5) s	2s	+ 1 (1) s	2s	2s					+		1 (7) s	1 (2) s		+ 2 (2) s	(1) s		+
Caprifoliaceae																															
Sambucus sp.			+		+	+		+			+		(3) s	+		(1) s	+							+				+		+	+
Viburnum sp.											+																	+			
Caryophyllaceae indet.				1 (5) s		(5) s			(5) s				(5) s		(2) s	1s	1 (3) s		1 (2) s				(1) s			(3) s					
Agrostemma githago L.				1 (9) s		(12) s	1s	2s	(18) s	1s	3 (7) s	(2) s	(6) s	(1) s	(1) s	5 (31) s	1s	2 (9) s	(2) s				1s	(5) s	(6) s	(6) s		(7) s	(9) s		
Arenaria serpyllifolia L.					1s							2s				5 (1) s	1s	2s	1s								1s	1s			
Cerastium vulgatum L.				1s		?1s			2s							2s								1s	1s				2s		
C. sp.						1s										3s													1s		
Dianthus sp.						(1) s																							1s		
D. type			+		+	+		+		+	+			+			+							+		+		+		+	+
Gypsophila muralis L.																		2s													
Lychnis flos-cuculi L.				1s		3s					1s	1s	1s		1s	3s	1s		5s						2s			2 (1) s	3 (2) s		
Malachium aquaticum (L.) Fr.													1s																		
Melandrium album (Mill.) Garcke				1s							2s												? (1) s								
M. noctiflorum (L.) Fr.						1s							1s		1s	3 (3) s	2s								1 (1) s	1 (1) s			2 (1) s		
M. sp.			+		+						+			+			+							+							+
Sagina cf. procumbens L.															1s																
Scleranthus annuus L.					+	+		+		+	+			+			+							+				+		+	+
S. cf. annuus L.											4f	2f				4f	3f	(1) f	10f					2f	1f	1 (1) f		1f	1f		
Silene gallica L.																													2s		
S. sp.															1s																
Spergula arvensis L.									(1) s			(2) s			(12) s	2 (5) s	(4) s	(2) s	1 (6) s									(1) s	(14) s		
S. sp.											+																				
Stellaria graminea L.											4s	2s	2s		3s	6 (1) s	4 (3) s	2s	11s					1 (1) s	3s	2s		3s	4 (1) s		
S. media Vill.				(1) s		2 (1) s		1s	1s		2s		2 (1) s			3 (2) s	(1) s							1 (1) s	1s				3 (2) s		
S. nemorum L.						1s			(1) s							1s	1s								1s			1s	2 (1) s		
S. sp.				(1) s				+				1s																			
Viscaria vulgaris Röhl.									1s				1s			1s															
Chenopodiaceae indet.			+		+	+		+		+	+			+			+						+	+		+	(1) s	+		+	+
Atriplex patulum L.												1s				(1) s															
Chenopodium album L. s. str.								2s				2s		3s		8s								1s							
Ch. album L. s. l.				3 (1) s	2s	4s	7 (1) s	3s	4 (3) s	4s	23 (4) s	14 (1) s	8 (5) s	4s	28 (4) s	40 (4) s	54 (3) s	28 (8) s	17s				3 (1) s	16s	8 (1) s	4s		4s	8s			
Ch. ficifolium Sm.				1s		1s					1s				1s	1s	2s		1s							1s					
Ch. glaucum L.															1s																
Ch. hybridum L.				(1) s									(1) s			2s									(1) s						
Ch. of. opulifolium Schrad.					1s						1s					2s	4s							1s							
Ch. polyspermum L.											1s		1s	2s	5s	1s		2s	1s												
Ch. cf. urbicum L.						1s									1s			1s						1s		1s					
Ch. cf. viride L.			1s				1s	1s	3s										2s						1s		1s				
Ch. cf. vulvaria L.									1s						2s																
Ch. sp.	1s			1 (9) s		2 (2) s			(29) s	1s	8 (1) s	4 (15) s	1 (11) s		14 (27) s	27 (3) s	12 (19) s	7 (1) s	14 (15) s	(2) s	(3) s	14s	1 (1) s	2 (4) s	3 (3) s	1 (7) s	2 (1) s	1 (1) s			
Cistaceae																															
Helianthemum sp.					+	+				+	+			+									+	+					+	+
Compositae indet.				1f							4f	(1) f			(1) f	1f			1 (1) f						2f			(1) f			
Achillea cf. millefolium L.																2f															
Anthemis arvensis L.				2f		4 (1) f			6 (8) f		19 (3) f	6 (3) f	2 (2) f		7 (2) f	42 (12) f	7f	4 (1) f	14 (8) f					3f	4 (1) f	(1) f		1 (1) f	4 (1) f		
A. cotula L.											(1) f	1f			21f	2f	1f	1f						1f					2f		
A. tinctoria L.											2f		3f			3f		1f								2f					
A. type			+		+	+		+		+	+			+			+							+				+		+	+
Arctium cf. lappa L.																												1f			
Arctium sp.											1f																				
Artemisia sp.			+		+	+		+		+	+			+			+						+	+		+		+		+	+
Aster type			+		+	+		+		+	+			+			+							+				+		+	+
Bidens cernuus L.												1f																			
B. tripartitus L.											1f																		2f		
Carduus sp.																1f			2f						1f						
Centaurea cyanus L.			+	1f	+	+ 1f		+	(1) f	+	+ 8f	2f	1 (1) f	+ (1) f	1f	1 (2) f	+ 2f		3f					+		+ 1f		+ 1f		+	+
C. jacea L.			+		+	+		+		+	+ 1f			+			+	1f	1f				+	+	1f	+		+		+	+
C. scabiosa L.			+		+	+		+		+	+			+			+							+				+		+	+
C. sp.												1f							1f										1f		
Chrysanthemum leucanthemum L.						(2) f					1 (2) f					2 (1) f	1f	1f	2f												
Cichorium intybus L.															1f			1f											1f		
Cirsium sp.			+		+	+		+		+	+ 1f			+			+		1f				+	+				+		+	+
Eupatorium cannabinum L.												1f																			
Hieracium sp.																1f													1f		
Lapsana communis L.									1f		1f		1f			4f			1f												
Picris hieracioides L.																1f			1f												
Sonchus arvensis L.																1f															
S. asper (L.) Hill.						1f																									
S. type			+		+			+									+							+					+		
Taraxacum type			+		+	+		+		+	+			+			+				+			+					+	+	+
Compositae Liguliflorae			+		+	+		+		+	+			+			+						+	+		+			+	+	+
Compositae Tubuliflorae			+		+	+		+		+	+			+			+						+	+					+	+	+

Pollen sample No. – Próby palinologiczne Nr / Macrofossil sample No. – Próby makroskopowe Nr	4a	4b	65 4c	4d	68 4e	72 4f	4g	76 4h	4i	79 4j	82 4k	4l	4m	88 4n	4o	4p	94 4r	4s	4t	11a	175 11b	11c	178 11d	181 11e	11f	184 11g	11h	190 11i	11j	192	195
Convolvulaceae																															
Convolvulus arvensis L.			+			+				+	+			+										+		+			+	+
Cornaceae																															
Cornus sanguinea L.					+																										
C. sp.														+										+				+			
Crassulaceae																															
Sedum sp.																								+							
Cruciferae indet.			+	(1) s	+	+		+		+	+			+			+	1 (1) s	(2) s					+		(1) f		+		+	+
Barbarea sp.						1 (1) s			2s		1s					2s			1s												
Brassica campestris L.						1s	1s				2s	1s	(1) s	1s	1s	1 (1) s	2 (2) s	1 (1) s													
B. napus L.											1 (2) s		2s	1s		1 (1) s	(2) s	1s								1s			1s		
B. nigra (L.) Koch.											1 (1) s						1 (3) s		2s					1s	(1) s						
B. oleracea L.										1 (1) s																					
B. sp.								(1) s	1s		(1) s					1 (2) s	(6) s												(2) s		
Capsella bursa-pastoris (L.) Med.												1s				4s		1s	1s									2s	2s		
Descurainia sophia (L.) Webb.																1s															
Neslia paniculata (L.) Desv.			(1) f	(4) f						1f	(2) f	(1) f	(2) f		(3) f	(2) f	1 (1) f	1f	1 (4) f					1 (4) f	1 (7) f				1 (1) f		
Rorippa cf. silvestris (L.) Bess.																			1s												
Sinapis arvensis L.											2s	2s				2 (1) s	1 (2) s		3 (1) s									1s	1s		
Thlaspi arvense L.						1s			1s	1s		(1) s	1s		1 (1) s	(1) s		1 (1) s	1 (2) s						1 (5) s	(1) s					
Cuscutaceae																															
Cuscuta sp.									1s						1s	1s	1s	2s	1s					1s					1s		
Cyperaceae indet.						1f			2f		3f				1f	2f	2f	1f	2f						2 (1) f				2f		
Carex sp.				11 (4) f	1f	7 (1) f	4f	4f	8 (1) f	5f	23f	19 (6) f	10f	5 (1) f	17 (1) f	37 (7) f	30f	17 (1) f	34 (1) f				1f	15 (3) f	10f	18f		25f 1u	25f 1u		
C. type			+		+	+		+		+	+			+			+						+	+				+		+	+
Cyperus fuscus L.				1f					1f																				1f		
Heleocharis cf. palustris (L.) R. et Sch.											1f		1f		1f	1f	1f	1f	2f					1f					1f		
Scirpus silvaticus L.				5f		8f			8f		5f	4f	6f	4f	8f	13f			4f					2f		2f		6f	9f 1u		
Dipsacaceae																															
Knautia arvensis (L.) Coult.																												(1) f			
K. sp.					+			+		+	+			+			+											+			
Scabiosa sp.										+																				+	
Succisa pratensis Mnch.					+			+		+	+			+			+													+	
Ericaceae indet.																															
Calluna vulgaris (L.) Salisb.			+		+	+		+		+	+			+			+						+	+				+	+	+
Vaccinium sp.								+																	1s						
Euphorbiaceae																															
Euphorbia helioscopia L.												1s																			
E. sp.										+	+																				+
Fagaceae																															
Fagus silvatica L.			+		+	+		+		+	+			+			+							+				+		+	+
Quercus sp.			+		+	+		+		+	+			+			+							+				+		+	
Gentianaceae																															
Gentiana pneumonanthe L. type					+	+					+																				
Geraniaceae																															
Geranium sp.			+		+	+				+	+			+												+		+		+	+
Gramineae indet.			+	7f	+ 1f	+ 3f		+ 7f		+ 5f	+ 25f	6f	2f	+			+	44f	12f		+		+	+ 7f	2f	+ 3f	9f	+ 13f	16f	+	+
Avena sp.										1f	+				(1) f		+									1 (1) f					
Digitaria sanguinalis (L.) Scop.																						1f									
Echinochloa crus-galli (L.) P.B.											1st	2st 1p	2p		2p	1st 2p		1st	1st 1p			4f							1st		
Elymus sp.														+																	
Hordeum sp.					+	+		+		+	+			+			+											+		+	
Lolium sp.																										1f					
Panicum miliaceum L.				2st					(2) p	2st	3st (2) p	1st	(2) p		(1) p	1st 2 (3) p	1st 2p	(1st (1) p	3st			1f									
Secale cereale L.			+	(1) r	+	+		+	(1) f (3) r (1) h (1) p	+	+			+	(1) f	1f	+				+		+	+	(1) f	2f		+		+	+
Setaria glauca (L.) P.B.			1p	1f 6 (5) p	1p	1st 9 (4) p	6st	6st 1p	3st 12p	8st 10p 3st	17 (4) st 6 (2) p 1st	15st (11) p	1st (2) p	4st (2) p 4st	4st 14p	10st 16p	12st 10p	10p	16st 10p 1st			1 (4) f 1st (2) p	1f	7p	3st 10p	1st 2p		3st 3p 3st 1p	2st 13p		
S. viridis (L.) P.B./S. verticillata (L.) P.B.																															
Triticum aestivum L. s. l.																						2 (4) f	3f								
T. sp.			+		+	+		+		+	+			+			+				+		+	+		+		+		+	+
Cerealia indet.															(1) f (1) p	(2) f	(1) f				(1) f		(5) f			(2) ?			(1) f		
Paniceae				1 (1) p		2st 1p																1f							2p		
Guttiferae																															
Hypericum cf. acutum Mnch.				1s									1s	1s		1s															
H. cf. maculatum Cr.					1s					1s	1s		2s					2s													
H. perforatum L.	1s	1s		1s		3s		1s	5 (2) s		2s		4s		1 (3) s	8s		5s	5s					2s		1s			1s		
H. sp.										1s			1s		2s																
Iridaceae																															
Iris sibirica L.										?1s	2s ?1s																				
I. sp.																												+			
Juglandaceae																															
Juglans regia L.																	+ (1) f											+		+	
Juncaceae																															
Juncus sp.	1s	14s	38s	26s	17s	31s	99s	90s		53s	1s	26s	26s	21s	196s	139s	54s	171s	1s							8s		7s			
Luzula multiflora (Retz.) Lej.			1s													1s								1s	1s						
L. sp.			1s		1s						2s	2s				1s	1s							2s					2s		
Labiatae indet.			(2) f		1f						1f		2f					1f	1f			1f			1f	2f			(1) f		
Ajuga reptans L.																			1f												
Betonica officinalis L.							1f						1f			1f															
Calamintha acinos (L.) Clairv.																1f		1f	1f												
C. officinalis Mnch.		◆																	1f										2f		
C. vulgaris (L.) Druce																			1f												
Galeopsis cf. ladanum L.									4f							1f	1f														
G. pubescens Bess.						1f							1f			1f													1f		
G. speciosa Mill.											2f						(1) f							(1) f							
G. tetrahit L.											1f		1f		?1f																
G. tetrahit L. type							(1) f	1f			(4) f	(1) f	1 (1) f			(8) f												(2) f	(1) f		
Glechoma hederacea L.													1f																		
Lycopus europaeus L.			1f	1f							1f	1 (1) f	1f		3f				3 (1) f						1f			1f			
Mentha cf. arvensis L.									1f																						
M. sp.				3f		2f			7f		3f	3f	3f	1f	3f	4f	5f	2f	3f					1f	1f	1f		2f	3f		
Mentha type			+		+	+		+		+	+			+			+							+				+	+	+
Nepeta cataria L.											1f																				
N. nuda L.																1f															
Origanum vulgare L.				1f		2f	1f		2f	1f	8f	8f		2f		4f	1f	2f	2f					1f	2f			1f	2f		
Prunella vulgaris L.				5?		5f			6f	1?	7f	6f	3f	2f	9f	28f	14f	7f	32 (1) f					3f	4 (1) f	2f		16 (1) f	18 (1) f		
Salvia cf. nemorosa L.									1f																						
S. verticillata L.											1f						?1f														
Scutellaria galericulata L.																									1f						
Stachys annua L.											1f																				
S. cf. palustris L.																	1f														
S. type			+		+	+		+		+	+			+										+				+		+	+
Thymus sp.									1f																				1f		
Liliaceae																															
Allium sp.																								+					+		
Anthericum sp.					+	+																		+					+	+	+
Linaceae																															
Linum catharticum L.									4s	+	+				1s	1s	2s	1s	1s					1s	3s			3s	3s		
L. usitatissimum L.						(2) s	1s			+ 2s 1s	1 (2) s		1s	+	1s	3s	+	3s						+					(1) s		
Loranthaceae																															
Viscum sp.					+																									+	
Lythraceae																															
Lythrum salicaria L.				1s		6s			7s	2s	2s		5s		12s	19s	1s	10s	9s						3s	2s		3s	10s		
L. sp.			+		+	+		+		+	+			+			+							+				+		+	+
Malvaceae																															
Malva silvestris L.										1f																					
M. sp.			+					+			+			+																	
Menyanthaceae																															
Menyanthes trifoliata L.														+			+														
Moraceae																															
Ficus carica L.									1f	1f		1f		1f	3f	1f	1f		1f					2f	3f			3f			
Nymphaeaceae																															
Nuphar sp.			+																												
Oenotheraceae																															
Chamaenerion sp.			+		+	+		+		+	+			+			+						+						+	+
Epilobium sp.											+ 1s							1s													
Oleaceae																															
Fraxinus excelsior L.					+	+																						+		+	+
Papaveraceae																															
Papaver argemone L.																1s															
P. somniferum L.																											1s	1s			
P. sp.			+		+	+		+		+	+	1s	1s	+	1s		+ 1s	2s						+				+		+	+
Papilionaceae indet.			+		+	+				+	+ 1s			+	1s		+							+				+		+	+
Trifolium arvense L. type			+		+	+		+		+	+			+										+				+		+	+
T. pratense L. type			+		+	+		+		+	+			+			+							+				+			
Vicia type			+		+	+		+		+							+							+				+		+	+
Plantaginaceae																															
Plantago cf. indica L.																							1s								
Plantago lanceolata L.			+		+	+		+		+	+			+			+							+				+		+	+
Plantago maior L.			+		+	+		+		+ 3s 1s	+ 1s			+		1s	+ 1s							+				+	1s	+	+
P. media L.										+	+			+			+							+				+		+	+
P. pauciflora Gilib.				1s		1s		+																1s					1s		

Pollen sample No. – Próby palinologiczne Nr / Macrofossil sample No. – Próby makroskopowe Nr	4a	4b	65 4c	4d	68 4e	72 4f	4g	76 4h	4i	79 4j	82 4k	4l	4m	88 4n	4o	4p	94 4r	4s	4t	11a	175 11b	11c	178 11d	181 11e	11f	184 11g	11h	190 11i	11j	192	195
Polygalaceae																															
Polygala sp.			+							+				+																	
Polygonaceae																															
Fagopyrum sp.																													+		
Polygonum aviculare L. s. l.			+		+	+ 2f	2f	+ 3f		+ 2f	+ 7(1) f	5f	4f	+	2f	12(5) f	+ 7f	2f	15(4) f					+ 5f	3(1) f	2f	6f	+ 5(1) f	2f	+	+
P. sect. Bistorta			+			+				+	+			+			+							+				+		+
P. convolvulus L.			1f	(3) f	+	+ 1f	1(1) f	+ 2f	1s(1) f	+ 1(1)f	+ 4(1) f	1f		1f		2(8) f	+ 1f	(3) f	2(5) f					+	(1) f	(3) f			(9) f	+	
P. hydropiper L.										1f	(1) f	(1) f													1(1) f	(1) f			1(1) f		
P. lapathifolium L. s. l.								1(2) f	2(2) f	1f	1(1) f	3f			3(1) f	4(5) f	5(3) f	1(3) f	1(3) f					1(3) f	8f	(1) f		(1) f	2(5) f		
P. minus Huds.				1f		1f				1f									1f						1f						
P. nodosum Pers.			(1) f		1f		(1) f			1f	6f			(1) f		1f			3(1) f					1(1) f							
P. persicaria L.				1f	+ 1f	+ 1(1)f		+ 1f	2(2) f	+ 2f	+ 9(1) f	5(2) f	3f	+ 2f	2(7) f	2(1) f	7(5) f	3f	4f					+ 4(5) f	2(2) f	1f		+	(2) f		
P. tomentosum Schrk.			1f	1(1) f	1(1) f	3f	5f	1(2) f		3f	9f	5(5) f		2(1) f		4f	3f	2(2) f	1f					3f		1f		2f			
P. sp.				(1) f		(6) f			(11) f		3(9) f	2(3) f	1(9) f		2(14) f	3(15) f	2(8) f	2(4) f	{(1) f (1) pth				1f	(2) f	(3) f	(1) f		(6) f	{3(7) f (1) pth		
Rumex acetosa L.			+		+	+		+		+	+			+		1f	+							+				+		+	+
R. acetosella L. s. l.			+	2(1) f	+	+ 9f	2f	+ 2f	13f	+	+ 20f	10f	11f	+ 3f	18f	42f	+ 29f	16f	52f				+	+ 8f	10f	+ 3f	1f	+ 14f	12f	+	+
R. crispus L.									21f ? (1) pth		?1f			1f	2f	3f		2f	4f											
R. cf. crispus L.			+		+	+		+		+	+			+			+										+		+	+
R. obtusifolius L.										1f						3f	?1f														
R. sp.									1f		2f	1f	2f		(3) f	3f	3f		3f					1f	1(1) f	1(2) f			1(1) f		
Portulacaceae																															
Portulaca oleracea L.													1s																		
P. sp.																			1s												
Potamogetonaceae																															
Potamogeton sp.														+			+													+	
Primulaceae indet.											1s	2s						1s													
Anagallis arvensis L.											2s			1s		1s		1s	1s									2s			
Lysimachia vulgaris L.											1s	?1s						1s											?1s		
L. sp.			+		+	+		+		+	+			+			+							+				+		+
Primula sp.										+																					
Ranunculaceae indet.																			1f							1f					
Batrachium sp.																	+														
Caltha sp.																1s		1s													
C. type			+		+	+		+		+	+			+										+				+			
Consolida regalis S.F. Gray					+	+		+		+	+													+						+	
Nigella arvensis L.			+		+			+																+				+		+	+
N. sativa L.					+	+		+		+														+				+			
Ranunculus acer L.				1f	1f	3f	1f		1f	2f		3f	1f		2f	3f	4f	3f	3f					3f	3(1) f			3f	4f		
R. arvensis L.			+			+					+			+																	
R. flammula L.															1f			1f							(1) f			1f	2f		
R. repens L.				4(3) f		1f	5(1) f	3f	(1) f	2f	5f	4f	3f		1f ?3f	8(3) f	9(2) f	2(2) f	1f ?1f					4f	6(2) f				?2(1)f		
R. sardous Cr.																													1f		
R. sceleratus L.				1f				1f			1f	1f	2f		(1) f														1f		
R. sp.			+		+	+ 1f	1f	+	5(6) f	+	+ 11f	4(1) f	(1) f	+	2f	3(1) f	+ 9f		6(1) f				+	+ 9(3) f	4(2) f	+ 2f		+ 2f	3(4) f	+	+
Thalictrum cf. flavum L.									1f															(1) hm							
T. sp.			+		+	+		+		+	+			+			+							+				+		+	+
Rhamnaceae																															
Frangula alnus Mill.						+								+			+							+							
Rosaceae indet.								(1) f		(1) f						(1) f			(7) f										(6) f		
Agrimonia eupatoria L.															(1) hm									(1) hm							
A. sp.																								+						+	
Aphanes arvensis L.																								1f							
Cerasus sp.							(1) f			(4) f	(2) f	(2) f			(4) f	(1) f	(2) f	(4) f						?(5) f		(2) f			(2) f		
C. type					+	+		+		+	+																				
Comarum palustre L.					+												1f													+	
Filipendula ulmaria (L.) Maxim.											3f	2f							3f					1f	(1) f			1f			
F. sp.			+		+	+		+		+	+			+			+							+				+		+	+
Fragaria vesca L.				9f		3f			6f		5f	3f	1f		3f	2f	4(1) f		5f					8f	4f		1f	8f	3(1) f		
F. viridis Duch.				1f																											
F. sp.						3f			3f						2f	1f	1f														
F. sp. / Potentilla sp.				1f			1f				1f					1f									1f						
Geum sp.					+	+		+		+														+				+		+	
Pirus sp. / Malus sp.									1s																		1f	1f	1f		
Potentilla cf. argentea L.				3f		3f			3f				3f	3f	2f	4f			1f												
P. erecta (L.) Raeusch.				4f		4f			4f		6f	4f	3f		3f	7(1) f	1f	4f	3f					3f	1f	3(1)f		2f	2f		
P. norvegica L.									?2f							1f															
P. sp.			+	3f	+	+ 2(1)f		+	8(5) f	+ 1(1)f	+ 6f	1f	8f	+ 2f	8f	6f	+ 5f	5f	6f			2f		+ 6f	7f	6f		+ 1f	8f	+	+
Prunus sp.											1f		(2) f			(1) f															
Rubus caesius L.											1f						1f		?1f												
R. idaeus L.				7f	2f	5f ?1f	2f	2f	1f		1f	1f	1f		1f	3f ?1f	2f	1f						?1f	1f ?1f	1f		1f	1f ?1f		
R. plicatus W. et N. type									1f				2f																		
R. sp.			+ 1f	(1) f	+	+ 1(2)f		+	2(1) f	+	+		(2) f	+		1f	+ 1f		1(1) f					+ 1f		+ (1)f		+	3(1) f	+	+
Sanguisorba officinalis L.			+		+	+		+		+	+			+			+							+				+		+	+
Sorbus sp.					+	+		+		+							+														
Rubiaceae indet.			+		+	+		+		+	+			+			+							+				+		+	+
Galium cf. boreale L.																1f															
G. elongatum Presl.																1f													1f		
G. cf. mollugo L.															1f																
G. palustre L.																			1f												
G. spurium L.																							1f								
G. spurium L. / G. tricorne Stock.										1f	1f		1f	1f		1f		(1) f	1(1) f										1(1) f		
G. sp.																(1) f			1f									1f			
Salicaceae																															
Populus sp.			+		+	+								+										+						+	
Salix sp.			+		+	+ 1bs		+		+	+ 1bs			+		1bs	+ 1bs	1bs	2bs				+	+				+		+	+
Saxifragaceae																															
Parnassia palustris L.								+		+																			+		
Ribes sp.														+																	
Scrophulariaceae																															
Linaria vulgaris (L.) Mill.						1s			2s	2s	3s				1s		4s	1s	2s						2s				1s		
Melampyrum sp.			+		+	+		+		+	+													+				+		+	+
Rhinanthus sp.			+		+	+		+		+	+			+			+						+	+				+		+	+
Scrophularia alata Gilib. / S. nodosa L.				1s		3s			1s			1s							2s										1s		
S. sp.					+	+				+	+			+										+							
Verbascum sp.																2s															
Veronica sp.				1s		1s					+ 1s			1s		7s															
Solanaceae indet.															1s																
Hyoscyamus niger L.				(1) s		1s					1s		1(3) s	1s		(1) s							3(1) s			3(1) s					
Solanum nigrum L.				1s		1s			1(1) s	3s		2s		1s		1s	1s		1s						1s	1s		1s			
Tiliaceae																															
Tilia cordata Mill.			+		+	+		+		+	+			+			+						+	+		+		+	+	+
T. platyphyllos Scop.					+	+		+		+	+			+			+							+				+	+	+
Typhaceae																															
Typha latifolia L.						+		+									+														
T. angustifolia L. / Sparganium sp.																														+	
T. sp.				1s				2s																							
Ulmaceae																															
Ulmus sp.			+		+			+		+	+			+			+							+				+	+		
Umbelliferae indet.			+		+	+		+		+	+	1f		+		(2) f	+		(1) f				+	+				+		+	+
Bupleurum rotundifolium L.							1f				1f		1f																		
Daucus carota L.				1(1)f		1f			4(2) f		1f		1(1)f			2f	1f	1f							1f			2f	1(2) f		
Heracleum sphondylium L. s.l.																			(1) f												
Peucedanum cervaria (L.) Lap.																	1f														
Urticaceae																															
Urtica dioica L.			+	8f	+	+ 3f	1f.	+	1f	+	+	1f	2f	+ 2f	4f	5f	+ 2f	1f	6f					+ 2f	2f		2f	+ 1f	1f	+	+
U. urens L.			+		+	+ 1f		+		+	+			+			+		1f					+				+		+	+
Valerianaceae																															
Valeriana cf. officinalis L.				2f						1f		1f				3f	1f		1f					1f	2f	1f			2f		
V. sp.			+		+	+		+		+	+			+			+							+				+		+	+
Valerianella dentata (L.) Poll.																4(1) f	3f								(1) f						
Verbenaceae																															
Verbena officinalis L.									1f				2f			(1) f															
Violaceae																															
Viola arvensis Murr. / V. tricolor L.				1s		1s			1(3) s				1s		1s	10(2) s		1s							1s						
V. silvestris Rchb. type															1(1) s	2s													1s		
V. sp.								+																					+		
Vitaceae																															
Vitis vinifera L. ssp. vinifera																													1(2) s		

+ – sporomorphs, 1,2,3,..... – number of complete specimens, (1,2,3,.....) – number of fragments, ? – uncertain determination, bs–bud scales, f – fruits, hm – hypanthium, n – needles, pth – perianth, s – seeds, u – utriculus. Explanations for Gramineae: g – gluma, h – hairs, p – lemma or palea, r – spike rachis, st – spikelet. Depth is given below 0= 211.91 m a.s.l. in profile 4 and 0= 211.47 m a.s.l. in profile 11

+ – sporomorfy, 1,2,3..... – liczba całych okazów, (1,2,3....) – liczba fragmentów, ? – oznaczenie niepewne, bs–łuski pączkowe, f – owoce, hm – hypancjum, n – szpilki, pth – okwiat, s – nasiona, u – pęcherzyk. Objaśnienia do Gramineae: g – plewa, h – włoski, p – plewka dolna albo plewka górna, r – osadka kłosa, st – kłosek. Głębokość podano poniżej 0= 211.91 m n.p.m. dla profilu 4 i 0= 211.47 m n.p.m. dla profilu 11.

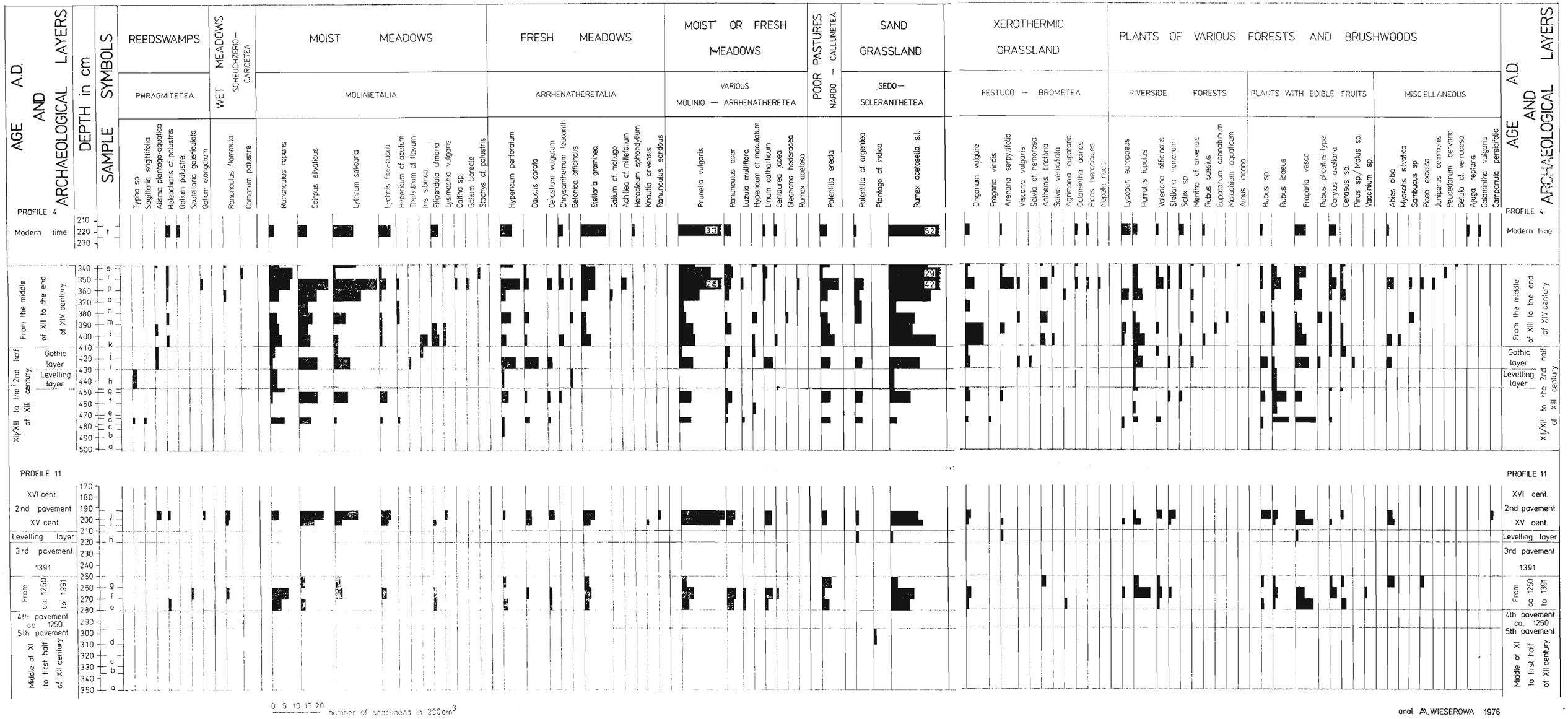


Fig. 7. Cracow, Main Market Square. Diagram showing the occurrence of macroscopic remains of plants of bogs, reedswamps, meadows, xerothermic grasslands, forests and brushwoods in particular archaeological layers of profiles 4 and 11

Ryc. 7. Kraków, Rynek Główny. Wykres szczątków makroskopowych z profilów 4 i 11, obrazujący udział roślin bagiennych, szuwarowych, łąkowych, muraw kserotermicznych, zbiorowisk leśnych i zaroślowych w poszczególnych warstwach archeologicznych

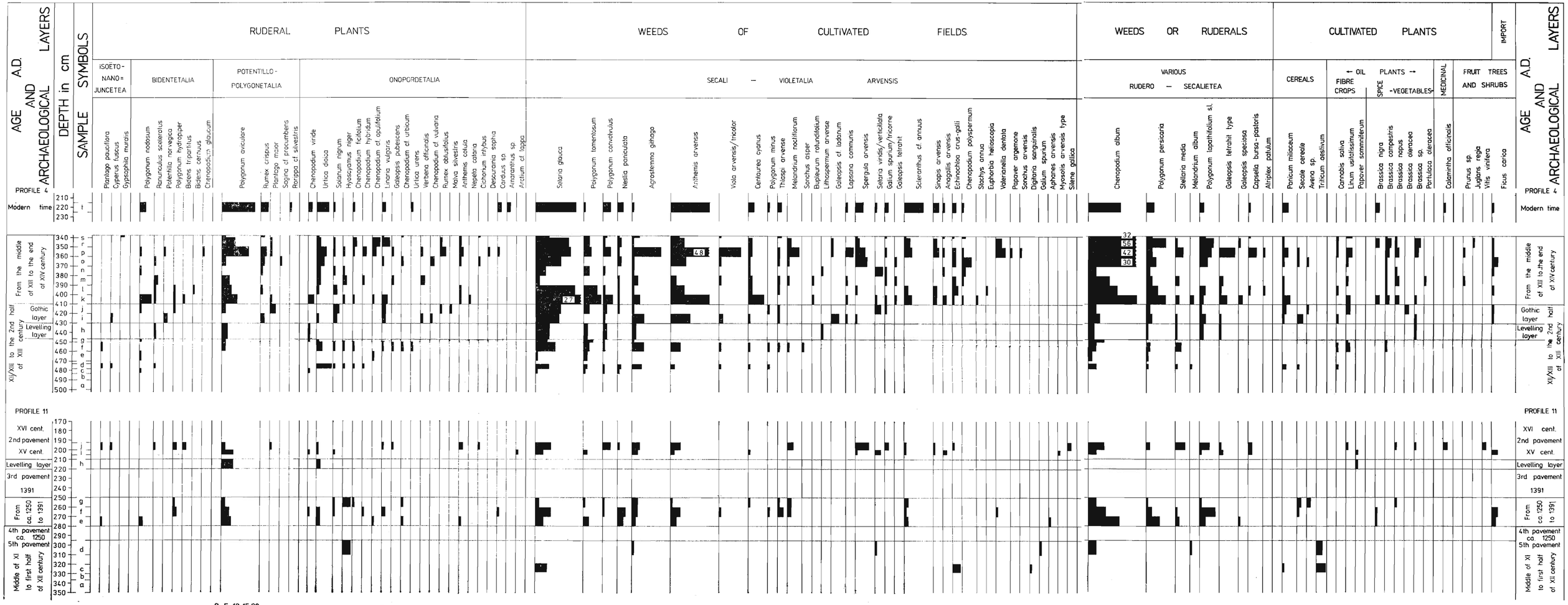


Fig. 8. Cracow, Main Market Square. Diagram showing the occurrence of macroscopic remains of ruderal plants, weeds of cultivated fields and cultivated plants in particular archaeological layers of profiles 4 and 11

Ryc. 8. Kraków, Rynek Główny. Wykres szczątków makroskopowych z profilów 4 i 11, obrazujący udział roślin ruderalnych, chwastów pól uprawnych i roślin uprawnych w poszczególnych warstwach archeologicznych