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PLANT REMAINS FROM EARLY AND LATE MEDIEVAL TIME FOUND ON THE WAWEL HILL IN CRACOW

Szczątki roślinne z wczesnego i późnego średniowiecza znalezione na Wzgórzu Wawelskim w Krakowie

ABSTRACT. Plant remains (macrofossils and sporomorphs) from culture layers dating back to the time from the 9—10th to 15th century A. D. were studied. 340 taxa were identified and 273 of them were classified according to phytosociological criteria. On this basis, plant communities were described which might have existed on the Wawel Hill and in the surroundings at that time. Changes in the species composition of plants found in different archaeological layers were interpreted as a result of changing type or intensity of human activity carried on in this part of the Hill. Possible fluctuations of water level in the Vistula valley were discussed.

CONTENTS

INTRODUCTION

Studies on medieval flora and vegetation of Cracow were initiated in the early thirties by W. Szafer, who, in 1931, found a rich and stratigraphically differentiated flora in an excavation situated in the Main Market Square. He

confined himself to preliminary identifications and never completed that work. Extensive archaeological studies undertaken after the second world war stimulated the development of botanical investigation of plant remains from different prehistoric periods. Several papers were published presenting lists of plants from archaeological excavations situated in the center of the old town and in the area which is now the quarter Nowa Huta. The Wawel Hill was also included in these studies. The first information about plants found in the culture layers of the Wawel was published by Burchardówna (1953) on the basis of identifications by K. Moldenhawer. In following years the papers of Giżbert (1960), Giżbert and Żaki (1954) and Klichowska (1955, 1956, 1964) appeared. The most complete list of plants identified from the Wawel, published by Klichowska (1964), included 19 species of cultivated and 21 of wild plants.

The present studies of plant remains from the Wawel Hill began in 1955. The late Professor Szafer, former Director of the Institute of Botany of the Polish Academy of Sciences, who initiated this research and enthusiastically advocated it, considered that there were good prospects for the reconstruction of the former vegetation of the Hill using palaeobotanical methods. Research was also encouraged by Doc. Dr. A. Żaki the then leader of the Archaeological Laboratory on the Wawel. Besides the present author, Doc. Dr. M. Reymanówna took part in this studies, dealing with wood determination and the late Professor B. Szafran identified mosses. In the first stage, the research was concentrated on field work and was limited to collecting samples for various examinations. Some preliminary identifications of macrofossils were also performed. After a long break the study was taken up again in 1972 with the cooperation of Dr. W. Koperowa, who did pollen analysis. In the last years Professor K. Karczmarz has carried out the examination of moss samples. The present paper is based on the author's own studies on subfossil fruits and seeds and it includes the results of pollen and wood analyses.

In the early sixtieth similar investigations were undertaken in the Main Market Square of Cracow by A. Wieserowa and are now completed. Both papers supplement each other in many respects. Most of plant identifications from both sites were confronted and discussed by both authors and descriptions are given only in one of the papers, unless there were special reasons for repeating them. With these two studies completed and supplemented by the moss identifications, the medieval flora of Cracow, numbering over 400 taxa, is among the best known town floras of the Middle Ages.

LOCATION OF THE WAWEL HILL AND PRIMARY VEGETATION OF ITS SURROUNDINGS

The morphology and hydrology of the territory of Cracow has been the subject of many studies, and attempts to reconstruct the early environment were undertaken as early as the 19th century. A critical review of the opinions of various authors was presented recently by Radwański (1975) who was con-

cerned mostly with the central part of the town, north from the Wawel. The basic information about the topography of the Hill itself was given by Jamka (1963). Only data having direct bearing on the subject discussed in the present paper will be briefly summarized here.

The Wawel Hill, situated in the center of the present-day town, rises to about 25 m above the surrounding terrain. It is built of Jurassic lime-stone

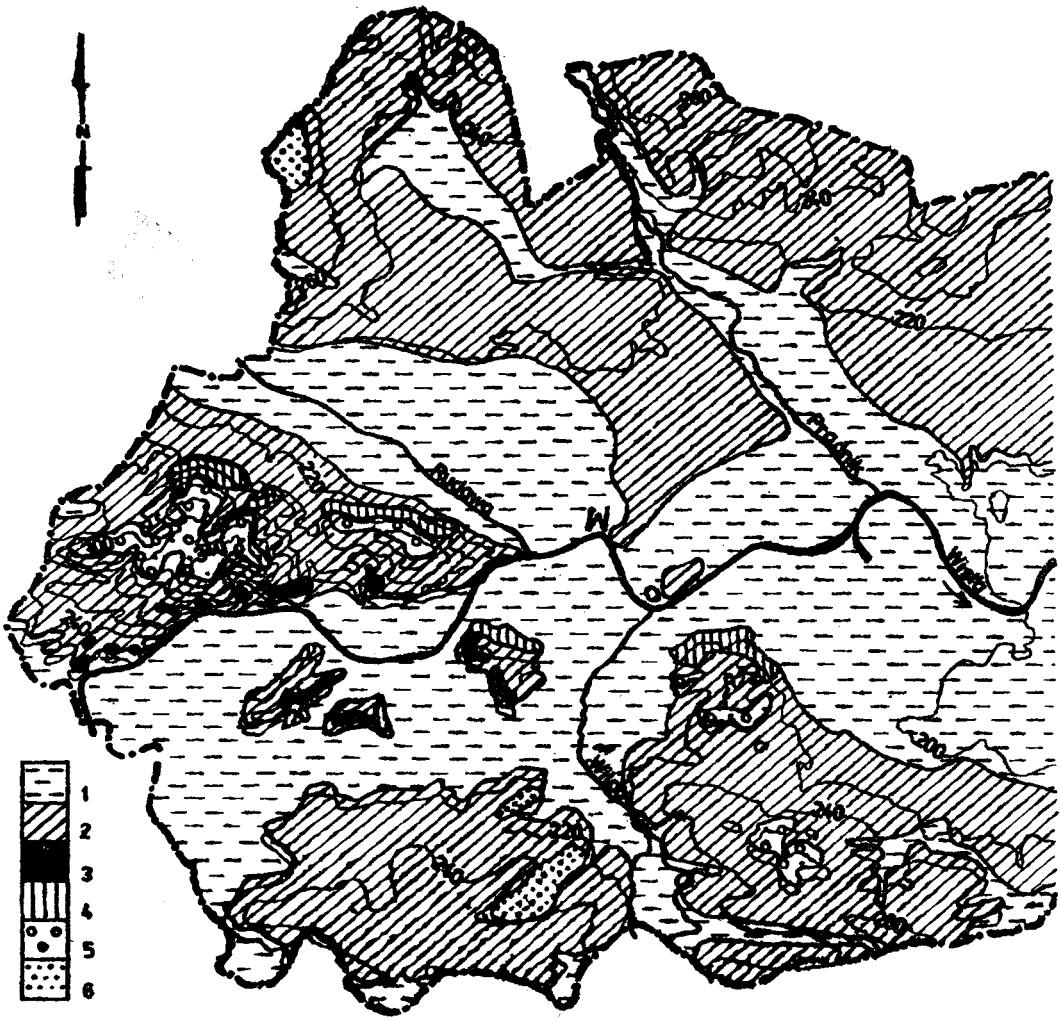

Fig. 1. Situation of the Wawel Hill and the distribution of natural habitats and complexes of natural plant communities (acc. to Kornaś & Medwecka-Kornaś 1974, slightly changed). 1 — complex of riverside forests, 2 — complex of oak-hornbeam forests, 3 — complex of xerothermic brushwoods, 4 — complex of beech forests, 5 — complex of oak-pine forests, 6 — complex of pine forests, W — Wawel Hill

Ryc. 1. Położenie Wzgórza Wawelskiego na tle pierwotnego zróżnicowania siedlisk i zbiorowisk roślinnych (wg Kornasia & Medweckiej-Kornaś 1974, nieco zmienione). 1 — kompleks łęgów, 2 — kompleks grądów, 3 — kompleks ciepłych zarośli, 4 — kompleks buczyn, 5 — kompleks borów mieszanych, 6 — kompleks borów sosnowych, W — Wzgórze Wawelskie

overlain by a thick cover of culture layers. The present-day configuration of the top surface is artificial, and was formed chiefly by leveling in the 19th century (Jamka 1963). The reconstruction of the original topography at the time of the earliest medieval settlement is hampered by changes caused by the successive building and rebuilding which took place on the Hill. We may suppose that it reflected to some degree the relief of the bed-rock with elevations of a few meters and depressions in the form of small ravines cut in the rocky slopes. Reconstructions presented by various authors differ in details (see Jamka 1963, p. 149, Fig. 77, Radwański 1975, p. 47, Fig. 18), but the general picture is as follows.

The culmination of the Hill is situated in its north-east part, which has a more diversified bed-rock topography then the remaining part. The maximum elevation of the rock is 229·00 m a.s.l. In the south-west part the rock forms an almost flat surface rising slightly above 220 m a.s.l. and sloping to the south and west to about 215 m a.s.l. near the present day fortifications (Jamka 1963).

The Hill dominated the Vistula and Rudawa valleys and was surrounded by lowlands from the north-west, west, and south (Fig. 1). To the north-east it bordered on the area of the middle terrace elevated above the lowlands and occupied by other fortified settlements. The reconstruction of habitats for the time about 1000 A.D. (Kornaś & Medwecka-Kornaś 1974) shows that lowlands were covered with riverside forests *(Salici-Populetum* and *Circeo-Alnetum)*, wet alderwoods *(Carici elongatae-Alnetum)*, and wet oak-hornbeam forests *(Tilio-Carpinetum stachyetosum)*. Eutrophic aquatic communities and reedswamps developed in slowly-flowing waters of the winding river and in numerous old river beds. The destruction of lowland forests led to the spread of various communities of wet meadows and pastures. The dominating community of the natural vegetation of the middle terrace was oak-hornbeam forest *(Tilio-carpinetum typicum, T.-C. caricetosum pilosae, T.-C. stachyetosum)*. As early as in the early Middle Ages large parts of these forests must have been cleared for developing settlements and for fields and pastures. The natural habitats of oak-hornbeam forests may also have existed on the top of the Wawel Hill, but only single trees would have survived when permanent settlement began. By analogy to the other limestone hills in the area, we may suppose that south facing slopes offered suitables conditions for the development of xerothermic brush-wood and grassland (Kornaś & Medwecka-Kornaś 1974).

HUMAN SETTLEMENT

The topography of the Hill and its location on the bank of a big river created favourable conditions for human habitation. Archaeological findings of various age (palaeolithic, neolithic, of Lusatian, Pomeranian, and Przeworsk cultures, Jamka 1963) prove that the Hill was inhabited many times from the earliest periods of human prehistory. Permanent uninterrupted settlement dates back

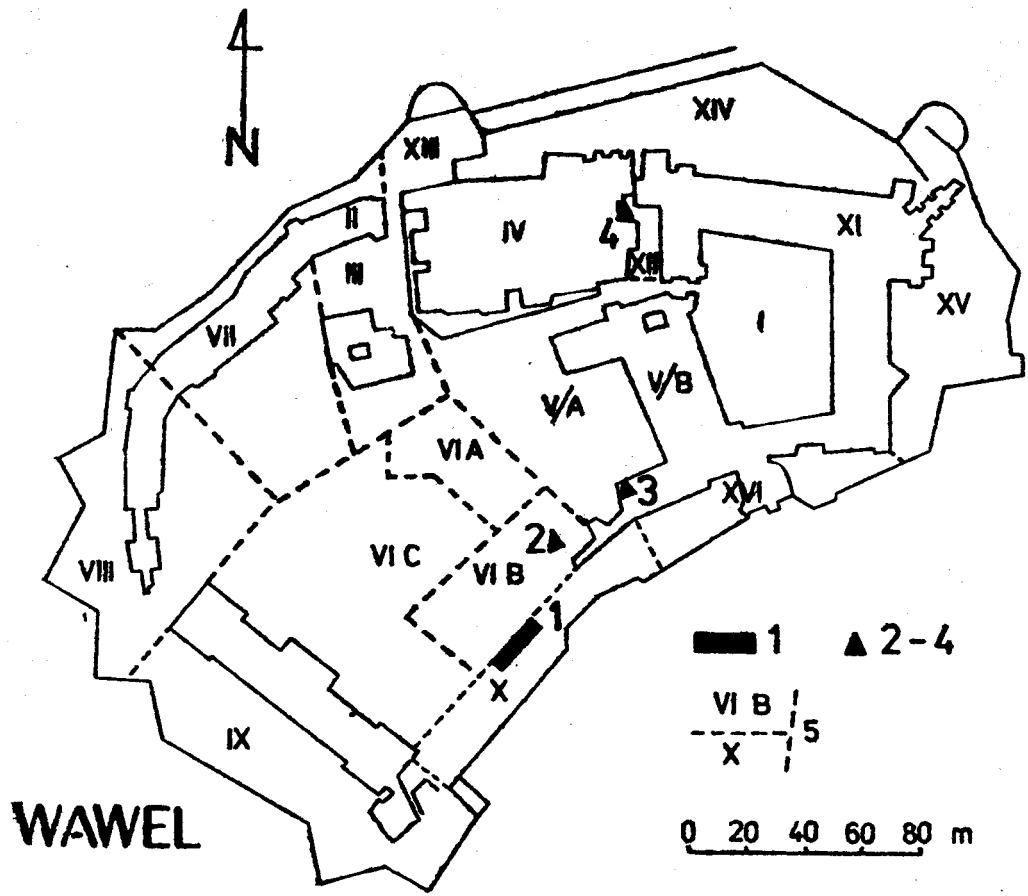

Fig. 3. Map of the Wawel Hill showing division into regions. Places where samples for botanical studies were collected: 1 — large-area excavation, 2—4 — other excavations, 5 — regions
Ryc. 3. Plan Wzgórza Wawelskiego z podziałem na rejony. Miejsca zebrania prób do badań botanicznych: 1 — wykop szerokoprzestrzenny, 2—4 — pozostałe wykopy, 5 — rejony

at least to the 9—10th century A.D. In the early Middle Ages the territory of the Hill was divided into two parts. The north-east part, where pre-Romanesque and Romanesque stone buildings were concentrated, was probably a seat of lay and ecclesiastical authorities. The west and south-west part was inhabited by knights, the lower orders of clergy, craftsmen, and other people working for the court. Wooden houses predominated in this part (Żaki 1956). Between the 9th and 13th century the whole top area was probably surrounded by one system of fortifications (Fig. 2[1]; Radwański 1975).

Botanical material, with the exception of a few samples from regions VIB, VB and XII, comes from the south-west part of the Hill, from region X (Fig. 3). Here, calcareous rock falling south is covered in places by a layer of sterile decomposed rock or with sand containing neolithic implements on a secondary

[1] Fig. 2 is under the cover.

bed and Late-Lusatian pottery. This is overlain by culture layers about 9 m thick approximately half of which accumulated during the early medieval time. Early medieval layers contain the remnants of a rampart, built of stone, timber, and earth and the traces of 2 to 8 levels of wooden constructions. Wooden houses were discovered on a surface about 4 to 8 m wide and 80 m long. They were arranged parallel to the rampart along its inner side, and probably covered a still larger area. The layers contained large numbers of potsherds, some other archaeological relics, large numbers of animal bones, fish scales and abundant plant material. The age of these layers was from the 9—10th to the second half of the 13th century A.D. In one excavation a settlement layer older than the rampart was found (Żaki 1956).

DATING AND DESCRIPTION OF ARCHAEOLOGICAL LAYERS

Dating of layers is based on pottery. In 1975, Dr. S. Kozieł of the Archaeological Laboratory of the Wawel was kind enough to check the dating for the purpose of this study. No more exact data on the character of the examined layers were available as the elaboration of archaeological material is not yet completed.

The Early Medieval Period is here taken to be the time from about 550 to 1257 A.D., the date of the granting of the foundation charter ("locatio civitatis"), the Late Medieval Period from this date to the end of Middle Ages in 1492.

Region X, large-area excavation:

layer IIb — débris from the destruction of early Gothic rampart with possible younger modifications and inclusions. Age: from the beginning of the 14th century to an unknown later time (perhaps even to the 19th century)

layer VIa — blackish-brown humic earth without manure, contains remnants of timber constructions (house no. 1). Age: middle and second half of the 13th century

layer VIb — blackish humic earth with timber constructions. Age: 12th and perhaps 12/13th century

layer VIc—d — bands of burnt material and unburnt clay, other traces of destruction (fire?), at the bottom remnants of timber constructions (house no. 2). Age: 11—12th century

layer VIe — brown earth with manure, often strong smelling manure. A number of minor layers (VIe_1—VIe_8) were distinguished, some of them occurring only locally. Remnants of timber constructions (house no. 3). Age: 11—12th century

layer VIe_4 — blackish-brown earth with manure, remnants of timber constructions. Age: 10—11th century

layer VIf — grayish-black, fairly loose earth, no manure, no construction levels. Age: 9—10th century

layer VIg — reddish-brown, very compact earth with manure, no construction levels. Age: 9—10th century

layer VIi — loamy earth. Age: 9—10th century
layer VIj — similar to VIg. Age: 9—10th century (it may be as old as the 8th century)

METHODS

Sampling

Samples used for the present study come from regions X, VIB, VB, and XII of the Wawel Hill (Fig. 3). The most abundant material was collected in the large-area excavation of region X. From this region a total number of 47 soil

Table 1
Tabela 1

List of samples from the large-area excavation in region X on the Wawel Hill used for detailed qualitative and quantitative studies

Wykaz prób z wykopu szerokoprzestrzennego w rejonie X na Wzgórzu Wawelskim wykorzystanych do szczegółowej analizy jakościowej i ilościowej

Profile Profil	Location on the plan Lokalizacja na planie	Nos. of samples Numery prób	Depth Głębokość cm	Layer Warstwa	Remarks Uwagi
I	are K, section 10	3a	477-483	VIc-d	} combined in the diagrams
		3b	487-493	VIc-d	
		3c	495-505	VIc-d	
		3d	510-515	VIc-d/VIe	
		3e	520-530	VIe	
		21a-21e 54a-54h	530-670	pit 1	In plant community tables divided in upper (21a-21d), middle (21e-54d) and lower (54e-54h) parts
II	are K, section 11/12	17z	470-480	VIc-d	
		17w	500-510	VIe	
		22b	540-550	VIe_4	
		45g	560-570	VIf	
		45j	590-600	VIg	
		45n	630-640	VIg	
		45o[x]	640-644	VIi	9-10th cent.
		45p	644-652	VIj	
		15/13-15/2 46/26-46/1	470-650	VIc-d to VIj+VIi	pollen profile
III	are L, section 13	51a	533-543	VIe_4	
		51h	600-610	VIg	
IV	are L, section 14	52a	530-540	VIe_4	
V	are L, section 15	19a[x]	270-280	IIb	ca. 14th cent. and younger
		19u[x]	330-340	IIb	"
		19q[x]	370-380	VIa	half and 2nd half of 13th cent.
		19p	380-390	VIa	"
		19m	410-420	VIb	
VI	are L, section 5	50a	480-490	VIb/VIc-d	
		50b	490-500	VIc-d	
		50d	510-520	VIe	
		50i	560-570	VIi	
		50k	580-590	VIf	
		50l[x]	590-600	VIf	9-10th cent.
		50m	600-610	VIi	
VII	are K, section 4	9u	475-485	VIb/VIc-d	} combined in the diagrams
		9v	485-495	VIb/VIc-d	
		9z	495-505	VIc-d	} combined in the diagrams
		9y	505-515	VIc-d	
		9x	515-523	VIe	
XVII	are L, section 7/8	56	-	VIe_1	
XVIII	are K, section 12	18	520-530	VIe	basket of lime bark

[x] Samples left out in the diagrams because of too small a number of specimens. The dating is given only for these samples. Age of other samples can be read from the diagrams.
Próby pominięte w diagramach ze względu na zbyt małą liczbę okazów. Tylko dla tych prób podano datowanie, wiek pozostałych prób można znaleźć na wykresach.

samples, 36 samples of fruit-stones and nuts, 44 samples of wood and charcoal, and 16 pollen samples were studied in detail (Tables 1 and 3[2]). In addition, 48 soil samples (here called supplementary samples) were checked only for dominating cereals and for new or interesting taxa. The following samples from other regions were subjected to detailed analyses: 2 soil samples and 7 samples of fruit-stones from region VIB, 2 soil samples from region VB, and 4 soil samples from region XII (Table 2).

Most of the samples were collected by archaeologists, but all samples from region X used in tables and diagrams (with the exception of samples from

Table 2

Tabela 2

List of samples from the regions VB, VIB, and XII on the Wawel Hill used for detailed qualitative and quantitative studies

Wykaz prób z rejonów VB, VIB i XII na Wzgórzu Wawelskim użytych do szczegółowych badań ilościowych i jakościowych

Sample number Numer próby	Layer Warstwa	Position on the plan and inventory number Lokalizacja na planie i numer inwentarza	Depth Głębokość cm	Century A.D. Wiek n.e.	Remarks Uwagi
7/70	Vb	Region VIB, are 579, large-area excavation B-1311/57	±190	XV	soil sample
8/70	"	Region VIB, are 579, large-area excavation B-1312/57	200-220	"	" "
11/70	Va	Region VIB, are 612B, B-1352/59	180-190	"	fruit-stones
12/70	"	" " , B-1350a	165-170	"	" "
13/70	"	" " , B-1354/59	210-220	"	" "
14/70	"	" " , B-1358/59	190-220	"	" "
15/70	"	" " , B-1353b/59	200-210	"	" "
16/70	"	" " , B-1357/59	220-230	"	" "
17/70	"	" " , B-1351/59	170-180	"	" "
1/70[X]	-	Region VB, excav. 4, P-27 kotłownia	-	XIV	soil sample
6/70[X]	-	" " , P-28 kotłownia	-	"	" "
2/70[X]	VIa	Region XII, excav. 2/70, Dziedziniec Batorego, B/1	382	XI	" "
3/70[X]	VIb	Region XII, excav. 2/70, Dziedziniec Batorego B/2	400	"	" "
4/70	VId	Region XII, excav. 2/70, Dziedziniec Batorego, B/3	418	"	" "
5/70	VIe	Region XII, excav. 2/70, Dziedziniec Batorego, B/4	440	X	" "

[X] Samples left out in tables and diagrams because of too small a number of specimens

Próby pominięte w tabelach i wykresach ze względu na zbyt małą liczbę okazów

house 3 and from the basket), as well as samples for pollen analysis were taken by the author. For macroscopic studies a series of samples were collected from the profiles of the large-area excavation at 13 fixed points (Fig. 4, points I—XIII). At each point samples were taken approximately every 10 cm. Their volume was about 200—400 cm³. Only a part of all samples was analysed. They were selected in such a way that each archaeological layer was represented by 1—5 samples originating from various sections of the excavation, distributed over a surface of about 40 m² (Figs. 5[2] and 6[2]). The number of samples in each layer is given in plant community tables. Samples taken at points II to XIII were

[2] Table 3, Figs, 5, 6 are under the cover.

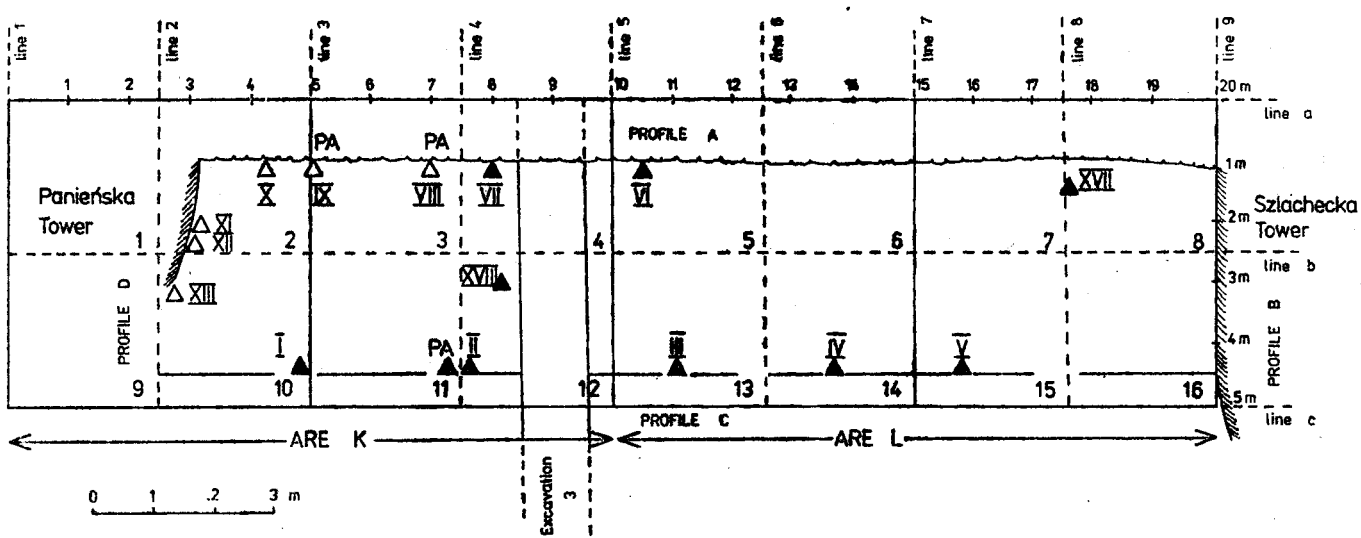

Fig. 4. Large-area excavation in region X. 1—16 sections of the excavation, I—XIII points where series of samples for botanical studies were taken from the exposed profiles of the excavation: I—VII included in this study, VIII—XIII not included in this study, XVII house 3, XVIII basket, PA series of pollen samples

Ryc. 4. Wykop szerokoprzestrzenny w rejonie X. 1—16 odcinki wykopu, I—XIII miejsca zebrania serii prób do badań botanicznych ze ścian wykopu: I—VII opracowane, VIII—XIII nie opracowane, XVII chata 3, XVIII korobka, PA próby do analizy pyłkowej

not connected with any recognizable archaeological objects and are considered here as random samples. In addition, samples from three archaeological objects were studied, namely a complete column of 12 samples from pit 1, one sample from inside house 3 and one sample from the basket (Table 1).

A series of samples for pollen analysis was taken at one point (Fig. 4, PA).

Samples of fruit-stones and nuts were collected by the excavators by hand-picking of these relatively large plant remains. Samples of wood and charcoal were selected by archaeologists, as were the supplementary soil samples, samples of mosses, and all samples from regions VIB, VB, and XII (Table 2).

Laboratory technique

Soil samples for the study of macrofossils were boiled in water with a small amount of sodium carbonate and washed on sieves with a 0·5 mm mesh. All seeds, fruits, and other identifiable plant remains were picked from each sample, determined (if possible), and counted. The number of diaspores per sample varied from 2 to about 1700 specimens (excuding seeds of *Typha*). Identification was based mainly on comparison with reference material of extant seeds and fruits from the reference collection of the Department of Palaeobotany, Institute of Botany of the Polish Academy of Sciences in Cracow. In every identification, it was attempted to check all taxa having similar diaspores which might have occurred in the study area, on the basis of ecological or phytogeographical criteria. The available publications on the morphology of seeds and fruits of several genera or families were used.

All drawings were done by Z. Tomczyńska with the use of an ocular drawing equipment adjusted to a low power binocular microscope. Measurements, exact to 0·05 mm, were performed with an ocular micrometer or a Brinell's micrometer.

The interpretation presented in this paper is based only on taxa, which could be classified according to phytosociological criteria. All these taxa are listed in tables and diagrams.

Tables

Plant community tables (nos. 5, 10, 11, 14, 16—18)[3] contain information about frequency of occurrence of taxa in the soil samples, the total sum of macrofossils of each taxon found in these samples, the occurrence of pollen and spores, and the occurrence of taxa in supplementary soils samples and in samples of fruit-stones and nuts. They also show the floristic composition of individual archaeological layers and objects for which a sufficient numbers of macrofossils were found. Samples poor in macrofossils and samples from transitional levels VIc—d/VIe and VIb/VIc—d were omitted in tables the

[3] Tables 5, 10, 11, 14, 16, 17 are under the cover.

better to show the differences between layers. The entries under the heading "Number of samples/Number of points" indicate the total number of samples studied from each layer and the number of points on the planes of excavations in which these samples were taken. For each taxon the first number gives the number of samples containing its macrofossils, the second number indicates the number of points from which these samples originated. The "Total in VIe" includes all samples from layer VIe in region X, namely the random samples, samples from pit 1, from house 3 and from the basket. "Total number of samples" shows the number of all soil samples containing macrofossils of a given taxon (including samples omitted in the central field of a table), with the exception of supplementary soil samples. "Total number of specimens" gives the number of seeds and fruits (in a few cases of other macrofossils) of each taxon found in the samples included in the total number of samples. The number of seeds or fruits equals the number of complete specimens plus recalculated number of fragments. The arrangement of taxa in each phytosociological unit is in order of, first, the number of samples in which they were found, then the total number of specimens. Plants found only in pollen spectra are given at the end of each group. A few exceptions in the order of listing were caused by varying accuracy of determination. In such cases, taxa which may represent the same plant are placed either one after the other or together in one line. Examples of the first case are *Triticum aestivum* and *T.* sp. in table 18 (counted as one taxon in table 6[4]) or *Typha* sp., *T. latifolia*, and *T. angustifolia* or *Sparganium* sp. in table 5 (counted as two taxa in table 6). An example of the second case is *Lythrum* cf. *salicaria* and *L.* sp. in table 14 (counted as one taxon in table 6).

A summary table (Table 6) gives an idea of the significance of described syntaxonomic units, as estimated from the number of species in individual layers and in the whole material. Vegetation complexes are according to Kornaś & Medwecka-Kornaś (1974) with supplements from Trzcińska-Tacik & Wieserowa (1976). "Total in VIe" includes taxa found in all samples from layer VIe in region X (see above). "Total sum of species" includes taxa found in all the examined samples. Percentages for all categories, with the exception of cultivated plants, are based on the sum of wild species found in each layer or object. For the total sum of species (the second last column) they are based on the total sum of species (excluding cultivated plants) found in all samples. Percentages of cultivated plants are based on the same totals with cultivated plants included.

Diagrams

Macrofossil diagrams illustrate the changes in the percentage numbers of fruits and seeds in stratigraphic sequence. Figs. 8 and 9[4] present separate curves for each taxon. Percentages are calculated from the total sum of specimens

[4] Table 6, Figs. 8, 9 are under the cover.

of all taxa found in every sample (ΣI+ΣII in Fig. 9). Fig. 10[5] shows summary curves for groups of taxa included in each syntaxonomic unit. In this diagram percentages are based only on the sum of specimens of phytosociologically classified taxa (ΣI in Fig. 9). The use of percentage numbers, instead of numbers of specimens in samples of constant volume, was necessitated by the fact that the volume was not measured with sufficient accuracy for all samples. Only soil samples, in which all macroscopic plant remains were counted are included in the diagrams, and a few samples with too small a number of fruits or seeds are omitted. Within each syntaxonomic unit taxa are arranged according to their appearance in time.

The vertical arrangement of samples in the diagrams requires additional explanation. In the upper part of diagrams samples coming from different sections of the large-area excavation, but from the same layer, are grouped together according to their depth. This part illustrates the variation in the numerical representation of taxa in eigth early medieval and one late medieval layer. In the lower part of diagrams there are samples taken in one column from pit 1 and from the superimposed layers VIe and VIc—d. Samples from these layers (nos. 3a/b, 3c, 3d, 3e) are repeated in the upper part of diagrams. At the very bottom, four samples are drawn: one from house 3, one from the basket, and two from region XII.

The depth of samples was measured from the 0 levels situated at the following elevations:

region VB — 228·535 m a.s.l.
region VIB — 225·035 m a.s.l.
region X, large-area excavation — 223·84 m a.s.l.
region XII (Dziedziniec Batorego) — 229·74 m a.s.l.

The diagram on figure 11[5] is the graphic presentation of data included in table 6.

Acknowledgments

I should like to express my thanks to Dr. W. Koperowa for rendering accessible the unpublished results of her pollen analytical studies, which greatly enriched this investigation. I also wish to thank Doc. Dr. M. Reymanówna for the identification of wood and charcoal. I am much indebted to Mrs. A. Wieserowa for her criticism of the determination of more difficult taxa and to Dr. H. Trzcińska-Tacik for discussing problems connected with modern plant sociology and the occurrence of synanthropic plants. I am most grateful to Ing. Z. Tomczyńska for the excellent drawings of plant remains. Thanks are due to Doc. Dr. A. Żaki who put at my disposal the excavated materials and to Dr. S. Kozieł, who kindly checked the dating of archaeological layers. I should also like to acknowledge the assistance of all archaeologists excavating

[5] Figs. 10, 11 are under the cover.

on the Wawel Hill, who helped me during field work. My sincere thanks are due to Professor A. Środoń for stimulating discussions over many years and for reading and criticism of the manuscript.

DESCRIPTION OF PLANT REMAINS

The chapter includes all taxa found on the Wawel Hill, identified on the basis of fruits, seeds, wood, charcoal, leaves, and sporomorphs. Pollen and spores were determined by W. Koperowa, wood and charcoal by M. Reymanówna (Table 3), mosses by B. Szafran, and other macrofossils by the present author. Plants are listed partly in systematic (divisions and subdivisions) and partly in alphabetical order (families, genera, species). Descriptions and drawings are given only for taxa identified by the author. Total number of specimens and total number of samples include only macrofossil remains found in samples subjected to detailed qualitative and quantitative analyses. In addition, the presence of a taxon in supplementary samples is indicated. The majority of plant remains are not charred. The state of preservation is mentioned only in the case of charred specimens. Measurements are given for dry specimens, unless otherwise stated. In a few cases measurements were performed twice, first on wet specimens, soon after the samples were washed, and later repeated on dry specimens. In all these cases considerable shrinkage was observed. Length of fruits or seeds usually means their largest dimension, breadth the largest dimension perpendicular to the length. A few exceptions are indicated in the text or in the plates. At the end of each description phytosociological classification is given for taxa included in plant community tables (all specific and a few generic determinations). The distribution of these taxa in different layers can be read from these tables and from diagrams. Remains identified only as genera or families are not listed in tables and diagrams and their occurrence in layers is given with the description. A full list of plants with the indication of their occurrence in early and late medieval times will be published separately (Wasylikowa, in print).

Plant names, except in a few cases, are according to "Rośliny polskie" (Szafer *et al.* 1953), names accepted in "Flora europaea" being given in parentheses. Doubtful determinations are indicated by cf. or type, and cf. is understood here as a closer identification. Depending on the position of cf. with the plant name the uncertainty may concern genus (cf. *Silene inflata*), species (*Lythrum* cf. *salicaria*) or variety (*Amaranthus lividus* cf. var. *lividus*). In most cases, the reasons for uncertainty are given with the description of a taxon. The term type is used when either a few species (more than two) have closely similar diaspores and no morphological criteria were found to separate them (*Cirsium oleraceum* type) or not all of the possibilities were checked (*Rubus plicatus* type). This term is also applied for sporomorphs in the same meaning. Phytosociological classification and nomenclature are according to "Szata ro-

ślinna Polski" (Medwecka-Kornaś *et al.* 1972), with supplements from Ellenberg (1974).

Abbreviations used in the text:

ch — characteristic species of the unit indicated in the text or of lower syntaxonomic units, which belong to it
EM — early medieval
LM — late medieval
AP — sum of arboreal pollen in the pollen diagram
NAP — sum of nonarboreal pollen in the pollen diagram
VIj, VIi ... Vb — symbols of archaeological layers

Fungi

Claviceps purpurea (Fries.) Tulasne. One sclerotium in pit 1.

Hepaticae

Anthoceros sp. Scattered spores in all EM layers.

Musci

Leaves and stems of 12 species were found in the basket from the layer VIe (Szafran 1963, unpubl.):

Anomodon apiculatus Br.
Antitrichia curtipendula (Hedw.) Brid.
Camptothecium sericeum Kindb.
Eurhynchium Zetterstedtii Stroem.
Hypnum cupressiforme Hedw.
Isothecium viviparum Lindb.
Leucodon sciuroides (L.) Schwägr.
Neckera complanata (L.) Hüb.
N. crispa (L.) Hedw.
Polytrichum attenuatum Menz.
Thamnium alopecurum (L.) Br.
Ulota ulophylla (L.) Broth.

More complete studies of mosses were carried out by Karczmarz (in print).

Sphagnum sp. Small number of spores in layers VIg, VIe_4, VIe, VIc—d.

Equisetaceae

Equisetum sp. Spores in all EM layers in small numbers.

Lycopodiaceae

Lycopodium clavatum L. One spore in VIe_4. *Nardo-Callunetea*, ch (Table 16).

Lycopodium complanatum L. (*Diphasium complanatum* (L.) Rothm.). One spore in VIf. *Vaccinio-Piceetea*, ch (Table 17).

Ophioglossaceae

Botrychium sp. Scattered spores in VIe_4 and VIe.

Osmundaceae

Osmunda regalis L. Two spores in VIc—d. ***Alnetea glutinosae***, ch (Table 17).

Polypodiaceae

Phegopteris sp. One spore in VIf.

Polypodium vulgare L. Scattered spores in VIg, VIf, VIe$_4$/VIc, and VIc—d. Various forests (Table 17).

Pteridium aquilinum (L.) Kuhn. (Pl. I) 16 fragments of tertiary leaf segments in 10 samples. Leaf segments thick with revolute margins, remnants of ciliate indusia can be seen on a few fragments. In addition, leaves of *Pteridium* were found in 4 supplementary samples from VIe and in one sample from VIf. One of the samples from VIe, collected near the house 3 (region X, are L, section 15, depth 530—550 cm), was composed of horizontally lying stems, straw, small branches, and larger fragments of *Pteridium* leaves. Large leaves of this species were probably used, together with other plants, for some purpose (bedding?). Small numbers of *Pteridium* spores were found in all EM layers with the exception of VIg. *Vaccinio-Piceetea*, ch (Table 17).

Polypodiaceae indet. Small numbers of spores in all EM layers. Leaf fragments in Vb.

Pinaceae

Abies alba Mill. 16 detached needles in 9 samples. Numerous branches, horizontally arranged, with needles attached, in one supplementary sample from VIf. Ten pieces of wood in 6 samples, including one post, one peg, and one lath (Table 3). Pollen in all EM layers, maximum amount 12% of AP. Various forests (Table 17).

Picea excelsa (Lam.) Lk. (*P. abies* (L.) Karsten subsp. *abies*) 14 needles and one unripe seed with a wing in 4 samples. Needles also in one supplementary sample from VIe and 2 cone fragments in VIf. Two wood pieces from VIa and VIc—d were determined as *Picea* or *Larix* (Table 3). Pollen in all EM layers with the maximum value of 8% of AP. *Vaccinio-Piceetea*, ch (Table 17).

Pinus silvestris L. Four cones in 3 supplementary samples from VIc—d, one cone from VIf. Seven pieces of wood from VIc—d (Table 3). Pollen in all EM layers in the amount of 6—43% of AP. Various forests (Table 17).

Taxaceae

Taxus baccata L. A bow identified by M. Reymanówna (Żaki 1974, phot. on p. 344). Not included in the plant community tables.

Aceraceae

Acer sp. Small amount of pollen in all EM layers, a maximum of 6% of AP in one sample from VIc—d. *Querco-Fagetea*, ch (Table 17).

Alismataceae

Alisma plantago-aquatica L. (Pl. I). Four seeds and 4 fruits in 7 samples. Size of 3 seeds: 1·1 × 0·6, 1·2 × 0·65, 1·25 × 0·5 mm. Size of 2 fruits: 1·5 × 0·8, 1·7 × 0·8 mm. Pollen of *Alisma sp.* forms a continuous curve from VIf to VIc—d. *Phragmitetalia*, ch (Table 5).

Amaranthaceae

Amaranthus lividus L. cf. var. *lividus*. (Pl. I). 18 and a half seeds in 6 samples. Three specimens from the sample no. 3d are swollen and their testa is covered with small cracks, as if they had been roasted. One seed from sample 51a is probably charred.

Seeds dark brown or blackish, circular or slightly oval in outline. Hilum in small incision on the seed circumference, at the end of the radicle. Lateral sides not differentiated into central and marginal parts (Kowal 1954), sometimes with small depression on each side near the apex of the radicle. Sculpture indistinct, rows of cells parallel to the seed circumference visible on the marginal part, particularly on the surface of the radicle. Seed edge blunt. Size of 8 seeds: 1·25×1·20, 1·50×1·35, 1·70×1·60, 1·60×1·55, 1·45×1·30, 1·60×1·35, 1·60× ×1·45, 1·60×1·60 mm. Average: 1·54(1·25—1·70)×1·42(1·20—1·60) mm.

A. lividus L. var. *ascendens* (Loisel.) Thell. (*A. ascendens* Loisel.) is the only species native in Europe, which occur in Poland today (Frey 1974). Fossil seeds from the Wawel have the same shape as seeds of this species but they are a little larger. The largest diameter in the reference material of var. *ascendens* from 6 localities was 1·5 mm and the size given in literature by various authors is 1·0 to 1·5 mm (Aellen 1959; Frey 1974; Knörzer 1970; Kovachev 1966). *A. lividus* has two cultivated varieties, *A. lividus* L. var. *oleraceus* (L.) Thell. with smaller seeds (diameter to ca. 1·3 mm) and *A. lividus* var. *lividus* with larger seeds (diameter to 1·75 mm, Aellen 1959). On the basis of the size subfossil seeds from the Wawel were identified as *A. lividus* cf. var. *lividus*. Their original size might even have been slightly larger than the measurements shown because in this material most seeds and fruits have slightly smaller dimensions than their modern counterparts (probably due to the shrinkage caused by long storage in dry conditions). The uncertainty of the determination is due to the lack of extant reference material.

Both varieties *oleraceus* and *lividus* are old cultivated plants. From written sources it seems likely that they were cultivated in the Mediterranean in Antiquity and they were certainly grown in Europe in the 8th, 16th, and 17th centuries as vegetables and medicinal plants (Hanelt 1968). They were used as fodder for pigs in 18th century, but in later times they became less important. Their cultivation in Thrace, as late as the beginning of 20th century, is mentioned in literature (Hanelt 1968) but now they can be found only in botanical gardens (Aellen 1959).

A large number of subfossil seeds of *Amaranthus lividus* L. from Roman time (1st century A.D.) was found in Neuss by Knörzer (1970). They were slightly smaller than the seeds from the Wawel, the diameter of 10 seeds was 1·42(1·2—1·6) mm. Knörzer assumes that the plant was cultivated because the seeds were found together with other plants used as vegetables. In Poland seeds of *Amaranthus* were found twice, namely in the early medieval layers from Gdańsk (*Amaranthus* sp., Mądalski 1952) and from Wrocław (*A. ascendens*

Loisel., Kosina 1974). Both findings were published without descriptions and measurements.

The only other species native to Europe, *A. graecizans* L. growing in the Mediterranean area, has seeds with lateral sides differentiated into central and marginal parts and with a distinct, even sharp, edge (Kowal 1954). Cultivated plant (Table 18).

Araliaceae

Hedera helix L. Large amount of pollen in layers from VIg to VIc—d (2—6% of AP). *Carpinion* (Table 17).

Betulaceae

Alnus glutinosa (L.) Gaertn. Two fruits in 2 samples. *Alnetea glutinosae*, ch (Table 17).

Alnus sp. Five wood fragments in one sample from VIc—d. Pollen in all EM layers in the amount of 3—16% of AP. *Alno-Padion* (Tables 3 and 17).

Betula verrucosa Ehrh. (*B. pendula* Roth.) or *B. pubescens* Ehrh. One fruit without wing. Various forests (Table 17).

Betula sp. 10 samples contained 2 wood pieces, 14 pieces of bark, and one broom made of birch twigs (Żaki 1974, phot. on p. 346). Pollen in all EM layers, 5—14% of AP. Various forests (Table 3 and 17).

Carpinus betulus L. Small amount of pollen in all EM layers up to 5% of AP. *Carpinion*, ch (Table 17).

Corylus avellana L. 12 fragments of nut shell in 4 samples. 35 supplementary samples contained about 10 complete nuts, 42 halves, and several smaller fragments. Only 2 fragments were charred. Size of 7 complete nuts: length 16·7(14·4—21·0) mm, breadth 13·6(12·6—15·8) mm, thickness 11·7(10·5—13·5) mm. Small amount of pollen in all EM layers (maximum up to 7% of AP). *Querco-Fagetea*, ch (Table 17).

Boraginaceae

Anchusa sp. Pollen in VIg, VIe, and VIc—d. The only species occurring in Poland, *A. officinalis* L., is a characteristic species of *Onopordion*. *Onopordetalia*, ch (Table 10).

Cerinthe minor L. (Pl. I). Two nutlets in 2 samples. One is a single fruit 2·4 mm long and 1·8 mm broad. The other with a bifurcated apex is composed of two nutlets grown together and is 3·0 mm long and 2·4 mm broad. Pollen of *Cerinthe* sp. in layers from VIg through VIc—d. *Festuco-Brometea* (Table 16).

Lithospermum arvense L. (*Buglossoides arvensis* (L.) I.M., Pl. I). 14 and a half nutlets in 7 samples. Four specimens, preserved without the outer tuberculate layer of pericarp, are of a pear-like shape, narrow end pointed and slightly curved, surface smooth with small depressions (Pl. I, fig. 8). Size of 6 complete nutlets: 2·45(2·25—2·65)×1·7(1·5—1·9) mm. *Centauretalia*, ch (Table 11).

Myosotis arvensis (L.) Hill. type. 17 nutlets in 11 samples. Nutlets narrow ovate, basal breadth distinctly smaller than the maximum breadth. Size of 10 fruits: 1·14(0·9—1·3) × 0·69(0·55—0·80) mm. In the Polish flora this type of fruits includes *M. arvensis* (L.) Hill., *M. micrantha* Pall., *M. collina* Hofm., and *M. versicolor* (Pers.) Sm. *M. arvensis*, most likely to occur, is a characteristic species of the order *Secali-Violetalia*. Other species may also grow in fields or on roadsides. *Secali-Violetalia* (Table 11).

Myosotis palustris (L.) Nathorst or *M. silvatica* (Ehrh.) Hoffm. Eight nutlets in 2 samples from Vb. Size: 1·54(1·50—1·60) × 0·89(0·80—1·00) mm (for description see Wieserowa in print).

Myosotis sp. 93 nutlets in 6 samples from VIf, pit 1, and Vb. Breadth at the base almost equal to the maximum breadth. Size of 5 specimens: 1·29 (1·2—1·45) × 0·8(0·7—0·9) mm.

Symphytum officinale L. (Pl. I). One nutlet with the remnants of smooth and shiny outer layer of pericarp. Size: length 4·0 mm, breadth 2·5 mm, thickness 2·4 mm. *S. cordatum* has fruits of about the same length (3·5—4·5 mm) but relatively broader and with a thicker collar-like ring. Fruits of *S. tuberosum* L. ssp. *nodosum* (Schur.) Soó are smaller (2·5—3·5 mm long, Grodzińska 1963). Small amount of pollen of *Symphytum* sp. in VIf, VIe, and VIc—d. *Molinietalia* (Table 14).

Campanulaceae

Campanula patula L. (Pl. I). Three seeds in 2 samples. Seeds oval in outline, slightly flattened, ± elliptical in cross-section (maximum thickness ± in the middle of the breadth). Delicate longitudinal striation on the surface of the testa. Size: 0·45 × 0·35 mm and 0·45 × 0·30 mm. *Arrhenatheretalia*, ch (Table 14).

Campanula persicifolia L. (Pl. I). Two seeds in 2 samples. Outline oval, the end with hilum blunt, cross-section narrow triangular (maximum thickness near one of the margins). Surface covered with delicate longitudinal striation. Size: 0·6 × 0·45 and 0·65 × 0·45 mm. *Querco-Fagetea*, ch (Table 17).

Campanula trachelium L. type (Pl. I). Three seeds in 2 samples from pit 1. Seeds very flat, narrow-oval, one end blunt with hilum, the other rounded. Narrow fringe along one margin. Striation more distinct than in *C. persicifolia*. Size of one seed: 1·4 × 0·75 mm. The type includes most of the species occurring in Poland.

Campanula sp. Small amount of pollen in all EM layers.

Jasione montana L. Pollen in all EM layers with the exception of VIf. *Sedo-Scleranthetea*, ch (Table 16).

Phyteuma sp. Pollen in all layers from VIg to VIc—d.

Cannabaceae

Cannabis sativa L. (Pl. I). 12 samples contained: 10 complete fruits and 10 halves and larger fragments. Usually only pericarp was preserved, in sample 54d three fruits with mineralized seeds were found (Pl. I, fig. 14). Size of 4 fruits: 3·7 × 2·85 × 2·2, 4·1 × 3·0 × 2·1, 3·65 × 2·8 × 2·1, 3·5 × 2·8 × 2·1 mm. In addition,

fruits in one supplementary sample from VIf. Pollen in all EM layers except for VIf. Cultivated plant (Table 18).

Humulus lupulus L. 72 fruits and 7 fragments in 21 samples. Mineralized specimens in samples 3d and 45g. Most specimens without perianth and without the outer epidermis of the pericarp, surface smooth, pillow-shaped trace of stigmas at the apex. A few specimens with perianth. Size of 10 fruits: length 2·60(2·2—2·9) mm, breadth 2·09(1·8—2·5) mm, thickness 1·68(1·4—2·2) mm. Pollen in all EM layers. *Salicion*, ch (Table 17).

Caprifoliaceae

Sambucus cf. ebulus L. One fruit-stone. Relatively shorter than fruit-stones of *S. racemosa* and *S. nigra* and with coarser sculpture, but dorsal side less convex than in typical fruits of *S. ebulus*. Size: 2·55×1·7×0·8 mm, length/breadth ratio 1·5. *Atropetalia* (Table 17).

Sambucus nigra L. 25 complete and 23 fragments of fruit-stones (2 charred) in 21 samples. Size of 16 fruit-stones: length 3·3(2·5—3·9) mm, breadth 1·69 (1·35—1·95) mm, thickness 0·95(0·7—1·2) mm, length/breadth ratio 1·96 (1·56—2·81). *Atropetalia*, ch (Table 17).

Sambucus sp. Pollen in all EM layers, maximum number 6% of AP. Two fruit-stones in VIa and VIe, region XII. *Atropetalia* (Table 17).

Viburnum opulus L. Two fruit-stones in 2 samples. Size of one specimen: 7·5×7·1×2·0 mm. One pollen grain in VIc—d. *Alno-Padion* (Table 17).

Caryophyllaceae

Agrostemma githago L. 865 seeds in 29 samples. In most cases only the empty testa is preserved, a few seeds contain a hard, mineralized inner part, 6 specimens are charred. Numerous seeds in 2 supplementary samples. Largest diameter of 20 seeds: 3·64(3·05—4·2) mm. *Centauretalia*, ch. (Table 11).

Arenaria serpyllifolia L. 11 seeds in 6 samples. Size of 9 specimens: 0·57 (0·50—0·60)×0·50(0·45—0·60) mm. *Festuco-Brometea* (Table 16).

Cerastium silvaticum W. K. (Pl. II). Two seeds in 2 samples. They differ from seeds of *C. vulgatum* in slightly larger dimensions, the ovate outline, and more regular arrangement of tubercles (longer axis of tubercles ± parallel to the seed circumference). Tubercle bases stellate, deeply incised. Size: 1·1×0·8 and 0·85×0·75 mm. Wojterska (1969) gives the following size for recent seeds (100 measurements): 0·81—1·5×0·51—1·20 mm, the largest diameter according to Zając (1975) is (0·8)0·9—1·2(1·25) mm. *Alno-Padion*, ch (Table 17). Today the species does not grow in the vicinity of Cracow. It occurs in south Poland only to the east from the Dunajec river (Zając 1975).

Cerastium vulgatum L. (*C. caespitosum* Gilib.). 14 seeds in 9 samples. Seeds triangular-ovate, with irregular arrangement of tubercles on lateral sides. Size of 6 seeds: 0·7(0·7—0·75)×0·68(0·6—0·7) mm. Size of extant seeds according to Wojterska (1969, 100 measurements) is 0·61—1·0×0·41—0·80 mm and the largest diameter according to Zając (1975) is (0·6)0·65—0·75(0·85) mm. *Arrhenatheretalia* (Table 14).

Dianthus armeria L. (Pl. II). Two seeds in one sample. They differ from similar seeds of *D. deltoides* L. in being slightly thicker and in having ± isodiametric cells on the whole surface of the dorsal side. The dorsal side of *D. deltoides* seeds is covered with cells elongated transversally to the length of the seed (Kowal & Wojterska 1966). Size: 1·32 × 0·9 × 0·55 mm and 1·4 × 0·85 × 0·25 mm. *Festuco-Brometea* (Table 16).

Dianthus sp. (Pl. I). Three seeds in 3 samples from VIe and pit 1. Size of 2 seeds: 1·9 × 1·5 and 1·8 × 1·3 mm. Small amount of pollen of *Dianthus* type in all EM layers.

Gypsophila muralis L. Four seeds in 4 samples. Size: 0·42 × 0·3, 0·42 × 0·40, 0·37 × 0·37 mm. *Isoëto-Nanojuncetea*, ch (Table 5).

Lychnis flos-cuculi L. 60 seeds in 18 samples. Size of 10 seeds: 0·74(0·65—0·80) × 0·62(0·58—0·70) mm. Scattered pollen grains of *Lychnis* type in VIj+i and VIe. *Molinietalia*, ch (Table 14).

cf. *Malachium aquaticum* (L.) Fr. (*Myosoton aquaticum* (L.) Moench.). 159 seeds (4 charred) in 19 samples. *M. aquaticum* and *Stellaria nemorum* have very similar seeds. Small differences are as follows: seeds of *Malachium* are almost circular in outline, they have tubercles on the lateral sides higher than in *Stellaria*, on the dorsal side conical and not compressed. Shape of seeds and tubercles in *Malachium* is less variable than in *Stellaria*. Size of 10 seeds: 0·81(0·67—0·97) × 0·78(0·65—0·87) mm. *Salicion* (Table 17).

Melandrium album (Mill.) Garcke. (*Silene alba* (Miller) E. H. L. Krause). 573 seeds in 41 samples. In most cases only empty testa, in a few cases with mineralized embryo and perisperm, one seed charred. Size of 10 seeds: 1·18 (1·00—1·32) × 0·99(0·85—1·17) mm. *Rudero-Secalietea*, ch (Table 11).

Melandrium noctiflorum (L.) Fr. (*Silene noctiflora* L.). 59 seeds in 21 samples. For description see Wieserowa (in print). Size of 10 seeds: 1·48(1·37—1·67) × × 1·26(1·15—1·4) mm. *Centauretalia*, ch (Table 11).

Melandrium rubrum (Weig.) Garcke (*Silene dioica* (L.) Clairv., Pl. II). Two seeds in one sample. Dorsal side evenly rounded, tubercles conical, pointed, higher and thinner than in *M. album*. Tubercle pattern around hilum as in *M. album* (Wieserowa in print). Size: 1·4 × 1·1 and 1·1 × 0·9 mm. *Alno-Padion* (Table 17).

Melandrium sp. Scattered pollen grains in VIi+j, VIg, VIe, VIc—d.

Moehringia trinervia (L.) Clairv. (Pl. II). One seed. Size: 1·0 × 0·9 mm. *Carpinion* (Table 17).

Saponaria officinalis L. (Pl. II). Three seeds in one sample. Size: 2·1 × 1·8, 1·8 × 1·6, and 1·9 × 1·7 mm. *Salicion*, ch (Table 17).

Scleranthus annuus L. Scattered pollen grains in all EM layers. *Centauretalia*, ch (Table 11).

Scleranthus sp. One fruit, sepals not preserved. *Centauretalia* (Table 11).

cf. *Silene inflata* (Salisb.) Sm. (*S. vulgaris* (Moench.) Garcke, Pl. II). 11 seeds (one charred) in 9 samples. Dorsal side ± evenly rounded or slightly flattened, tubercles coarse, on lateral sides arranged in ± concentric rows, near the hilum

forming radial wrinkles (as in seeds of *Melandrium noctiflorum*). They differ from seeds of *M. album* in coarser sculpture and the absence of ring-like thickening near the hilum. Seeds of *M. noctiflorum* have a more flattened dorsal side, on the lateral sides tubercles are finer and more elongated. Seeds from the Wawel show great variation in shape and sculpture. Size of 8 seeds: 1·56(1·25—1·75)×1·26(0·95—1·45) mm. *Festuco-Brometea* (Table 16).

Silene/Melandrium type. 14 seeds in 8 samples from VIg and pit 1.

Spergula arvensis L. var. *arvensis* (after Mansfeld 1959, Pl. II). Three seeds in 2 samples. Wings and papillae not preserved. Largest seed diameter: 1·05, 1·00, 1·15 mm. According to Kulpa (1974) the size of extant seeds is 0·9—1·2 mm in var. *arvensis* (= *S. vulgaris* Boenn.) and 1·1—1·6 mm in var. *sativa* (= *S. sativa* Boenn.). Kowal (1966) gives 0·81—1·4 mm for the largest seed diameter in both varieties. Size of subfossil seeds is closer to var. *arvensis* but the cultivated var. *sativa* cannot be excluded. *Secali-Violetalia*, ch (Table 11).

Spergula arvensis L. var. *maxima* (Weihe) Mert. et Koch. (includes *S. maxima* Weihe and *S. linicola* Boreau, Pl. II). Three complete and 18 halves of seeds in 6 samples. Wings and papillae not preserved. Largest diameter of 18 specimens: 1·87(1·65—2·2) mm. Size of extant seeds according to Kulpa (1974) is 1·6—2·0 mm, according to Kowal (1966) 1·41—1·8 mm. *Centauretalia*, ch (Table 11).

Stellaria graminea L. 56 seeds in 26 samples. Size of 10 seeds: 0·89(0·75—1·05)×0·86(0·75—1·0) mm. *Arrhenatheretalia* (Table 14).

Stellaria media Vill. 30 seeds in 14 samples. Size of 10 seeds: 1·14(0·95—1·22)×1·12(0·95—1·35) mm. *Rudero-Secalietea*, ch (Table 11).

cf. *Stellaria nemorum* L. One seed. It differs from *Malachium aquaticum* in its oval outline and compressed tubercles on the dorsal side. Size: 0·9×0·8 mm. *Alno-Padion* (Table 17).

Stellaria sp. Two pollen grains in VIi+j and VIe.

Viscaria vulgaris Röhl. (*Lychnis viscaria* L.). Six seeds in 5 samples. Size of three seeds: 0·55×0·45, 0·65×0·47, 0·60×0·50 mm. *Festuco-Brometea* (Table 16).

Caryophyllaceae indet. 26 seeds in 15 samples from VIj, VIi, ,VIg, VIf, VIc—d, Vb, pit 1, and house 3.

Chenopodiaceae

Identification of seeds is based on characteristics described by Kowal (1953). Measurements were performed as was indicated by this author. Number of seeds includes complete specimens and recalculated number of fragments: 2 halves = 1 seed, 4 smaller fragments = 1 seed.

Atriplex cf. *nitens* Schrk. (Pl. I). 101 seeds in 7 samples. The presence of *A. hastatum* cannot be entirely excluded. Size of 10 seeds: 1·46(1·25—1·85)× ×1·42(1·25—1·85) mm. *Onopordetalia* (Table 10).

Atriplex patulum L. Two seeds in 2 samples. Size of one seed: 1·65×1·5 mm. *Rudero-Secalietea*, ch (Table 11).

Atriplex sp. 13 seeds in 8 samples from VIg, VIf, VIe_4, VIe, and pit 1.

Chenopodium album L. s. str (Pl. I). 397 seeds (4 charred) in 37 samlpes. Only specimens with all characteristics typical of *C.album* were included here. Size of 10 seeds: 1·26 (1·15—1·35)×1·16(1·0—1·25) mm. *Rudero-Secalietea*, ch (Table 11).

Chenopodium album L. s. l. 4736 seeds in 15 samples. The group includes specimens with some characteristics typical of *C. viride*, *C. opulifolium*, and of varieties of *C. album*, as well as damaged specimens. *Rudero-Secalietea*, ch (Table 11).

Chenopodium ficifolium Sm. 41 seeds in 15 samples. Size of 10 seeds: 1·04(0·9—1·1)×0·96(0·85—1·05). *Onopordetalia* (Table 10).

Chenopodium hybridum L. 155 seeds in 35 samples. Size of 10 seeds: 1·75(1·5—1·85)×1·56(1·4—1·7) mm. *Onopordetalia*, ch (Table 10).

Chenopodium cf. *opulifolium* Schrad. (Pl. I). 14 seeds in 9 samples (one seed charred). Size of all specimens: 1·20(1·1—1·35)×1·27(1·15—1·4) mm. *Onopordetalia*, ch (Table 10).

Chenopodium polyspermum L. 87 seeds in 19 samples. Size of 10 specimens: 0·95(0·75—1·15)×0·87(0·75—1·0) mm. At present characteristic species of *Eu-Polygono-Chenopodion*, is here included in *Onopordetalia* (Table 10) on the basis of its occurrence in the diagram (Fig. 9).

Chenopodium cf. *rubrum* L. One seed, oval in outline, elongated and thinner towards the apex of the radicle. On both sides delicate reticulate sculpture fading towards seed circumference. Similar seeds of *C. glaucum* L. for the most part have a circular outline and uniform thickness along the whole diameter. Size: 0·6×0·6 mm (0·7 with radicle). *Bidentetalia*, ch (Table 5).

Chenopodium urbicum L. 176 seeds in 24 samples. Size of 10 seeds: 0·96 (0·85—1·0)×0·88(0·8—0·95) mm. *Onopordetalia* (Table 10).

Chenopodium cf. *viride* L. (Pl. I). 23 seeds in 10 samples. Size of 20 seeds: 1·18(1·0—1·3)×1·25(1·05—1·4) mm. *Onopordetalia* (Table 10). For description see Wieserowa (in print).

Chenopodium cf. *vulvaria* L. Three seeds in one sample. Size: 1·05×1·0, 1·0×0·95, and 1·05×0·9 mm. *Onopordetalia* (Table 10).

Chenopodium sp. 1686 seeds (4 charred) in 45 samples from all EM and LM layers. Seeds damaged. In addition, 25 seeds without testa (11 charred) and numerous specimens of inner seed epidermis.

Chenopodiaceae indet. Pollen in all EM layers, maximum up to 6% of AP+NAP.

Cistaceae

Helianthemum sp. Few pollen grains in VIj+i, VIg, VIf, VIc—d. *H. ovatum* (Viv.) Dun., a species most common in Poland, is a characteristic species of *Festuco-Brometea* (Table 16).

Compositae

Achillea cf. *millefolium* L. One achene. *A. nobilis* L., a very rare species in Poland, has similar fruits. Size: 2·05×0·7 mm. *Arrhenatheretalia*, ch (Table 14).

Anthemis cotula L. 35 achenes in 7 samples. Size of 15 fruits: 1·52(1·3—1·7)× ×0·74(0·6—0·9) mm. *Onopordetalia*, ch (Table 10).

Anthemis tinctoria L. Five achenes in 5 samples. Size of 4 specimens: 1·75× ×1·05, 1·7×0·7, 1·85×0·75, and 1·55×0·5 mm. *Festuco-Brometea*, ch (Table 16).

Anthemis type. Pollen in all EM layers.

Arctium lappa L. 11 and a half achenes in 5 samples. Fruits narrowed at the apex, the breadth of apical depression less than half of the fruit breadth (Kulpa 1974). Size of 6 dry specimens: 5·6×2·2, 4·4×1·6, 4·6×2·0, 5·35×2·1, 5·0×2·4, and 5·3×2·6 mm. Fruits are shorter than extant specimens due to storage in dry condition. Two achenes were 6·2 and 4·9 mm long when measured wet and respectively 5·6 and 4·4 mm long after 8 years of dry storage. *Onopordetalia*, ch (Table 10).

Artemisia sp. Pollen in all EM layers up to 5% of AP+NAP.

Aster type. Few pollen grains in all EM layers.

Bidens tripartitus L. Two achenes in one sample. Size: 4·75 (6·5 including awn)×2·3 and 5·25(7·5)×1·9 mm. *Bidentetalia*, ch (Table 5).

Carduus crispus L. or *C. acanthoides* L. (Pl. III). Three complete and 2 halves of achenes in 5 samples. Fruits smaller and with less distinct transverse wrinkles than in *C. nutans*. Size: 2·1×0·95, 2·5×1·1, 2·1×1·05 mm. *Onopordetalia*, ch (Table 10).

Carduus cf. *nutans* L. (Pl. III). One achene. Size: 2·8×1·3 mm. *Onopordetalia*, ch (Table 10).

Centaurea cf. *austriaca* Willd. (*C. phrygia* L. subsp. *phrygia*, Pl. III). Three samples contained: 2 complete involucres and one fragment, several involucral bracts with well preserved appendages, and 3 fruits (2 with remnants of pappus). Similarly shaped appendages may be found in *C. oxylepis* (Wimm. et Gr.) Hay (*C. macroptilon* Borbás subsp. *oxylepis* (Wimm. et Grab.) Soó), a rare species in Poland. Achenes with dorsal and ventral sides ± parallel, not contracted below the truncate apex, attachement scar lateral, short. Size of fruits 2·8× ×1·05 mm, attachement scar 0·75 mm long; 2·2×0·85 mm, attachement scar 0·5 mm long; 3·0×1·15 mm, attachement scar 0·75 mm long. *C. rhenana* Boreau and *C. oxylepis* have similar fruits but *C. rhenana* differs in the shape of involucral bracts. *Molinio-Arrhenatheretea* (Table 14).

Centaurea cyanus L. One complete achene and one fragment in one sample. Size: 3·85×1·7 mm, the length of the depression with attachement scar ±1·5 mm. Two pollen grains in VIf and VIc—d. *Centauretalia*, ch (Table 11).

Centaurea jacea L. (Pl. III). 11 achenes in 7 samples (one fruit charred). Achenes contracted below the apical rim, dorsal and ventral sides convex, attachement scar in deep, short depression. No pappus. Size of 11 fruits: 2·58(2·0—3·1)×1·26(1·0—1·5) mm, length of attachement scar in 7 fruits: 0·7(0·5—0·85) mm. Pollen in all EM layers. *Molinio-Arrhenatheretea*, ch (Table 14).

Centaurea scabiosa L. (Pl. III). Two achenes (one with pappus) and one seed with partly preserved pericarp in 3 samples. Pollen in all EM layers. Size:

4·0×1·75 mm, attachement scar 1·25 mm long; 4·5×1·65 mm, attachement scar 1·0 mm long. *Festuco-Brometea*, ch (Table 16).

Centaurea sp. (Pl. III). Three damaged achenes in 3 samples from VIf, VIc—d, and pit 1, without the outer layer of pericarp.

Chrysanthemum leucanthemum L. (*Leucanthemum vulgare* L.). Four achenes without outer layer of pericarp in 3 samples. Size: 1·65×0·55, 1·65×0·75, 2·0×0·55, and 1·5×0·9 mm. *Arrhenatheretalia*, ch (Table 14).

Cichorium intybus L. Six achenes in 3 samples. Size of 6 fruits: 2·46(2·30—2·75)×1·19(1·05—1·40) mm. *Onopordetalia* (Table 10).

Cirsium arvense (L.) Scop. type (Pl. III). Seven achenes in 6 samples. *C. palustre* (L.) Scop. and *C. canum* (L.) M. B. cannot be excluded. Size of 7 fruits: 2·6(2·2—2·8)×1·01(0·8—1·2) mm. Characteristic species of the class *Rudero-Secalietea* is here included in *Salicion* (Table 17), where it may have had its natural habitats (Trzcińska-Tacik & Wieserowa 1976).

Cirsium oleraceum (L.) Scop. type (Pl. III). Six achenes in 4 samples. *C. lanceolatum* (L.) Scop. and *C. erisithales* (Jacq.) Scop. cannot be excluded. Size of 5 fruits: 4·1×1·7, 3·3×1·1, 3·0×1·1, 3·5×1·2, 3·7×0·8 mm. *Molinietalia* (Table 14).

Cirsium sp. Pollen in all EM layers.

Crepis type. Pollen in all EM layers.

Lapsana communis L. Nine achenes in 5 samples. Size of 8 fruits: 3·38(3·2—3·65)×0·66(0·55—0·75) mm. *Secali-Violetalia*, ch (Table 11).

Picris hieracioides L. Four and a half achenes in 4 samples. Size: 2·85×0·65, 2·8×0·65, 2·5×0·8, and 2·5×1·0 mm, *Festuco-Brometea* (Table 16).

Sonchus arvensis L. Four achenes in 3 samples. Size: 2·05×0·8, 2·35×0·7, 2·05×0·75, 2·0×0·85 mm. *Secali-Violetalia*, ch (Table 11).

Sonchus asper (L.) Hill. Three achenes in 2 samples. Size: 2·6×1·1, 2·65×1·0, 2·45×0·9 mm. *Polygono-Chenopodietalia*, ch (Table 11).

cf. *Sonchus oleraceus* L. One achene badly damaged. Size: 2·65×0·6 mm. *Onopordetalia*, ch (Table 10).

Sonchus type. Scattered pollen grains in all EM layers.

Taraxacum type. Pollen in all EM layers.

Xanthium strumarium L. One involucre with beaks and prickles broken. Length 9·5 mm, breadth 5·6 mm, thickness 4·8 mm. *Onopordetalia*, ch (Table 10).

Compositae indet. Nine samples from VIg, VIc—d, VIc—d/VIe, and pit 1 contained: 9 achenes, 4 fragments of involucres and 2 fragments of inflorescence. Involucral bracts acuminate, ciliate, without appendages. A small percent of pollen of *Compositae Liguliflorae* and *Tubuliflorae* in all EM layers.

Convolvulaceae

Convolvulus arvensis L. (Pl. III). Eight complete seeds and 4 fragments in 2 samples. Size of 2 seeds: 3·7×2·2 and 4·0×3·2 mm. Scattered pollen grains in VIf, VIe$_4$, and VIc—d. *Rudero-Secalietea*, ch (Table 11).

Cornaceae

Cornus sanguinea L. One pollen grain in VIg. *Querco-Fagetea*, ch (Table 17).

Cornus sp. Two pollen grains in VIg.

Cruciferae

Barbarea sp. Two seeds in 2 samples from pit 1 and from the basket.

Brassica campestris L. (*B. rapa* L., Pl. III). 31 complete seeds and 8 fragments in 14 samples. For description see Wieserowa (in print). Diameter of 26 seeds: 1·26(1·1—1·6) mm. Cultivated plant (Table 18). It may also grow as a field weed or ruderal plant.

Brassica nigra (L.) Koch. Two seeds in 2 samples. Diameter: 1·2 and 1·1 mm. Cultivated plant (Table 18). It may also grow as a ruderal plant.

Brassica sp. Two seeds and 4 fragments of testa in 4 samples from VIj, VIe_4, VIe/VIc—d, and pit 1.

Camelina microcarpa Andrz. *ssp. sylvestris* (Wallr.) Hüt. (Pl. II). One seed. Radicle narrower than cotyledons, surface tuberculate, epidermal cells in longitudinal rows. Seed size: 1·3 × 0·95 mm. On the basis of seed size *C. sativa* (L.) Crantz. *subsp. pilosa* (DC) N. Zing. cannot be excluded (Table 4). Both species *C. microcarpa* subsp. *sylvestris* and *C. sativa* subsp. *pilosa* may grow as field weeds and ruderal plants (Smejkal 1971). *Secali-Violetalia* (Table 11).

Table 4
Tabela 4

Size of seeds of different species of Camelina
Wymiary nasion różnych gatunków Camelina

Extant seeds - Nasiona współczesne		Length Długość mm	Breadth Szerokość mm
	Camelina sativa (L.) Crantz.		
	Knörzer 1974, 10 seeds 10 nasion	1.5 - 1.6 av. 1.55	0.8 - 0.9 av. 0.82
	Körber-Grohne 1967		
	20 seeds 20 nasion	1.3 - 2.0 av. 1.8	0.9 - 1.0 av. 0.9
	Kulpa 1974	1.6 - 2.2(- 2.5)	0.9 - 1.4
	Smejkal 1971, ssp. sativa	1.5 - 2 (- 2.5)	0.9 - 1.4
	ssp. pilosa	1.2 - 1.6(- 1.8)	
	Camelina alyssum (Mill.) Thell.		
	Smejkal 1971	2 - 3	
	Kulpa 1974	(2.2-) 2.5 - 3	1.2 - 1.8(-2.5)
	Camelina microcarpa Andrz.		
	Kulpa 1974	1 - 1.2	0.7 - 0.9
	Smejkal 1971		
	ssp. sylvestris	1.2 - 1.5(- 1.6)	
	ssp. microcarpa	0.7 - 1 (- 1.2)	
Wawel, Early Medieval time, one seed Wawel, wczesne średniowiecze, jedno nasienie		1.3	0.95

Capsella bursa pastoris (L.) Med. Five seeds in 3 samples. Epidermal cells elongated parallel to the seed length. Size of 4 seeds: 0·85 × 0·5, 0·85 × 0·55, 1·0 × 0·55, 1·0 × 0·55 mm. *Rudero-Secalietea*, ch (Table 11).

Conringia orientalis (L.) Andrz. (Pl. II). Two complete and one damaged seed in one sample. Outline oval, narrow radicle slightly longer than broad cotyledons. Outer surface light olive-yellow, covered with longitudinal rows of tubercle-like prominences of different hight (Pl. II, Fig. 11a). Deeper lying layers of testa black, composed of longitudinal rows of transversally elongated cells (Pl. II, Fig. 11b). The shape of these cells differentiates seeds of *Conringia* from those of *Camelina macrocarpa* Wierzb., *C. sativa* (L.) Crantz., and *C. alyssum* (Miller) Thell., which are of a similar shape and size (Pl. II, Figs. 12, 13, 14).

The surface of dry extant seeds of *Conringia* is covered with irregular longitudinal depressions and protuberances. After short soaking in water epidermal cells swell and form mucilaginous finger-like processes. In fossil seeds the swelling probably began but was interrupted at an early stage, when the outer cell-walls became only slightly convex. Size of fossil seeds: 2·5×1·5 and 2·2×1·5 mm. *Centauretalia*, ch (Table 11).

Descurainia sophia (L.) Webb. Two seeds in 2 samples. Longer axis of epidermal cells transversal to the seed length. Size: 0·9×0·5 and 0·7×0·35 mm. *Onopordetalia*, ch (Table 10).

Neslia paniculata (L.) Desv. 10 complete specimens and 7 half-fruits in 11 samples. Size of 8 fruits: 2·11(1·8—2·6)×1·96(1·65—2·3) mm. *Centauretalia*, ch (Table 11).

Rorippa palustris (Leyss.) Bess. (*R. islandica* (Oeder) Borbás). 27 seeds in 4 samples. Epidermal cells with convex outer walls. Size of 10 seeds: 1·37(1·25—1·6)×1·07(0·95—1·15) mm. *Bidentetalia*, ch (Table 5).

Rorippa cf. *silvestris* (L.) Bess. One seed, size 1·2×1·0 mm. Epidermal cells with concave cell walls. *Potentillo-Polygonetalia*, ch (Table 10).

Sinapis arvensis L. Seven seeds in 2 samples. Diameter of 4 seeds: 1·7, 1·7, 1·6, and 1·6 mm. *Secali-Violetalia*, ch (Table 11).

Thlaspi arvense L. 81 complete seeds and 5 halves in 18 samples. Size of 10 seeds: 1·88(1·65—2·05)×1·41(1·25—1·6) mm. *Secali-Violetalia*, ch (Table 11).

Cruciferae indet. 30 seeds in 9 samples from VIg, VIf, VIe$_4$, VIe, VId, Vb, and pit 1. Pollen in all EM layers.

Cuscutaceae

Cuscuta sp. Three seeds in 3 samples from VId, Vb, and pit 1. Size: 0·9×0·8, 0·9×0·75, 1·45×1·35 mm.

Cyperaceae

Blysmus compressus (L.) Panz. (Pl. IV). Three complete achenes and 2 fragments in one sample. Cross-section lenticular, with one side more convex, fruits abovate or narrowly obovate with rather long stipe. Two fruits have awns 2—2·5 times longer than fruits (Soják 1958). Longitudinal rows of polygonal cells on the surface. Pericarp very fragile. Size: length with stipe 1·85 mm, breadth 1·0 mm, stipe length 0·35 mm, and respectively 2·3×±1·2 mm, 0·5 mm; 2·5×1·5 mm, 0·5 mm. *Scheuchzerio-Caricetea*, ch (Table 5).

Carex caryophyllea Latourette type (Pl. IV). Two achenes without perigynia

in 2 samples. Style base surrounded by white collar-like rim. The specimens differ from typical fruits of *C. caryophyllea* in the greatest breadth being in the middle instead of in the upper part. Size: 1·8×1·1 and 1·3×1·1 mm. *Festuco-Brometea*, ch (Table 16).

Carex fusca Bell. et All. (*C. nigra* (L.) Reichard, Pl. IV). 14 achenes without and one with perigynium in 9 samples. Six of them are of typical shape, the rest could also belong to *C. gracilis* Curt. Size of 10 fruits: 1·6(1·4—2·1)×1·09(0·85—1·3) mm. *C. fusca* is a characteristic species of *Scheuchzerio-Caricetea* but it may also occur in wet meadows of the order *Molinietalia* (Zarzycki 1958). Its occurrence in the material from the Wawel resembles other species of this order (Fig. 8). *Molinietalia* (Table 14).

Carex hirta L. type (Pl. IV). 26 achenes without, one with complete, and 3 with fragments of perigynia in 14 samples. Lateral sides of fruits with papillae (Nilsson & Hjelmqvist 1967). *C. lasiocarpa* Ehrh. cannot be excluded. Size of 9 achenes: 2·67(2·35—2·95)×1·51(1·3—1·8) mm, length of stipe 0·25(0·15—0·35) mm. *C. hirta* is a characteristic species of *Agropyro-Rumicion crispi*, but it also grows in wet meadows of the order *Molinietalia* (Zarzycki 1958) and is here included in *Molinio-Arrhenatheretea* (Table 14) on the basis of its appearance in seed diagram (Fig. 8).

Carex leporina L. (Pl. IV). 44 achenes without and 2 with perigynia in 13 samples. Achene surface highly lustrous. Lateral margins of perigynia flat, winged (Berggren 1969). Size of 10 fruits 1·74(1·55—2·0)×0·89(0·55—1·0) mm. *Molinietalia* (Table 14).

Carex sect. *Muehlenbergianae* Carey (Pl. IV). 17 achenes without and 2 with perigynia in 15 samples from VIi, VIg, VIf, VIe_4, VIe, and pit 1. Shape of fruits as in *C. contigua* Hoppe, *C. Pairaei* F. Schultz, and *C. divulsa* Stokes. Specimens with perigynium probably belong to *C. Pairaei*, because the basal part of perigynium wall is not spongy. Size of 10 fruits: 2·13(1·95—2·4)×1·67(1·4—1·85) mm.

Carex rostrata Stokes (Pl. IV). Two samples contained: 26 achenes in perigynia, 9 empty perigynia, and 6 naked achenes. Size of 10 achenes: 1·6(1·25—2·0)×1·21(0·95—1·4) mm. Size of 10 perigynia (without beak): 3·39(3·0—3·75)×2·2(1·9—2·7) mm. *Phragmitetalia*, ch (Table 5).

Carex vesicaria L. (Pl. IV). 29 perigynia, including one with achene, in 2 samples. Length of 10 perigynia: 5·87(5·4—6·5) mm, breadth of 8 perigynia: ±2·1(1·8—2·6) mm. Size of achene: 2·0×1·2 mm. *Phragmitetalia*, ch (Table 5).

Carex cf. *vulpina* L. (Pl. IV). 19 perigynia with achenes in 2 samples. Size of 6 perigynia (stipe and beak included): 4·63(4·1—4·9)×1·97(1·6—2·3) mm. Achenes with verrucae (Nilsson & Hjelmqvist 1967). *Phragmitetalia*, ch (Table 5).

Carex sp. 36 lenticular achenes (7 with perigynia) in 20 samples. 164 trigonous achenes (one charred, 2 with perigynia) in 37 samples. 44 empty perigynia in 6 samples. Remains in all EM and LM layers except VIi. Pollen of *Carex* type in all EM layers in amounts up to a few per cent.

Cyperus flavescens L. (*Pycreus flavescens* (L.) Rchb., Pl. IV). One achene. Lustrous surface covered with very delicate longitudinal striation. Transversal wrinkles, characteristic of the species, not visible, but they may be absent also in extant reference material (Soják 1958). Length (including beak) 1·0, breadth 0·75 mm. *Isoëto-Nanojuncetea*, ch (Table 5).

Cyperus fuscus L. One achene, size: 0·9×0·55 mm. *Isoëto-Nanojuncetea*, ch (Table 5).

Eriophorum angustifolium Honck. or *E. latifolium* Hoppe. One damaged achene. Size: 2·8×1·25 mm. *Scheuchzerio-Caricetea*, ch (Table 5).

Heleocharis palustris (L.) R. et S. (Pl. IV). 69 achenes in 7 samples. 10 specimens composed only of ± crumpled epidermis of pericarp, preserved with fragments of ± conical stylopodia separated from achenes by a constriction. Two specimens with bristles. Specific determination of fruits preserved without stylopodium uncertain. Epidermis of all specimens smooth (Strandhede 1966, Żukowski 1965). Size of 10 achenes without stylopodium: 1·47(1·25—1·6) ×1·13(0·95—1·3) mm. *Phragmitetalia*, ch (Table 5).

Heleocharis sp. One unripe achene with the base of the stylopodium in VIf. *Phragmitetalia* (Table 5).

Scirpus silvaticus L. (Pl. IV). 174 achenes in 30 samples. Three specimens with bristles. Size of 20 fruits: 0·95(0·7—1·15)×0·63(0·45—0·7) mm. In addition, 54 seeds in 5 samples. Seeds obovate, with broadly rounded apex and tapering base. Epidermal cells large, polygonal. Similar seeds occur in other genera of *Cyperaceae* having small fruits. Determination was possible because a few seeds were found inside pericarp. *Molinietalia*, ch (Table 14).

Cyperaceae indet. Four achenes in 4 samples from VIe$_4$, VIc—d, pit 1, and house 3.

Dipsacaceae

Knautia arvensis (L.) Coult. (Pl. III). Four and a half fruits in 3 samples. *Knautia silvatica* (L.) Duby has relatively narrower and longer fruits, more narrowed at the apex. Size: 3·95×2·05, 4·75×2·3, 3·65×1·9, 3·8×1·85 mm. A few pollen grains of *Knautia* sp. in VIe and VIc—d, *Arrhenatheretalia* (Table 14).

Scabiosa sp. A few pollen grains. The occurrence of *S. ochroleuca* L. or *S. columbaria* L. is most likely on the basis of their present day distribution. Both species are characteristic of *Festuco-Brometea* (Table 16).

Succisa pratensis Mnch. Scattered pollen grains in all EM layers except for VIj+i. *Molinietalia*, ch (Table 14).

Ericaceae

Calluna vulgaris (L.) Salisb. Small amount of pollen. *Nardo-Callunetea*, ch (Table 16).

Vaccinium sp. A few pollen grains. *Vaccinio-Piceetea*, ch (Table 17).

Euphorbiaceae

Euphorbia helioscopia L. 10 samples contained 3 complete and 6 halves of

seeds. Size of 7 seeds: 2·11(1·9—2·3)×1·56(1·4—1·8) mm. *Polygono-Chenopodietalia*, ch (Table 11).

Euphorbia platyphyllos L. (Pl. V). Two seeds in 2 samples. Seeds broadly ovate, dorso-ventrally flattened, on ventral side obliquely truncated at the apex. Chalazal wart surrounded by circular rim (Serwatka 1972). Surface smooth. Size: 2·2×1·7 and 2·1×1·7 mm. *Onopordetalia* (Table 10).

Euphorbia sp. (Pl. V). Two seeds in 2 samples from VIf and pit 1. Scattered pollen grains in VIe$_4$, VIe and VIc—d.

Fagaceae

Fagus silvatica L. Two fragments of pericarp in one sample. Size of one fruit valve: length 12·0 mm, breadth 7·0 mm. Pollen in all EM layers up to a few percent of AP. *Querco-Fagetea*, ch (Table 17).

Quercus sp. Three leaf fragments in 3 samples. One cupula and 2 fragments of acorns in 3 supplementary samples. Four pieces of charcoal and 5 of wood in the basket. The other 15 samples contained 15 pieces of wood from different elements of wooden structures (laths, dowels, posts) and from wooden objects (Table 3). Pollen in all EM layers up to a few per cent of AP. Various forests (Table 17).

Gentianaceae

Gentiana pneumonanthe L. type. Scattered pollen grains. *Molinietalia* (Table 14).

Geraniaceae

Geranium cf. *silvaticum* L. (Pl. V). One seed slightly swollen (roasted?), only fragments of testa preserved. Outline oval, both ends rounded. Chalazal disc circular, flat, length of raphe ± equals half the seed length. Indistinct reticulum on the surface of testa (Tokarski 1972). Length of seed 2·9 mm, breadth ±1·9 mm, thickness 1·8 mm, length/breadth ratio ±1·52. *Molinio-Arrhenatheretea* (Table 14).

Geranium sp. A few pollen grains in all EM layers except for VIj+i.

Gramineae

Agropyron repens (L.) P. B. (Pl. V). Two charred grains in 2 samples. Breadth and thickness of caryopsis ± uniform along its whole length. Hilum long, reaches the apex of grain. On the surface longitudinal rows of transversally elongated cells. Size of grains: 3·15×?×0·85 mm and 3·15×1·15×1·05 mm. Two macerated grain coats found in one sample probably belong to the same species. Their size is: 4·5×1·55 and 5·0×1·9 mm. *Potentillo-Polygonetalia*, ch (Table 10).

Avena sativa L. (Pl. V). Eight uncharred, macerated grains with lemma and palea in 4 samples. Elongated cells of pericarp arranged in groups (Körber-Grohne 1964). Size (base of lemma included): 9·2×3·3, 8·7×3·0, 6·6×2·3 mm. Cultivated plant (Table 18).

Avena sp (Pl. V). Five macerated uncharred grains in 3 samples, 8 charred naked grains in 8 samples. Size of 2 uncharred specimens: 5·8×2·1 and 6·9×2·5 mm. Size of 8 charred grains: 5·32(4·6—6·4)×2·11(1·9—2·5)×1·75(1·3—

2·5) mm. Two carbonized grains in 2 supplementary samples from VIf and Va. Pollen in VIe_4/VIe, VIe, and VIc—d. Probably cultivated (Table 18).

Bromus secalinus L. (Pl. V). One and a half charred grains in one sample. Size: 5·7×1·7×1·4 and 5·2×2·0×1·0 mm. *Centauretalia*, ch (Table 11).

Bromus sp. 14 macerated grains in 7 samples from VIe, pit 1, and the basket. Elongated thick-walled cells of pericarp at the apex ± parallel to the margin of caryopsis (Körber-Grohne 1964). Size of 7 grains: 5·88(5·2—6·8)×2·18(1·8—2·4) mm.

Digitaria ischaemum (Schreb.) Muehlenb. (Pl. V). One charred grain, naked. Relatively shorter and broader than grains of *D. sanguinalis*. Embryo short, hilum oval. Size: 1·2×0·8×0·5 mm. *Polygono-Chenopodietalia*, ch (Table 11).

Digitaria sanguinalis (L.) Scop. (Pl. V). Four samples contained: 6 uncharred empty spikelets with almost complete lemma and palea and fragments of glumes, one charred grain with fragments of lemma and palea. Size of 6 uncharred spikelets: 2·71(2·25—2·9)×0·87(0·8—1·05) mm. Size of grain: 2·2×0·7 mm. *Polygono-Chenopodietalia*, ch (Table 11).

Echinochloa crus-galli (L.) P. B. (Pl. VI). The following specimens were found in 27 samples: 1) uncharred — 265 spikelets composed of almost complete lemma and palea but without glumes and grains, 8 detached lemmas and paleas, one spikelet with the remnants of glumes and spikelet base, one naked grain; 2) charred — 25 naked grains, 8 grains with fragments of lemma or palea, one spikelet with glume remnants at the apex. Size of 10 charred grains: 1·61(1·25—2·05)×1·30(1·15—1·55)×1·03(0·9—1·2) mm. Size of 10 uncharred spikelets: 2·35(2·1—2·65)×1·54(1·35—2·3)×1·07(0·95—1·25) mm. *Polygono-Chenopodietalia*, ch (Table 11).

cf. *Festuca pratensis* Huds. (Pl. V). One charred grain, naked. Size: 2·4×1·1×0·9 mm. *Molinio-Arrhenatheretea*, ch (Table 14).

Hordeum vulgare L. Two samples contained: one hulled grain, charred, and 3 uncharred fragments of ear rachis of a naked, six-row form. One charred grain in a supplementary sample from VIf. A few pollen grains of *Hordeum* type in VIj+i, VIf, VIe, and VIc—d. Cultivated plant (Table 18).

Panicum miliaceum L. (Pl. VI). Remains of millet were most common of all plant remains from the Wawel. They were found in 45 samples subjected to detailed studies. Uncharred remains: 863 spikelets in 27 samples, about 2550 detached lemmas and paleas in 26 samples. Charred remains: 344 naked grains in 35 samples, 34 grains with fragments of lemma or palea in 12 samples, 7 fragments of lemma or palea in 7 samples. Many samples contained large numbers of small palea and lemma fragments but only complete or almost complete specimens were counted. Due to their light brownish or yellowish colour, they were easily recognized during field work and many supplementary samples containing millet were collected by excavators. 34 of these samples were preliminary checked for the presence of *Panicum*, with the folllowing result:
layer VIf — 3 samples containing lumps of charred grains with remnants of lemmas and paleas, 3 samples of uncharred spikelets, one sample with mixed

charred and uncharred specimens, 2 samples of charred wheat with a small amount of charred millet

layer VIe — 21 samples of uncharred spikelets, sometimes with an admixture of charred grains (3 samples connected with house 3)

transitional layer VIe/VIc—d — 2 samples of uncharred spikelets

layer VIc—d — one sample of charred grains (house 2)

layer VIb — one sample of uncharred spikelets

Uncharred spikelets, composed of lemma and palea, are empty or contain remains of pericarp with hilum visible at the lower end. Surface of well preserved lemma or palea is smooth and highly lustrous, without traces of transversal wrinkles characteristic of *Setaria italica* (L.) P. B. convar. *maohria* (Alef.) Körn. Only specimens with damaged outer layer are rough. The surface of all specimens of palea is not differentiated in the central and marginal parts, as is the case in *S. italica* convar. *moharia* and convar. *maxima* (Alef.) Körn. (Scholz 1960).

Charred grains have short and broad embryo and roundish hilum. Shape of grains variable. Size of 35 uncharred spikelets: 2·96(2·7—3·4)×1·98(1·6—2·3)×1·37(1·1—1·7) mm. Size of 10 charred grains: 1·86(1·45—2·35)×1·51(1·15—1·65)×1·29(0·95—1·7) mm. Cultivated plant (Table 18).

Phleum pratense L. (Pl. V). One macerated grain, laterally compressed. Length 1·25 mm, thickness 0·95 mm. *Arrhenatheretalia* (Table 14).

Poa sp. (Pl. V). Two charred grains in one sample from VIe/VIc—d. Lemma and palea partly preserved. Lemma with 5 nerves (3 of them pronounced), laterally compressed at the base. Size of one grain: 1·2×0·5×0·45 mm.

Secale cereale L. (Pl. V). 19 samples contained: 210 complete and 6 fragments of charred grains, 3 uncharred fragments of ear rachis, and one uncharred macerated grain with transversal cells visible. Size of 10 charred grains: 5·87(5·0—7·0)×2·18(1·8—2·6)×2·08(1·7—2·5) mm. Charred grains also present as admixture in 5 supplementary samples from VIf and VIe. Fairly large amount of pollen in all EM layers (2—4% of AP+NAP) with the maximum of 26% in VIj+i. Cultivated plant (Table 18).

Setaria glauca (L.) P. B. (Pl. VI). 31 samples contained: 826 spikelets, about 100 detached lemmas and paleas, 8 naked grains, all uncharred, and 12 charred grains, naked or with remnants of lemma and palea. Size of 20 spikelets: 2·95(2·6—3·2)×1·87(1·7—2·1)×1·24(1·1—1·4) mm. *Polygono-Chenopodietalia*, ch (Table 11).

Setaria viridis (L.) P. B. or *S. verticillata* (L.) P. B. (Pl. VI). 27 samples contained: uncharred — 324 spikelets and 49 detached lemmas and paleas; charred — 13 naked grains, 11 grains with fragments of lemma and palea, one detached lemma, 2 spikelets with remnants of glumes. No marked differences between these two species were observed. In Poland *S. viridis* is more common as a weed. Size of 10 spikelets: 2·11(1·95—2·3)×1·20(1·1—1·4)×0·76(0·6—0·85) mm. Size of 7 charred grains: 1·41(1·2—1·6)×1·10(0·9—1·35)×0·77(0·5—1·15) mm. *Polygono-Chenopodietalia*, ch (Table 11).

Triticum aestivum L. s.l. (Pl. V). 118 complete and 11 fragments of charred grains in 26 samples. Most grains of intermediate shape between vulgare and compactum types. Size of 50 grains: 4·55(2·72—5·63)×2·91(1·63—3·92) ×2·32(1·35—3·16) mm, length/breadth ratio 156 (111—196), thickness/breadth ratio 79 (57—95). One grain found separately is narrower and longer, similar in shape to *T. aestivum* L. s. str. (*T. vulgare* Vill.). Its dimensions are: 7·9×2·55 ×2·1 mm, L/B 309, T/B 82.

Three supplementary samples from VIe and two samples from VIf contained small amount of charred grains, the species dominated in two other samples of charred grain from VIf. Cultivated plant (Table 10).

Triticum sp. 10 macerated uncharred grains in 3 samples. Transversal cells of pericarp with triangular thickenings at the corners and with pits typical of the genus (Körber-Grohne 1964). One uncharred glume basis of a spelt wheat with ring-like thickening at the base. Large amount of pollen in all EM layers (3—10%), maximum 23% of AP+NAP in VIj+i. Cultivated plant (Table 18).

Cerealia indet. One complete and 59 fragments of charred grains in 4 samples. 39 complete and 13 fragments of uncharred macerated grains in 3 samples. Cultivated plant (Table 18).

Paniceae indet. Three charred grains and one fragment of uncharred spikelet in 3 samples from VIf, VIe_4, and VIe.

Gramineae indet. 28 samples from all EM and LM layers (except for VIj and VIi) contained: 430 uncharred macerated grains (4 with lemma and palea) and 26 charred grains (2 with lemma and palea). Most of uncharred grains (428 specimens) were found in 2 LM samples from Vb. Large amount of pollen in all EM layers (22—55% of AP+NAP).

Guttiferae

Hypericum cf. *acutum* Mnch. (*H. tetrapterum* Fries.). 78 seeds in 13 samples. At least some of the testa cells broader than in seeds of *H. maculatum*. The difference between seeds of these two species is not distinct. On the basis of seed morphology *H. montanum* L., a rare species in Poland, cannot be excluded. Size of 10 seeds: 0·79(0·65—0·9)×0·32(0·27—0·37) mm. *Molinietalia*, ch (Table 14).

Hypericum cf. *maculatum* Cr. 11 seeds in 5 samples. Cells of testa very narrow. Size of 8 seeds: 0·72(0·6—0·77)×0·30(0·30—0·32) mm. *Molinio-Arrhenatheretea* (Table 14).

Hypericum perforatum L. 109 seeds in 26 samples. Size of 15 seeds: 1·03(0·9—1·1)×0·4(0·4—0·4) mm. *Arrhenatheretalia* (Table 14).

Hypericum sp. Two seeds in one sample from VIf.

Iridaceae

Iris sp. One pollen grain in VIg.

Juglandaceae

Juglans regia L. Few pollen grains in VIg, VIe_4/VIe, and VIe. Cultivated plant (Table 18).

Juncaceae

Juncus cf. *bufonius* L. 17 seeds in 6 samples. Seeds relatively broad, with both ends rounded, small warts on one end. Epidermal cells small, all cell walls of ± the same thickness (Körber-Grohne 1964). Size of 10 seeds: 0·49(0·45—0·55)×0·32(0·27—0·42) mm. *Isoëto-Nanojuncetea*, ch (Table 5).

Juncus sp. Over 600 seeds in 24 samples from all EM and LM layers with the exception of VIe_4. One damaged capsule with seeds.

Luzula cf. *multiflora* (Retz.) Lej. (Pl. VII). 19 seeds and one capsule in 4 samples. Seeds rounded at both ends. Surface covered with distinct net of 4—6 sided cells arranged in longitudinal rows. Very similar seeds of *L. campestris* (L.) DC. are slightly smaller and have smaller cells on the surface of testa. Size of 13 seeds: 1·19(1·05—1·35)×0·87(0·7—1·0) mm. *Molinio-Arrhenatheretea* (Table 14).

Luzula cf. *nemorosa* (Poll.) E. Mey. (Pl. VII). One seed. Outline narrow-oval, both ends slightly narrowed, indistinct net pattern on the surface. Size: 0·95×0·6 mm. Various forests (Table 17).

Luzula sp. 21 seeds in 11 samples from VIi, VIe_4, VIe, VIe/VIc—d, VId, pit 1, and the basket.

Labiatae

Ajuga cf. *reptans* L. Two nutlets in 2 samples. No marked features differentiating extant seeds of *A. reptans* from *A. genevensis* L. were found. Size: 2·2×1·35 and 1·9×1·3 mm. *Carpinion* (Table 17).

Ballota nigra L. (Pl. VII). Six nutlets in 5 samples (Wojciechowska 1966). Size of 4 fruits: 1·7×0·95, 2·05×1·2, 1·85×1·1, 1·95×0·9 mm. *Onopordetalia*, ch (Table 10).

Betonica officinalis L. (*Stachys officinalis* (L.) Trevisan, Pl. VII). Seven nutlets, including 4 without outer layer of pericarp, in 4 samples. Remnants of wing preserved at the apex. Size of 5 fruits: 2·55×1·15, 2·7×1·35, 2·1×1·65, 2·25×1·25, 2·8×2·0 mm. *Arrhenatheretalia* (Table 14).

Chaiturus marrubiastrum (L.) Rchb. (*Leonurus marrubiastrum* L., Pl. VII). Three nutlets in 2 samples. Apex triangular, surrounded by distinct rim. Fruits relatively narrower than similar fruits of *Leonurus cardiaca* L. Size of 2 fruits: 1·9×0·9 mm, breadth/length ratio 0·47 and 1·8×0·8 mm, breadth/length ratio 0·50 (Wojciechowska 1972). *Onopordetalia* (Table 10).

Galeopsis cf. *angustifolia* Ehrh. (Pl. VII). Twelve nutlets in one sample. Smaller and narrower than nutlets of *G. ladanum*. Size of 10 fruits: 2·15(1·9—2·25)×1·26(1·05—1·45) mm. Characteristic species of the class *Thlaspeetea*,

near Cracow probably grew as field weed (Trzcińska-Tacik & Wieserowa 1976). *Secali-Violetalia* (Table 11).

Galeopsis cf. *ladanum* L. (Pl. VII). 46 nutlets in 5 samples. Fruits larger and broader than fruits of *G. angustifolia*, slightly smaller, narrower and with smaller attachement scar than in *G. tetrahit* type. Size of 10 fruits: 2·42(2·2—2·55) ×1·60(1·55—1·75) mm. Characteristic species of *Thlaspeetea* is included here in *Secali-Violetalia* on the same basis as *G. angustifolia* (Table 11).

Galeopsis ladanum L. type. 11 nutlets in 4 samples. Size and shape intermediate between *G. ladanum* and *G. angustifolia*. Size of 10 fruits: 2·20(2·1—2·35) ×1·32(1·1—1·5) mm. *Secali-Violetalia* (Table 11).

Galeopsis pubescens Bess. 21 nutlets in 4 samples. Size of 10 fruits: 2·63(2·45—2·80)×2·24(2·05—2·50) mm. *Onopordetalia*, ch (Table 10).

Galeopsis cf. *speciosa* Mill. Seven nutlets in 3 samples. Size of 6 fruits: 3·27(2·8—3·5)×2·6(2·4—3·0) mm. *Rudero-Secalietea*, ch (Table 11).

Galeopsis tetrahit L. 136 nutlets in 16 samples. Size of 10 fruits: 2·79(2·60—3·10)×2·7(1·90—2·25) mm. Characteristic species of *Rudero-Secalietea*, at present a common field weed, frequently found in subfossil samples of cereal grain, fruit curve from the Wawel similar to the curves for other weeds. *Secali-Violetalia* (Table 11).

Galeopsis tetrahit L. type. 127 nutlets (2 charred) and one seed in 23 samples. The type includes *G. tetrahit*, *G. pubescens*, *G. speciosa*, and *G. bifida* Boenn. (for description see Wieserowa, in print). *Secali-Violetalia* (Table 11).

Lamium cf. *album* L. (Pl. VII). Eight nutlets in 3 samples. Outer surface damaged, basal appendage not preserved. Fruit base gradually tapering. Size of 8 fruits: 2·06(1·75—2·40)×1·24(1·20—1·30) mm. *Onopordetalia*, ch (Table 10).

Lamium purpureum L. (Pl. VII). One nutlet with abruptly tapering base. Surface irregularly verrucose. Size: 2·05×1·25 mm. *Polygono-Chenopodietalia*, ch (Table 11).

Lycopus europaeus L. 33 nutlets in 9 samples. Size of 10 fruits: 1·34(1·20—1·55)×0·94(0·80—1·05) mm. *Alnetea glutinosae*, ch (Table 17).

Marrubium vulgare L. (Pl. VII). Three nutlets in 3 samples. Outline narrow oval, surface covered with small cells forming reticulate pattern and with irregularly distributed thick warts. Size: 1·8×1·0, 2·0×0·95, 1·85×1·05 mm. *Onopordetalia*, ch (Table 10).

Mentha cf. *arvensis* L. (Pl. VII). 32 nutlets in 12 samples. Size of 10 fruits: 0·84(0·65—0·97)×0·55(0·37—0·70) mm. *Salicion* (Table 17).

Mentha sp. 51 nutlets in 16 samples from all EM layers. Pollen of *Mentha* type in all EM layers.

Nepeta cataria L. (Pl. VII). Nine nutlets in 8 samples. Size of 7 fruits: 1·5(1·3—1·65)×1·03(0·95—2·15) mm. *Onopordetalia*, ch (Table 10).

Nepeta cf. *nuda* L. (Pl. VII). One nutlet without outer layer of pericarp. It differs from *N. cataria* in distinct ventral edge and gradually tapering apex. Size: 1·45×1·1 mm. *Festuco-Brometea* (Table 16).

Prunella vulgaris L. 42 nutlets in 13 samples. Size of 10 fruits: 1·72(1·5—2·0) ×1·04(0·9—1·25) mm. *Molinio-Arrhenatheretea*, ch (Table 14).

Salvia cf. *nemorosa* L. (Pl. VII). Eight nutlets in 4 samples. Size of 7 fruits: 1·62(1·5—1·75)×1·29(1·2—1·4) mm. *Festuco-Brometea*, ch (Table 16).

Salvia cf. *pratensis* L. (Pl. VII). Three nutlets in 2 samples. Size: 1·8×1·5, 1·5×1·3, 1·65×1·55 mm. *Festuco-Brometea*, ch (Table 16).

Salvia verticillata L. (Pl. VII). Six nutlets in 4 samples. Size of 6 fruits: 1·69(1·5—1·85)×1·07(0·85—1·25) mm. *Festuco-Brometea*, ch (Table 16).

Stachys annua L. (Pl. VII). 19 and a half nutlets in 12 samples. Size of 10 fruits: 1·83(1·65—2·0)×1·56(1·5—1·65) mm. *Centauretalia*, ch (Table 11).

Stachys palustris L. (Pl. VII). 64 nutlets in 22 samples. Size of 10 fruits: 2·15(1·9—2·4)×1·49(1·2—1·7) mm. *Molinietalia*, ch (Table 14).

Stachys recta L. (Pl. V). 26 nutlets in 3 samples. Size of 10 fruits: 2·12(1·9—2·4)×1·55(1·25—1·70) mm. *Festuco-Brometea*, ch (Table 16).

Stachys silvatica L. (Pl. VII). One nutlet. Size: 1·75×1·4 mm. *Alno-Padion*, ch (Table 17).

Stachys sp. Two nutlets in 2 samples from VIf and VIc—d. Pollen of *Stachys* type in all EM layers.

Teucrium sp. A few pollen grains in VIc—d.

Labiatae indet. 20 samples from VIg, VIf, VIe_4, VIe, VIc—d, VIc—d/VIb, Vb, pit 1, house 3, and the basket contained 86 nutlets (one charred) and 2 calyces.

Liliaceae

Allium sp. Small amount of pollen in VIg, VIe, and VIc—d.

Anthericum sp. Pollen in all EM layers. At present *A. ramosum* L. is a common species characteristic of *Festuco-Brometea*, *A. liliago* L. occurs very rarely on dry slopes. *Festuco-Brometea*, ch (Table 16).

Linaceae

Linum catharticum L. Three seeds in 3 samples. Size of 2 seeds: 1·1×0·65 and 1·1×0·65 mm. *Molinio-Arrhenatheretea* (Table 14).

Linum usitatissimum L. (Pl. VII). Eight samples contained: 24 complete seeds, 8 seed fragments, and 8 fragments of capsules. Size of 18 seeds (soaked with glycerine): 4·07(3·4—4·5)×2·42(2·1—2·75) mm. Seeds and capsules in 2 supplementary samples from VIf and VIe. A few pollen grains in VIg and VIc—d. Cultivated plant (Table 18).

Loranthaceae

Viscum sp. Scattered pollen grains in all EM layers with the exception of VIf.

Lythraceae

Lythrum cf. *salicaria* L. (Pl. VII). 81 seeds (one charred) in 15 samples. Surface of several seeds papillose. Similar papillae appear on extant seeds after short boiling with 10% KOH. On the basis of seed morphology, *L. virgatum* L.,

a rare species in Poland, is also possible. Size of 10 seeds: 0·98(0·80—1·02) ×0·50(0·42—0·57) mm. Pollen of *Lythrum* sp. in layers from VIg to VIc-d. *Molinietalia*, ch (Table 14).

Malvaceae

Lavatera thuringiaca L. (Pl. VII). Eight seeds in 7 samples, one specimen with remnants of pericarp. Seeds reniform, longer than broad, dorsal side rounded, not separated by an edge from lateral sides. Seed surface almost smooth, pericarp without ribs. They differ from similar seeds of *Althaea officinalis* L. in larger size and relatively deeper and narrower depression with hilum. Size of 7 seeds: 2·60(2·35—2·9)×2·1(1·8—2·4) mm. *Festuco-Brometea* (Table 16).

Malva alcea L. or *M. moschata* L. (Pl. VII). One seed partly charred, with broken testa, in VIc—d. Depression with hilum small and narrow, no edge between dorsal and lateral sides, seed surface smooth. Size: 2·1×1·8 mm.

Malva cf. *crispa* L. (Pl. VII). Three seeds in 2 samples. Seeds ± as broad as long. Dorsal side slightly flattened, separated by blunt edge from flat lateral sides. Surface covered with delicate wrinkles. Size: 2·35×2·35, 2·55×2·35, 2·4×2·3 mm. *Onopordetalia*, ch (Table 10).

Malva silvestris L. Five samples contained: 7 seeds, 2 mericarps with seeds, and 2 empty mericarps. Seeds relatively short and broad, often broader than long, dorsal and lateral sides flat, separated from each other by distinct edge. Surface with distinct wrinckling. Mericarps with thick, prominent net on dorsal side and sharp edge between dorsal and lateral sides, not winged. Size of 7 seeds: 1·53(1·25—2·1)×1·72(1·4—2·2) mm. *Onopordetalia*, ch (Table 10)

Menyanthaceae

Menyanthes trifoliata L. Small amount of pollen in VIg, VIc, and VIc—d. *Scheuchzerio-Caricetea*, ch (Table 5).

Oenotheraceae

Chamaenerion sp. One pollen grain in VIf.

Epilobium sp. 43 seeds in 5 samples from VIc—d, Vb, and pit 1.

Oleaceae

Fraxinus excelsior L. Small amount of pollen in VIj+i, VIg, VIc, and VIc—d. *Alno-Padion* (Table 17).

Papaveraceae

Chelidonium maius L. Two fragments of seeds in one sample from VIa. *Onopordetalia*, ch (Table 10).

Fumaria officinalis L. (Pl. VII). Four fruits in 3 samples. Fruits preserved without outer layer of pericarp, oval in outline, broader than long, similar to fruits of ssp. *officinalis* (Zając 1974). Size of 3 fruits (length × breadth): 1·9×2·3, 1·95×2·4, 2·0×2·35 mm. *Polygono-Chenopodietalia*, ch (Table 11).

Papaver rhoeas L. type (Pl. VII). Five seeds in 3 samples. The type includes *P. rhoeas*, *P. dubium* L., and *P. strigosum* (Boenn.) Schur. Size: 0·7×0·5,

0·7 × 0·55, 0·7 × 0·5, 0·8 × 0·55, 0·65 × 0·4 mm. *P. rhoeas* is a characteristic species of *Centauretalia*, *P. dubium* and *P. strigosum* may also occur as weeds. *Secali-Violetalia* (Table 11).

Papaver somniferum L. One seed, size: 1·3 × 1·05 mm. Cultivated plant (Table 18).

Papaver type. Pollen in layers from VIg to VIc—d.

Papilionaceae

Coronilla varia L. (Pl. VIII). One seed, charred. Size: 3·2 × 1·1 mm. *Festuco-Brometea* (Table 16).

Lathyrus sp. Small amount of pollen in VIe and VIc—d.

Lens esculenta Moench. (*Lens culinaris* Medicus, Pl. VIII). Three charred seeds in 2 samples. Size: 2·9 × 2·8 × 1·7, 2·5 × 2·2 × 2·0, 2·9 × 2·6 × 2·2 mm. Seed size approaches the smallest dimensions given by Barulina (1930) for *L. esculenta* Moench. var. *microsperma* (Baumg.) Barulina. Cultivated plant (Table 18).

Medicago lupulina L. (Pl. VIII). One reniform legume. Size: 2·3 × 1·1 mm. *Potentillo-Polygonetalia* (Table 10).

cf. *Pisum sativum* L. Four and a half seeds in 5 samples, charred, without testa. Diameter of 3 seeds: 4·9, 5·3, 5·0 mm. Besides, charred seeds in 2 supplementary samples from VIf together with charred cereals and in 3 samples from Va. Cultivated plant (Table 18).

Trifolium arvense L. type. Pollen in all EM layers. *Sedo-Scleranthetea*, ch (Table 16).

Trifolium pratense L. type. Pollen in layers from VIg to VIc—d. *Molinio-Arrhenatheretea*, ch (Table 14).

Trifolium cf. *repens* L. (Pl. VIII). Two seeds in 2 samples (one charred). Size: charred specimen 0·85 × 0·7 mm, uncharred specimen 1·15 × 0·8 mm. *Arrhenatheretalia*, ch (Table 14).

Vicia sp. One charred and one uncharred seeds in 2 samples from pit 1. Charred seed has diameters 2·5 × 2·3 mm, hilum short. Size of uncharred seed 2·1 × 1·8 mm, hilum long equals ±1/4 to 1/5 of seed circumference.

Vicia type. Four almost complete seeds (2 charred) and 8 charred fragments in 9 samples from VIg, VIf, VIe_4, VIc—d, pit 1, and the basket. All specimens without testa. They may belong to *Vicia*, *Pisum* or *Lens*. Pollen of *Vicia* type in layers from VIg to VIc—d.

Papilionaceae indet. Three seeds (one charred) in 3 samples from VIf, house 3, and pit 1. Pollen in layers from VIg to VIc—d.

Plantaginaceae

Plantago lanceolata L. (Pl. VII). Two seeds in 2 samples. Size 2·3 × 1·2 and 2·1 × 1·0 mm. Pollen in all EM layers. *Molinio-Arrhenatheretea*, ch (Table 14).

Plantago maior L. 14 seeds in 4 samples. Size of 10 seeds: 1·45 (1·1—1·7) × × 0·83 (0·6—1·0) mm. Pollen in all EM layers. *Potentillo-Polygonetalia*, ch (Table 10).

Plantago media L. Pollen in all EM layers except for VIf. *Festuco-Brometea*, ch (Table 16).

Plantago pauciflora Gilib. (*P. major* L. subsp. *intermedia* (DC) Arcangeli). One pollen grain in VIe/VIe$_4$. *Isoëto-Nanojuncetea*, ch. (Table 5).

Polygalaceae

Polygala sp. A few pollen grains in VIg and VIe.

Polygonaceae

Fagopyrum sp. Seven pollen grains in VIc—d. Cultivated plant (Table 18).

Polygonum aviculare L. 160 fruits in 22 samples. Size of 20 fruits: 2·46 (1·9—3·4) × 1·40 (0·9—2·1) mm. Pollen in all EM layers. *Potentillo-Polygonetalia*, ch (Table 10).

Polygonum cf. *bistorta* L. Scattered pollen grains in all EM layers. *Molinietalia*, ch (Table 14).

Polygonum convolvulus L. (*Bilderdykia convolvulus* (L.) Dumort). 546 complete and 45 fragments of fruits (7 fruits charred) in 35 samples. A few specimens with perianth. 19 trigonous seeds (2 charred) probably belong also to this species. Size of 20 fruits: 3·30 (3·1—4·0) × 2·2 (1·8—2·6) mm. Pollen in VIe and VIc—d. *Secali-Violetalia*, ch (Table 11).

Polygonum dumetorum L. (*Bilderdykia dumetorum* (L.) Dumort). One fruit with lustrous surface. Size: 3·9 × 2·1 mm. Characteristic species of *Convolvuletalia sepium*, here included in *Salicion*, where it may have grown on natural habitats (Table 17).

Polygonum hydropiper L. Seven fruits with reticulate sculpture in 4 samples. Size of one fruit: 3·0 × 1·6 mm. *Bidentetalia*, ch (Table 5).

Polygonum minus Huds. One fruit, size: 1·9 × 1·4 mm. *Polygono-Chenopodietalia*, ch (Table 11).

Polygonum lapathifolium L. s. l. 48 complete fruits and 26 halves in 13 samples. They may belong to *P. nodosum* or *P. tomentosum*. *Rudero-Secalietea*, ch (Table 11).

Polygonum nodosum Pers. 25 complete and 13 halves of fruits in 6 samples. Size of 10 fruits: 2·13 (1·75—2·50) × 1·68 (1·35—1·85) mm. *Bidentetalia*, ch (Table 5).

Polygonum persicaria L. 392 complete fruits (2 charred) and 20 halves in 26 samples. Four fruits trigonous, others lenticular. Size of 35 fruits: 2·45 (2·1—2·8) × 1·85 (1·4—2·0) mm. Pollen in all EM layers. *Rudero-Secalietea*, ch (Table 11).

Polygonum tomentosum Schrk. 32 complete and 8 halves of fruits in 12 samples. Size of 10 fruits: 2·21 (1·95—2·35) × 2·01 (1·85—2·25) mm. *Polygono-Chenopodietalia*, ch (Table 11).

Polygonum sp. 24 samples contained: 69 complete (one charred) and 31 halves of lenticular fruits, 5 trigonous fruits, and 11 trigonous seeds. In all EM and LM layers with the exception of VIj.

Rumex acetosa L. Pollen in all EM layers. *Molinio-Arrhenatheretea*, ch (Table 14).

Rumex acetosella L. type. Pollen in all EM layers. It may represent *R. tenuifolius* (Wallr.) A. Löve. *Sedo-Scleranthetea*, ch (Table 16).

Rumex crispus L. 20 fruits and 17 perianths (some with fruits) in 12 samples. Size of 10 fruits: 1·94(1·7—2·25)×1·22(1·05—1·35) mm. Scattered pollen grains in VIe/VIc—d and VIc—d. Characteristic species of *Potentillo-Polygonetalia (Agropyro-Rumicion crispi)*, here included in *Molinio-Arrhenatheretea* (Table 14) on the basis of the occurrence of its fruits in the diagram (Fig. 8).

Rumex cf. *maritimus* L. (Pl. VII). One fruit, spindle-shaped in outline, edges sharp. Similar fruits of *R. paluster* Sm. are pear-shaped (Marek 1954). Size 1·25×0·65 mm. *Bidentetalia*, ch (Table 5).

Rumex obtusifolius L. 37 fruits and 5 perianths in 13 samples. Size of one perianth: approximate length and breadth of valves 2·8×2·0, 2·4×2·1, and 2·9×2·0 mm, length and breadth of tubercles 1·8×0·8, 1·4×0·4, and 1·6×0·8 mm. Size of 10 fruits: 2·42(2·2—2·8)×1·41(1·1—1·6) mm. *Onopordetalia*, ch (Table 10).

Rumex tenuifolius (Wallr.) A. Löve. 115 fruits (one charred) in 28 samples. Size of 100 fruits: 0·96(0·65—1·2)×0·74(0·60—0·95) mm (Fig. 7). According to Rechinger (1964) the length of extant fruits of *R. acetosella* L. s. str. is 1·3—1·5 mm and of *R. tenuifolius* 0·9—1·3 mm. Today *R. tenuifolius* is very

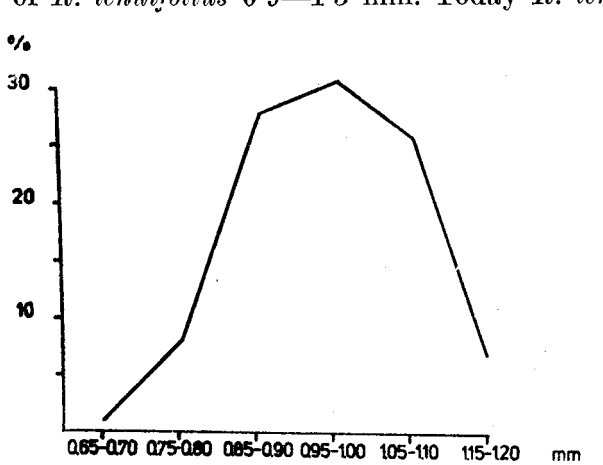

Fig. 7. Length of the early medieval fruits of *Rumex tenuifolius* from the Wawel Hill
Ryc. 7. Długość wczesnośredniowiecznych owocków *Rumex tenuifolius* ze Wzgórza Wawelskiego

seldom found in the surroundings of Cracow, in the opinion of H. Trzcińska-Tacik based on the review of herbarium material (oral information). In subfossil materials from Poland the species was not distinguished from *R. acetosella* L., which was described from 17 archaeological sites (2 from Hallstatt, one from Roman, and 14 from early medieval times). The length of fruits is given only for a few specimens from 4 localities: 0·8—1·05 mm (4 fruits from

Hallstatt time, Biskupin, Jaroń 1938), 0·95 mm (one fruit from early Roman time, Wąsosz Górny, Orlicz 1967), 1·2 mm (one fruit from 8th century A.D., Gniezno, Jaroń 1939), 0·8 mm (a few fruits from the 10th century A.D., Poznań, Moldenhawer 1939). All these dimensions point to the presence of *R. tenuifolius*. Larger fruits were found by Wieserowa (in print) in EM and LM layers (12/13th to 14th century) from the Main Market Square in Cracow. Their length 0·8—1·4 mm (100 measurements) indicates that probably both species were present and *R. tenuifolius* predominated.

R. tenuifolius was described by Knörzer (1970) from Roman sites near Neuss and at that time — in his opinion — the species must have been more common in this area than today. *Sedo-Scleranthetea*, ch (Table 16).

Rumex sp. Seven fruits in 3 samples from VIg, VIe, and pit 1.

Potamogetonaceae

Potamogeton sp. Scattered pollen grains in all EM layers with the exception of VIc—d. *Potametea* (Table 5).

Primulaceae

Anagallis sp. 12 seeds in 8 samples. Size of 10 seeds: 1·12(1·0—1·25)× ×0·82(1·25—1·4) mm. Both species occurring in Poland, *A. arvensis* L. and *A. coerulea* Schreb., are field weeds, *A. arvensis* is a characteristic species of *Secali-Violetalia* (Table 11).

Lysimachia vulgaris L. Four seeds in 3 samples. Size: 1·0×0·6, 1·4×1·15, 1·2×0·85, 1·3×0·9 mm. Pollen of *Lysimachia sp.* in VIg, VIe_4/VIe, and VIc—d. *Molinietalia*, ch (Table 14).

Primula sp. (Pl. VII). Four seeds (one charred) in 4 samples from VIe_4, VIc—d, and pit 1. Size: 1·45×1·2, 1·35×1·2, 1·2×1·0, 1·3×0·8 mm.

Primulaceae indet. One charred seed in pit 1. Size: 1·2×0·95 mm.

Ranunculaceae

Batrachium sp. One achene. Pollen in VIg and VIe. *Potametea* (Table 5).

Caltha palustris L. s. l. Two seeds in 2 samples. Size of one seed: 2·35× ×1·05 mm. Pollen of *Caltha* type in VIg and VIe_4. *Molinietalia*, ch (Table 14).

Consolida regalis S. F. Gray. Pollen grains in VIj+i and VIg. *Centauretalia*, ch (Table 11).

Nigella arvensis L. Scattered pollen grains in VIg, VIe, and VIc—d. *Centauretalia*, ch (Table 11).

Nigella sativa L. Scattered pollen grains in VIe and VIc—d. Cultivated plant (Table 18).

Ranunculus acer L. 45 complete and one half of achene in 12 samples. Size of 10 specimens: 1·87(1·45—2·1)×1·50(1·15—1·8) mm. *Molinio-Arrhenatheretea*, ch (Table 14).

Ranunculus arvensis L. Scattered pollen grains in all EM layers, except for VIj+i. *Centauretalia*, ch (Table 11).

Ranunculus flammula L. Four achenes in 2 samples. Size: 1·4×1·1, 1·3×1·1, 1·1×0·7, 1·45×0·95 mm. *Scheuchzerio-Caricetea*, ch (Table 5).

Ranunculus repens L. 281 complete and 4 halves of achenes in 18 samples. Size of 20 fruits: 2·35(1·9—2·7)×1·82(1·4—2·2) mm. *Molinietalia* (Table 14).

Ranunculus sceleratus L. 94 complete and 26 halves of achenes in 10 samples. Size of 10 fruits: 1·02(0·85—1·2)×0·89(0·7—1·05) mm. *Bidentetalia*, ch (Table 5).

Ranunculus sp. 26 complete and one half of achenes in 8 samples from VIf, VIe_4, VIe, VIc—d, pit 1, and the basket. Pollen in all EM layers.

Thalictrum flavum L. type (Pl. VIII). 15 achenes in 10 samples. Fruits narrow-oval with tapering both ends to broad-oval with shortly rounded ends. Cross-section circular or slightly flattened. Ribs thick and blunt or thin and ± sharp. Size of 14 fruits: 1·81(1·0—2·35)×1·15(0·9—1·6) mm. Similar fruits were described by other authors as *T. flavum* (see Jaroń 1939 — two types of fruits, Knörzer 1970; Wieserowa, in print). However, in the reference material, extant fruits of *T. flavum* (5 collections), *T. lucidum* (2 collections), and *T. simplex* (3 collections) show such great variation in size, outline, and shape of ribs, that in some cases the determination of species on the basis of fruit morphology may be uncertain. This difficulty concerns in particular the short and broad fruit type. Most of subfossil fruits from the Wawel certainly belong to *T. flavum* (narrower fruits) but some of them may also belong to the two other species. *Molinietalia*, ch (Table 14).

Thalictrum cf. *lucidum* L. (Pl. VIII). 23 achenes in 3 samples. Outline narrow-oval, cross-section usually slightly flattened (lateral ribs more pronounced than the others), sometimes circular. They differ from narrow-oval fruits of *T. flavum* in narrowing more gradually towards both ends and in the shape of the ribs. Fruits of *T. simplex* are usually broader. Size of 12 fruits: 2·02(1·6—2·4)×1·04(0·8—1·2) mm. *Molinietalia*, ch (Table 14).

Thalictrum minus L. (Pl. VIII). One achene. Fruit broad-ovate, slightly flattened, with 14 ribs of which two lateral are distinctly larger than the others. Size: 2·5×1·4 mm. *Festuco-Brometea*, ch (Table 16).

Thalictrum sp. Two and a half achenes in one sample from pit 1, unripe. Size: 2·5×1·15 and 2·7×1·05 mm. Pollen in all EM layers.

Rhamnaceae

Frangula alnus Mill. (Pl. VIII). One fruit-stone 3·8 mm long and 3·8 mm broad. Pollen in all EM layers except for VIc—d. Various forests (Table 17).

Rosaceae

Agrimonia cf. *eupatoria* L. One hypanthium preserved without bristles, obconical, with ± flat apex. Pollen of *A.* sp. in VIg and VIe_4. *Festuco-Brometea*, ch (Table 16).

Aphanes arvensis L. One achene. Size: 1·25×0·9 mm. *Centauretalia*, ch (Table 11).

Cerasus avium (L.) Moench. or *C. vulgaris* Mill. (*Prunus avium* L. or *P. cerasus* L.). Two fruit-stones in random sample from VIe and in the basket. 116 fruit-stones in 6 samples from Va, which contained only stones of edible fruits. Size of 20 specimens: 7·56(6·7—8·3)×6·30(5·3—7·1) mm. *C. avium*

is a native species characteristic of *Carpinion*, *C. vulgaris* is a cultivated plant of Asiatic origin. *Carpinion* (Table 17).

Cerasus fruticosa (Pall.) Woronow (*Prunus fruticosa* Pallas). 117 fruit-stones in 7 samples from Va. The samples contained only fruits of edible plants. Size of 20 specimens: 6·09(5·5—6·8) × 5·25(4·5—6·4) mm. *Querco-Fagetea*, ch (Table 17).

Cerasus type. Pollen in all EM layers, maximum of 28% of AP in VIj+i and of 7% in VIc—d. *Carpinion* (Table 17).

Comarum palustre L. (*Potentilla palustris* (L.) Scop.). Small amount of pollen in VIe and VIc—d. *Scheuchzerio-Caricetea*, ch (Table 5).

Filipendula ulmaria (L.) Maxim. (Pl. VIII). 14 achenes and 2 seeds in 9 samples. Size of 6 fruits: 2·21(1·7—2·7) × 0·85(0·65—1·1) mm. Size of seeds: 1·5 × 0·5 and 1·8 × 0·7 mm. Pollen of *F.* sp. in all EM layers. *Molinietalia*, ch (Table 14).

Fragaria vesca L. (Pl. VIII). 24 achenes in 11 samples. Size of 10 fruits: 1·20(1·1—1·3) × 0·84(0·75—0·95) mm. *Atropetalia*, ch (Table 17).

Fragaria viridis Duch. (Pl. VIII). 24 achenes in 15 samples. Fruits broader in relation to their length than in *F. vesca*. Outline often in the shape of an inverse trapezium. Beak indistinct, straight or slightly bent, usually towards ventral, seldom towards dorsal side. Surface smooth or with delicate venation. Many fruits crumpled. Size of 10 fruits: 1·29(1·1—1·45) × 0·98(0·9—1·05) mm. *Festuco-Brometea* (Table 16).

Fragaria sp. 85 achenes in 21 samples from VIg, VIf, VIe_4, VIe, VIc—d, pit 1, and the basket.

Malus sp. 14 complete seeds and 8 fragments in 14 soil samples. 10 seeds in 3 samples from Va composed only of the remnants of edible plants. Surface of testa covered with dense but delicate longitudinal striation. Size of 9 seeds: 6·18(5·2—7·6) × 3·55(1·8—4·6) mm. *M. domestica* Borb. is known only as a cultivated plant, *M. silvestris* (L.) Mill. is native to Poland and occurs in deciduous forests. *Carpinion* (Table 17).

Malus sp. or *Pirus communis* L. One damaged seed. *Carpinion* (Table 17).

Padus avium Mill. (*Prunus padus* L.). Two complete and two halves of fruit-stones in 2 samples. Size: complete specimens 5·4 × 4·4 × 4·0 and 5·9 × × 4·7 × 4·0 mm, one half 4·2 × 2·8 mm. *Alno-Padion*, ch. (Table 17).

Pirus communis L. 20 complete seeds and 4 fragments in 8 samples. Surface of testa covered with polygonal cells (140 × magnification). Below them a layer with striation similar to the outer layer of *Malus* seeds. Size of 9 seeds: 5·70(4·7—7·3) × 2·93(2·1—4·4) mm. *Carpinion* (Table 17).

Potentilla anserina L. (Pl. VIII). One achene, size: 1·7 × 1·2 mm. *Potentillo-Polygonetalia*, ch (Table 10).

Potentilla argentea L. Nine achenes in 2 samples. Slightly more elongated than those of *P. norvegica*. Ridges on lateral sides ± parallel to the dorsal side. Size of 9 fruits: 0·69(0·62—0·82) × 0·48(0·45—0·55) mm. *Sedo-Scleranthetea*, ch (Table 16).

Potentilla argentea L. or *P. norvegica* L. 97 achenes in 15 samples from all EM layers except for VIj. Surface smooth, without ridges. Unripe fruits of other *Potentilla* species may have similar shape.

Potentilla erecta (L.) Räusch. 42 complete and 2 halves of achenes in 17 samples. Size of 10 fruits: 1·39(1·15—1·55) × 0·87(0·67—1·0) mm. *Nardo-Callunetea* (Table 16).

Potentilla norvegica L. Three achenes in one sample. Size 0·85 × 0·67, 0·80 × × 0·57, 0·92 × 0·75 mm. (For description see Wieserowa, in print). *Bidentetalia* (Table 5).

Potentilla recta L. (Pl. VIII). Three achenes in 2 samples. Outline obliquely ovate with flattening on ventral side. The narrower end of fruit has a beak. Delicate ridges on the surface, narrow wing along the dorsal side. Size: 1·20 × 0·90, 1·22 × 0·92, 1·25 × 0·95 mm. *Festuco-Brometea* (Table 16).

Potentilla reptans L. (Pl. VIII). 30 complete and 5 halves of achenes in 11 samples. Ventral side almost straight, dorsal side convex. On lateral sides sparsely distributed ridges and thick warts. Characteristic large epidermal cells visible on fossil fruits. Size of 10 fruits: 1·10(0·95—1·2) × 0·74(0·67—0·85) mm. *Potentillo-Polygonetalia*, ch (Table 10).

Potentilla supina L. (Pl. VIII). Seven fruits in 3 samples. Fruits ± as long as broad, outline rounded-triangular, beak lacking, attachement scar in the form of relatively large circular depression. Lateral sides with thick ridges Size of 7 fruits: 0·71(0·6—0·8) × 0·60(0·52—0·65) mm. *Isoëto-Nanojuncetea* ch (Table 5).

Potentilla sp. 137 complete fruits and 4 halves in 29 samples from all EM and LM layers. Pollen in all EM layers.

Prunus domestica L. (*P. domestica* L. subsp. *domestica*). Two complete fruit-stones and one fragment in 3 samples. Size: 21·0 × 10·0 and 19·0 × 10·0 mm. Cultivated plant (Table 18).

Prunus insititia Juslen (*P. domestica* L. subsp. *insititia* (L.) C. K. Schneider). 27 fruit-stones in 7 samples from Va. Size of 10 fruit-stones: 13·70(12·20—17·60) × 9·53(7·35—12·50) × 6·28(5·00—8·15) mm. Cultivated plant (Table 18).

Prunus persica Batsch. Four additional samples from VIf contained 4 halves of fruit-stones. Size of 2 specimens: 27·0 × 23·0 and 25·0 × 21·0 mm. Cultivated plant (Table 18).

Prunus spinosa L. 48 complete and 9 halves of fruit-stones in 12 samples. Most of these specimens found in 6 samples from Va containing only remains of edible fruits. One specimen with remnants of fleshy pericarp. Outline of fruit-stones oval to circular. Size of 10 stones: 8·81(6·95—10·25) × 6·98(6·25—7·70) × 5·32(4·65—5·85) mm, length/breadth ratio 1·28(1·1—1·6). *Querco-Fagetea*, ch (Table 17).

Prunus sp. One complete fruit-stone with fleshy pericarp and 16 fragments of fruit-stones (one charred) in 10 samples from VIi, VIg, VIe, VIc—d, and VIa. Eleven pollen grains in one sample from VIc—d. Small fragments of *Prunus* or *Cerasus* fruit-stones in 4 samples from Va.

Rubus caesius L. 18 fruit-stones in 14 samples. Size of 13 specimens: 3·15(2·1—4·3)×1·82(1·3—2·1) mm. *Salicion*, ch (Table 17).

Rubus idaeus L. 158 complete fruit-stones and 20 halves in 35 samples. Size of 14 specimens: 2·17(1·8—2·4)×1·26(1·1—1·5) mm. *Atropetalia*, ch (Table 17).

Rubus plicatus W. et N. type. Two fruit-stones in 2 samples. Size: 2·65×1·85 and 2·50×1·6 mm. The type, often described as *R. fruticosus* L., may include different species from the section *Rubus*, with the exception of *R. caesius*. *Atropetalia* (Table 17).

Rubus sp. Five complete fruit-stones and one half in 6 samples from VIg, VIe, VIc—d, and pit 1. Pollen in layers from VIg to VIc—d. *Atropetalia* (Table 17).

Sanguisorba officinalis L. Pollen in all EM layers with the exception of VIe_4. *Molinietalia*, ch (Table 14).

Sorbus sp. Few pollen grains in VIe and VIc—d. Various forests (Table 17).

Rubiaceae

cf. *Asperula cynanchica* L. (Pl. VIII). Two mericarps in 2 samples. Dorsal outline narrow-oval with slightly flattened ends, lateral outline reniform. Longitudinal depression on ventral side. Surface covered with small warts. Size: 1·35×0·85 and 1·2×0·9 mm. *Galium saxatile* L. has verrucose fruits of similar size but with distinct ridges on the dorsal side. Other possibilities were not checked. *Festuco-Brometea*, ch (Table 16).

Galium aparine L. 12 mericarps (one charred) in 7 samples. Only one fruit with the outer layer of the pericarp on which rounded bases of broken bristles are preserved. Other specimens with rows of transversally elongated cells on the surface (Szydłowski & Wasylikowa 1973). Size of charred fruit: 2·0×1·8 mm. The species may have had its natural habitats in the communities of *Alno-Padion* (Trzcińska-Tacik & Wieserowa 1976). Here included in field weeds because it was often found in samples of charred cereals from prehistoric sites and its fruit curve from the Wawel is similar to the curve for weeds. *Secali-Violetalia* (Table 11).

Galium elongatum Presl. Four mericarps in 4 samples. Outer layer of pericarp lacking. On ventral side, large depression transversally elongated and constricted in the middle. Size of 2 fruits: 1·6×? and 1·6×1·4 mm. Similar fruits of *G. palustre* are smaller. *Phragmitetalia*, ch (Table 5).

Galium cf. *mollugo* L. Four mericarps (one charred) in 3 samples. Size, 1·0×0·9, 1·05×0·95, 0·75×0·6, 0·75×0·55 mm. *Arrhenatheretalia* (Table 14).

Galium palustre L. Four mericarps in 2 samples. The same shape as *G elongatum* but smaller dimensions. Size of 2 fruits: 1·15×1·0 and 1·2×1·1 mm. *Phragmitetalia*, ch (Table 5).

Galium cf. *silvaticum* L. (Pl. VIII). Four mericarps with complete pericarp in 2 samples. Dorsal outline circular, ventral depression irregular, surface lustrous, covered with shallow wrinkles. Fruits identical with extant specimens

of this species, but other possibilities were not checked. Size of 2 fruits: 1·25 × 1·3 and 1·2 × 1·15 mm. At present *G. silvaticum* grows only in western Poland and does not occur in the surroundings of Cracow (Kucowa 1967). *Carpinion*, ch (Table 17).

Galium spurium L. 17 samples contained: uncharred — 28 and a half mericarps with complete seeds preserved, 56 empty pericarps; charred — 21 and a half mericarps. Size of 20 charred fruits: 1·67(1·3—2·3) × 1·40(1·1—1·7) mm. Size of 10 uncharred fruits: 1·54(1·4—1·6) × 1·32(1·15—1·45) mm. Average size of all 30 fruits 1·63 × 1·37 mm. *Centauretalia*, ch (Table 11).

Galium spurium L. or *G. tricorne* Stok. 41 empty pericarps in 10 samples. All specimens crumpled. Isodiametric cells on the surface. *Centauretalia*, ch (Table 11).

Galium tricorne Stok. (*G. tricornutum* Dandy). Eight samples contained: 13 uncharred empty pericarps, 16 complete and 4 fragments of charred mericarps. All specimens without outer verrucose layer of pericarp. Charred fruits almost globular, with circular depression on ventral side and isodiametric cells visible on the surface of 7 specimens. Identification of only these 7 mericarps is certain. Uncharred fruits show similar cell pattern which, however, can be found in extant fruits of *G. tricorne* and *G. spurium*. All pericarps are crumpled and their original shape is not recognizable but their size is nearer to that of *G. tricorne* than to *G. spurium*. Greatest diameter of 16 charred fruits: 2·34(2·15—2·7) mm. *Centauretalia*, ch (Table 11).

Galium uliginosum L. (Pl. VIII). Two mericarps in 2 samples. Fruits preserved with complete pericarp. Dorsal outline oval with rounded ends, lateral outline reniform. Ventral depression elongated. Surface verrucose. Size: 0·8 × 0·6 and 0·9 × 0·6 mm. *Scheuchzerio-Caricetea* (Table 5).

Galium sp. 27 and a half charred and 10 uncharred mericarps in 16 samples from VIf, VIe$_4$, VIc—d, VIb, pit 1, house 3, and the basket.

Rubiaceae indet. Pollen in all EM layers.

Salicaceae

Populus sp. Small amount of pollen in all EM layers, with a maximum of 1·7% of AP in VIj+i. One lath probably made of *Populus* wood. Various forests (Table 17).

Salix sp. 10 bud scales in 9 samples. Two wooden posts. Pollen in all EM layers in great amount, from 1·5 to 37% of AP, with two maxima in VIg and VIe. *Salicion* (Table 17).

Santalaceae

Thesium sp. Eight pollen grains in one sample from VIc—d.

Saxifragaceae

Parnassia palustris L. Two pollen grains in one sample. *Scheuchzerio-Caricetea*, ch (Table 5).

Ribes sp. One pollen grain. Various forests (Table 17).

Scrophulariaceae

Alectorolophus sp. One seed in pit 1 with only partly preserved epidermis. Scattered pollen grains in all EM layers.

Linaria vulgaris (L.) Mill. Seven seeds in 6 samples. Size of 4 seeds: 2·2 × 1·5, 2·0 × 1·6, 1·9 × 1·6, 1·9 × 1·55 mm. *Onopordetalia*, ch (Table 10).

Melampyrum sp. Scattered pollen grains in all EM layers.

cf. *Odontites* sp. One seed in VIj. Seed narrow-fusiform, tapering at both ends. Surface covered with 13 longitudinal ribs and transversal short striae. Striae and fields between them whitish-yellow. Size: 1·4 × 0·4 mm. Seed very narrow compared with extant material.

Pedicularis palustris L. (Pl. IX). One seed, 3·15 × 1·85 mm. *Scheuchzerio-Caricetea*, ch (Table 5).

Scrophularia alata Gilib. or *S. nodosa* L. Four seeds in 4 samples from VIi, VIf, and pit 1. Size: 0·7 × 0·45, 0·8 × 0·55, 0·7 × 0·4, 0·7 × 0·45 mm. Scattered pollen grains of *Scrophularia* sp. in VIg, VIe_4, VIe, and VIc—d.

Verbascum cf. *nigrum* L. (Pl. IX). One sample contained 3 complete capsules and 3 fragments, with seeds. Identification uncertain because capsules are deformed and probably not quite ripe. Best preserved specimen is broadly oval, with the rest of pedicel at the base and a style at the apex. All capsules have stellate hairs. Length and breadth of capsules: 4·2 × 3·4, 4·0 × 3·2, 2·0 × ×1·6 mm. Size of 8 seeds from capsules: 0·82 (0·55—1·3) × 0·52 (0·35—0·8) mm. Several seeds unripe. In our species having capsules covered with stellate hairs, capsules of *V. thapsus* L., *V. phlomoides* L., and *V. thapsiforme* Schrad. are distinctly larger, those of *V. lychnitis* L. relatively narrower. *Festuco-Brometea* (Table 16).

Verbascum sp. Two seeds in 2 samples from VIe_4 and VIe. Size: 0·6 × 0·5 and 1·05 × 0·6 mm.

Veronica chamaedrys L. type. Six seeds in 3 samples from VIe and pit 1. Size of 5 seeds: 1·2 × 1·1, 1·2 × 0·8, 1·35 × 1·1, 1·2 × 0·85, 1·2 × 0·9 mm. The type includes *V. chamaedrys*, *V. teucrium* L., and *V. prostrata* L. (Kulpa 1968).

Veronica sp. Nine seeds in 4 samples from pit 1 and Va. A few pollen grains in 2 samples from VIf and VIc—d.

Solanaceae

Hyoscyamus niger L. 192 seeds (one charred) in 23 samples. Size of 10 seeds: 1·39 (1·3—1·55) × 1·29 (1·2—1·5) mm. *Onopordetalia*, ch (Table 10).

Solanum nigrum L. 257 complete seeds and 12 fragments in 29 samples. Size of 10 seeds: 1·93 (1·7—2·1) × 1·44 (1·2—1·7) mm. Characteristic species of the suborder *Polygono-Chenopodietalia*, here included in *Onopordetalia* (Table 10) on the basis of the occurrence in macrofossil diagram (Fig. 9).

Sparganiaceae

Sparganium ramosum Huds. (Pl. VIII). Eight fruits in 2 samples. Size of 4 fruits (with broken one end): 5·15 × 2·6, 5·7 × 2·5, 4·8 × 2·35, 6·4 × 4·2 mm.

Size of 3 fruit-stones: 4·1 × 2·2, 3·6 × 1·9, 3·6 × 2·1 mm. *Phragmitetalia*, ch (Table 5).

Tiliaceae

Tilia cordata Mill. Pollen in all EM layers, 3 — 26% of AP, with two maxima in VIe and VIc—d. *Carpinion*, ch (Table 17).

Tilia platyphyllos Scop. Small amount of pollen (maximum 1·5% of AP) in VIj+i, VIe_4, VIe, and VIc—d. *Carpinion* (Table 17).

Tilia sp. Basket made of lime bark. *Carpinion* (Table 17).

Typhaceae

Typha angustifolia L. or *Sparganium* sp. Small amount of pollen in all EM layers. *Phragmitetalia* (Table 5).

Typha latifolia L. (Pl. IX). Small amount of pollen in all EM layers. One sample from pit 1 (no. 21d) contained clusters of fruits (over 5000 fruits) representing probably the remnants of whole spikes. Fruits on very long stipes with long styles and lance-ovate stigmas. The shape of stigma differentiates *T. latifolia* from *T. angustifolia* (Hegi 1965). Pericarp very delicate and transparent, operculate seeds are visible. In tables and diagrams seeds of *T. latifolia* were classed together with seeds of *Typha* sp. *Phragmitetalia*, ch (Table 5).

Typha sp. 35 samples contained great number of uncharred seeds. An accumulation of over 5000 specimens was found in sample 4/70 and a total sum of 2100 seeds in the remaining 34 samples. A few charred seeds were scattered among uncharred ones. All seeds may belong to *T. latifolia*, but the determination of species on the basis of seed morphology is not possible. In tables and diagrams all macrofossils of *Typha* were groupped together as *Typha* sp. Size of 20 uncharred seeds: 1·11(0·95—1·2) × 0·27(0·2—0·35) mm. *Phragmitetalia*, ch (Table 5).

Ulmaceae

Ulmus sp. Wood in 5 supplementary samples from VIe and VIc—d. Small amount of pollen in all EM layers (less than 1% of AP). *Alno-Padion* (Table 17).

Umbelliferae

Angelica silvestris L. (Pl. IX). Three mericarps in 2 samples. Outline narrow or broad-oval, on dorsal side 3 pronounced unwinged ribs, lateral ribs broadly winged. Size: 4·9 × 2·8, 3·4 × 2·9, 3·3 × 1·5 mm. *Molinietalia*, ch (Table 14).

Astrantia maior L. (Pl. IX). Six mericarps in 2 samples. Size of 6 fruits: 4·48(3·8—5·3) × 1·73(1·5—2·1) mm. *Carpinion* (Table 17).

Bupleurum rotundifolium L. 12 mericarps in 3 samples. Size of 10 fruits: 3·03(2·7—3·4) × 1·47(1·2—1·6) mm. Scattered pollen grains of *Bupleurum* sp. in VIe_4, VIe, and VIc—d. *Centauretalia*, ch (Table 17).

cf. *Carum carvi* L. (Pl. IX). Two mericarps in one sample. Fruits mineralized, without outer layer of pericarp. Size: 2·6 × 1·15 and 2·75 × 2·05 mm. *Arrhenatheretalia*, ch (Table 14).

Caucalis daucoides L. (*C. platycarpos* L., Pl. IX). One fragment of mericarp in a supplementary sample from VIf. Only two thick secondary ribs preserved, with broad bases of spines. Spines and fruit apex broken. The length of the fragment is 7·7 mm. The sample contained large amount of uncharred millet and charred grains of *Triticum aestivum* and *Secale cereale*. *Centauretalia*, ch (Table 11).

Chaerophyllum aromaticum L. (Pl. IX). Two mericarps in 2 samples. Fruits oblong, lower end rounded, apex narrowed, on dorsal side 5 blunt primary ribs, on ventral side remnants of carpophore preserved. Fossil specimens are longer than fruits of *C. bulbosum* L. and *C. temulum* L. and broader than those of *C. hirsutum* L. (Kowal & Latowski 1973). Size of one fruit: 9·0 × 2·7 mm. *Alno-Padion* (Table 17).

Cicuta virosa L. (Pl. IX). One mericarp, size: 2·3 × 1·55 mm. *Scheuchzerio-Caricetea* (Table 5).

Conium maculatum L. (Pl. IX). Five mericarps in 3 samples. All specimens without outer layer of pericarp. On dorsal side traces of 5 ribs, surface between ribs covered with thin longitudinal slightly sinuous wrinkles and very delicate transversal striae. Size: 3·2 × 1·5, 2·0 × 1·1, 2·5 × 1·45 mm. *Onopordetalia*, ch (Table 10).

Daucus carota L. Nine mericarps in 6 samples. Spines not preserved, ribs partly broken. Size of 9 fruits: 2·01 (1·75—2·75) × 1·30 (1·05—1·8) mm. *Arrhenatheretalia*, ch (Table 14).

Pastinaca cf. *sativa* L. (Pl. IX). One mericarp. Marginal wings damaged. Two vittae on ventral side reach ±3/4 of the fruit length, 4 vittae on dorsal side near the fruit base. At the apex, marginal nerves almost perpendicular to the longitudinal fruit axis, while in similar fruits of *Peucedanum cervaria* (L.) Lap. they meet at an acute angle. Size of shrunken mericarp: 3·2 × 2·3 mm. Identification uncertain because fruits of *Pastinaca opaca* Bernh. are very similar. *Arrhenatheretalia*, ch (Table 14).

Pimpinella cf. *maior* (L.) Huds. (Pl. IX). 11 mericarps in 5 samples. Fruits oval. Five dorsal filiform ribs, two of them shifted to the ventral side. On dorsal side vittae in groups of three between ribs, on ventral side 2 vittae in each comissural half. Size of 10 shrunken fruits: 2·07 (1·8—2·4) × 1·10 (0·9—1·3) mm. Identification uncertain because fruits of *P. maior* and *P. saxifraga* are very much alike. As a rule, fruits of *P. saxifraga* are smaller (less than 2·5 mm long, while those of *P. maior* are more than 2·5 mm long), distinctly ovate or pyriform. But these characters are often poorly visible in damaged fossil specimens. *P. anisum* L. has larger fruits with broader ventral side. Slightly similar in shape, fruits of *Berula erecta* (Huds.) Coville, *Petroselinum sativum* Hoffm., and *Apium graveolens* L. differ in the distribution of vittae (Klan 1947). *Arrhenatheretalia*, ch (Table 14).

Pimpinella cf. *saxifraga* L. (Pl. IX). One pyriform mericarp. Vittae as in *P. maior*. Size 1·7 × 1·15 mm. *Festuco-Brometea*, ch (Table 16).

Torilis japonica (Houtt.) DC. (Pl. IX). Three mericarps in 3 samples. Short

spines curved upwards preserved on the dorsal side of one specimen. Size of 2 fruits: 2·45×1·50 and 2·50×1·4 mm. *Atropetalia*, ch (Table 17).

Umbelliferae indet. 37 damaged mericarps in 16 samples from VIj, VIg, VIf, VIe, VIc—d, and Vb. Pollen in all EM layers.

Urticaceae

Urtica dioica L. 1693 fruits (4 charred) in 35 samples. Size of 35 fruits: 1·10(0·9—1·3)×0·76(0·6—0·9) mm. Pollen in all EM layers. *Onopordetalia* (Table 10).

Urtica urens L. 55 complete fruits and one half in 13 samples. Size of 10 fruits: 1·62(1·35—1·75)×1·12(0·85—1·3) mm. Pollen in all EM layers. *Onopordetalia*, ch (Table 10).

Valerianaceae

Valeriana sp. 48 complete fruits (one charred) and one half in 13 samples from VIg, VIe, pit 1, and the basket. Pollen in VIg, VIf, VIe_4, VIe, and VIc—d.

Valerianella dentata (L.) Poll. One fruit. Size: 1·8×1·2 mm. *Centauretalia*, ch (Table 11).

Verbenaceae

Verbena officinalis L. 14 nutlets in 8 samples. Size of 10 fruits: 1·65(1·45—1·9)×0·59(0·5—0·7) mm. *Onopordetalia*, ch (Table 10).

Violaceae

Viola arvensis Murr. or *V. tricolor* L. 14 samples contained: 19 complete seeds, one half of a seed, and one valve of a capsule. Size of 17 seeds: 1·38(1·15—1·7)×0·79(0·6—1·0) mm. Length of capsule valve about 3·2 mm (one end broken). *Secali-Violetalia*, ch (Table 11).

Viola canina Rchb. type. Seven samples from VIe, VIe/VIc—d, and pit 1 contained: 5 complete and 3 halves of seeds, one capsule valve. Seeds larger than those of *V. arvensis* and *V. tricolor*. They differ from seeds of *V. silvestris* Rchb. (Wieserowa, in print) in greater breadth compared with their length. Many other species have a similar shape. Size of 4 seeds: 1·9×1·2, 1·7×1·1, 1·55×1·15, 1·75×1·15 mm. Length of capsule valve 7·7 mm.

Viola sp. One pollen grain in VIj+i.

Vitaceae

Vitis vinifera L. Six seeds in 5 samples: one sample from VIf (9—10th century) and 4 from Va (15th century). Basal beak relatively narrow, gradually passes into broader upper part. This shape is more common in the wild form *V. vinifera* L. subsp. *sylvestris* (C. C. Gmelin) Hegi but occurs also in cultivated *V. vinifera* subsp. *vinifera*. Size: 4·5×3·0, 4·4×3·2, 5·8×3·3, 5·5×3·7, 5·4×2·9, 6·0×3·8 mm. Cultivated plant (Table 18).

RECONSTRUCTION OF MEDIEVAL PLANT COMMUNITIES

Medieval vegetation was described by referring the information on present day plant communities to the conditions of the past. To this end, all species and a few genera found in subfossil material were classified according to the Braun-Blanquet's system adopted in the studies of modern vegetation in south Poland (Medwecka-Kornaś *et al.* 1972, in few cases according to Ellenberg 1974). Syntaxonomic units were described on the basis of characteristic species. In addition, plants which to-day occur most commonly in communities of given units were included in these units (following Trzcińska-Tacik & Wieserowa 1976). The classification of 11 species was based on other criteria, namely on their occurrence in the stratigraphic sequence (appearance or disappearance, continuous curve or scattered specimens, culmination of curve) or on their possible growth on natural habitats. This concerns the following species: *Carex fusca*, *C.* cf. *hirta*, *Chenopodium polyspermum*, *Cirsium arvense* type, *Galeopsis* cf. *angustifolia*, *G. ladanum*, *G. tetrahit*, *Galium aparine*, *Polygonum dumetorum*, *Rumex crispus*, and *Solanum nigrum*.

Species counted in each unit were listed in plant community tables and presented in detailed as well as in summary diagrams. The lists of species, in spite of a certain superficial resemblance, do not correspond exactly to modern phytosociological records. Firstly, they reflect the species composition of samples, which contain the remains of plants originating from various communities. Secondly, they cover the long time span from about the 9—10th to 15th century A. D., and an unknown area (though it is reasonable to assume that most plants, at least those brought by chance, come from not far distant sources). It seems, however, that keeping these limitations in mind, these lists may be used to describe types of plant communities whose existence in the past was very probable, assuming that plant communities have undergone no radical changes since the Middle Ages.

To gain additional data on the ecological conditions of the growth of plant communities described from the Wawel, the average values of Ellenberg's figures for soil moisture (F), nitrogen (N) and calcium carbonate (R) content were calculated (Ellenberg 1974). The limitations concerning the phytosociological interpretation are also valid in the case of the reliability of applying Ellenberg's index values for fossil material.

Potametea (R. Tx. et Prsg. 1942)

Aquatic communities of this class are poorly reflected in the material from the Wawel. The only two genera, *Potamogeton* sp. (only pollen) and *Batrachium* sp. (pollen and one fruit) were found in small numbers. They were probably brought to the Hill together with other plants growing in river valleys (Tables 5 and 6, Fig. 8).

Phragmitetalia (W. Koch 1926)

Reedswamp communities are represented by 10 species. Quantitatively only seeds of *Typha* sp. (probably *T. latifolia*) play an important role. They were found in most of the samples and usually in large numbers. Other species occurred in small numbers in EM layers and were relatively more abundant in LM layer Vb. Among them *Heleocharis palustris* was most common (Tables 5 and 6, Figs. 8, 10 and 11).

Species of this order probably came from two main types of plant communities, which developed in stagnant or slowly running waters. One type included stands of *Typha* and *Sparganium ramosum*, perhaps with *Alisma plantago-aquatica* and *Heleocharis palustris*, which may have grown in shallow water (F 10, Table 7), in places rich in nitrogen (N 8, Table 8). The other type is indicated by the presence of five characteristic species of the alliance *Magnocaricion*. Communities of this alliance probably grew on wet soils (F 9—10, Table 7), poorer in nitrogen compared with the former group (N 3—5, Table 8). Both groups were resistant to prolonged lowering of water table. In the Vistula valley they bordered on the areas covered with moist meadows and may occasionally have been cut for fodder or bedding (particularly *Typha*). Their growth on the Hill was highly improbable.

Isoëto-Nanojuncetea (Br.-Bl. et R. Tx. 1943)

Six characteristic species belong to this class (Tables 5 and 6, Figs. 8 and 10. Five of them are represented by fruits or seeds and one only by pollen. Smal numbers of specimens were found, *Juncus bufonius* was most frequent (17 seeds in 6 samples).

These therophytes may have had their natural habitats on periodically inundated sandy or muddy soils on shores of old river beds. They may also have formed short-lived communities on wet roads and field furrows. They may have been brought to the Hill from both types of habitats and may also have occur temporarily on the Hill. The presence of 6 characteristic species indicates that they must have been common in the area, because these small plants have little chance of getting into the culture layers. On the other hand, average values of Ellenberg's indices for this group point to more moist soils (F 7·5), more acid (R 3·0), and poorer in nitrogen (N 4·7) than, for instance, soils overgrown by the communities of *Onopordetalia*, which were certainly present on the top of the Hill (Tables 7—9).

Scheuchzerio-Caricetea fuscae (R. Tx. 1937)

The occurrence of communities of this class is indicated by the presence of 9 species (including 7 characteristic ones). Three of them were found in the pollen spectra. All species appeared in small numbers (1—4 specimens), which

Table 7
Tabela 7

Moisture numbers for plant communities described from medieval material from the Wawel Hill

Liczby wilgotności dla zbiorowisk roślinnych opisanych z materiału średniowiecznego ze Wzgórza Wawelskiego

Moisture numbers (Ellenberg 1974) Liczby wilgotności F	Phragmitetalia	Scheuchzerio-Caricetea	Alnion	Bidentetalia	Isoëto-Nanojuncetea	Alno-Padion	Salicion	Potentillo-Polygonetalia	Molinio-Arrhenatheretea	Carpinion	Atropetalia	Vaccinio-Piceetea	Onopordetalia	Secali-Violetalia	Nardo-Callunetea	Festuco-Brometea	Sedo-Scleranthetea
10	5	1							1								
9	4	5	2	2	1	1	3	1	9					1			
8		3	1	2		3	1		8	2							
7					3	1		1	8			1	5	2			
6								2	5	4	5		8	14			1
5				1			2	1	8			1	10	7	1	1	8
4								1				2	5	8		6	1
3																1	2
2																	
Number of species Liczba gatunków	9	9	3	5	4	5	6	6	39	6	5	3	28	32	1	16	4
Mean F value Średnia wartość F	9.6	8.8	8.7	7.8	7.5	7.0	6.8	6.2	6.2	5.3	5.0	4.7	4.5	4.4	4.0	3.6	3.0
Number of indifferent species Liczba gatunków obojętnych	1	0	0	3	2	5	2	1	10	4	1	1	7	13	2	11	0

Table 8
Tabela 8

Nitrogen numbers for plant communities described from medieval material from the Wawel Hill

Liczby zasobności w azot dla zbiorowisk roślinnych opisanych z materiału średniowiecznego ze Wzgórza Wawelskiego

Nitrogen numbers (Ellenberg 1974) Liczby zasobności w azot N	Bidentetalia	Atropetalia	Onopordetalia	Salicion	Alno-Padion	Potentillo-Polygonetalia	Alnion	Carpinion	Phragmitetalia	Secali-Violetalia	Isoëto-Nanojuncetea	Molinio-Arrhenatheretea	Festuco-Brometea	Scheuchzerio-Caricetea	Vaccinio-Piceetea	Nardo-Callunetea	Sedo-Scleranthetea
9	3	1	7	1					1								
8	2	2	11	2	1	1			2	2		1					
7		1	1	1	3	1	1	2		7		4	1				
6		1	5	1	2	1	1	1		5	2	3					
5	2		4	1		1	1	3	2	4		9		1			
4									1	8		4	4				
3			1						1	4		7	6	1	1		
2											1	3	4	6	2	2	2
1												1				1	2
Number of species Liczba gatunków	7	5	29	6	6	4	2	6	6	31	3	32	15	8	3	3	4
Mean N value Średnia wartość N	7.6	7.6	7.6	7.2	6.8	6.0	6.0	5.8	5.5	5.4	4.7	4.5	3.3	2.5	2.3	1.7	1.5
Number of indifferent species Liczba gatunków obojętnych	1	1	6	2	4	3	1	4	4	14	3	17	12	1	1	0	0

indicates that their diaspores were rarely brought to the Hill. Their transport to the Hill was more significant in the LM time, because the only two samples from these period contained 5 species, i.e. 10% of the total number of species found in this layer (Tables 5 and 6, Figs. 8, 10 and 11).

Table 9
Tabela 9

Reaction numbers for plant communities described from medieval material from the Wawel Hill

Liczby odczynu dla zbiorowisk roślinnych opisanych z materiału średniowiecznego ze Wzgórza Wawelskiego

Reaction numbers (Ellenberg 1974) Liczby odczynu R	Atropetalia	Potentillo-Polygonetalia	Festuco-Brometea	Onopordetalia	Carpinion	Salicion	Alno-Padion	Secali-Violetalia	Bidentetalia	Molinio-Arrhenatheretea	Alnion	Scheuchzerio-Caricetea	Phragmitetalia	Isoëto-Nanojuncetea	Sedo-Scleranthetea	Vaccinio-Piceetea	Nardo-Callunetea
9			1					4									
8	2	2	8	5	2			9	1	3		1					
7		1	3	5	1	2	5	8	1	5		1					
6			1		1	1		2		1	1		1				
5							1	2	1	2	1	1					
4								2	1	3							
3										3		2	1	2	2	1	
2								3							1	2	1
1																	1
Number of species Liczba gatunków	2	3	13	10	4	3	6	30	4	17	2	5	2	2	4	3	2
Mean R value Średnia wartość R	8.0	7.7	7.7	7.5	7.2	6.7	6.7	6.7	6.0	5.6	5.5	5.2	4.5	3.0	2.3	1.7	1.5
Number of indifferent species Liczba gatunków obojętnych	4	4	14	25	6	5	4	15	4	32	1	4	8	4	0	1	1

Plants of this class probably grew in the communities of wet meadows, which occupied peaty soils, poor in nitrogen (F 8·8, N 2·5, Tables 7 and 8). These meadows spread in the valley as substitute communities after the destruction of natural riverside forest (Kornaś & Medwecka-Kornaś 1974). Larger number of species found in the LM layer may point to their greater expansion in the 15th century compared with the EM period (Trzcińska-Tacik & Wieserowa 1976).

Bidentetalia tripartitae (Br.-Bl. et R. Tx. 1943)

Nitrophilous communities of this order are represented by 8 (7 characteristic) species preserved only as macrofossils (they are not identifiable by pollen grains). They were most abundant in layers VIg and VIf, disappeared in VIc—d and did not occur in younger layers (Tables 5 and 6, Figs. 8, 10 and 11). *Ranunculus scleratus* was most abundant (107 fruits in 10 samples). Species of this order, together with *Atropetalia* and *Onopordetalia*, represent communities showing the highest nitrogen figures (N 7·6) in the material from the Wawel (Table 8). They probably had their natural habitats on the shores of stagnant or slow running waters in the valleys, on soils rich in nitrogen and periodically inundated. Their occurrence on the Hill as ruderal communities would be possible along road side ditches or around dunghills (if there were any) but their high moisture figure (F 7·8), much higher that that for *Onopordetalia* (F 4·5) points to relatively moist soils which probably did not exist on the top of the Hill (Table 7).

Potentillo-Polygonetalia (R. Tx. 1947, syn. *Plantaginetea maioris* R. Tx. et Prsg. 1950)

The order is represented by 7 (6 characteristic) species. Fruits of *Polygonum aviculare* and *Potentilla reptans* were most frequent, continuous pollen curves were obtained for *Polygonum aviculare* and *Plantago maior* (Tables 10 and 6, Figs. 8, 10 and 11). Several species — *Potentilla reptans*, *P. anserina*, *Agropyron repens*, *Rorippa silvestris* — as well as *Rumex crispus* and *Carex hirta*, assigned here to *Molinio-Arrhenatheretea* — may have come from natural communities of the alliance *Agropyro-Rumicion crispi* growing on low river terraces, on sites similar to those occupied by communities of *Bidentetalia*. Partly, however, species of *Potentillo-Polygonetalia* grew on the Hill itself. They appeared more frequently in samples from the Wawel than species of *Bidentetalia* and — as results from Ellenberg's index figures — they occupied slightly drier (F 6·2), poorer in nitrogen (N 6·0), and more or less neutral soils (R 7·7, Tables 7—9). They could grow as ruderals on trodden places, particularly *Polygonum aviculare* and *Plantago maior*. Pollen curves of these two species show a decrease in layer VIc, similar to the decrease of *Onopordetalia* (Wasylikowa, in print).

Onopordetalia acanthii (Br.-Bl. et R. Tx. 1945, syn. *Artemisietea* Lohm.)

Ruderal communities of this order include 35 species, with 24 characteristic ones (Table 10, Fig. 9). The time of their best development was connected with the formation of the layers VIg, VIf, and VIe_4. Samples from these layers contain the greatest numbers of species (Table 6, Fig. 11), including many characteristic species (28 species in these three layers, 10 characteristic ones). Layers VIf and VIe_4 are also characterized by a large number of seeds and fruits of many species, while in VIg the number of diaspores is smaller, mainly due to the fall of *Urtica dioica* curve (Fig. 10). In the layer VIe the decrease of the number of species and of the number of specimens can be seen (see the discussion on p. 183). This concerns only random samples from the layer, because samples from special objects connected with layer VIe (pit 1, house 3 and the basket) are rich in ruderals (Fig. 11). In all 18 samples from layer VIe a total number of 30 species (13·5%) was found (29 characteristic species). This means that at the time when the layer VIe was formed ruderal communities were still well developed on the Hill, but were more or less confined to the nearest surroundings of house 3 and pit 1.

In the middle of layer VIc—d the role of *Onopordetalia* species increased again, but in this younger phase ruderal communities were poorer in species than in layer VIe_4. From all the layers younger than VIe only 18 species were determined (11 characteristic species).

Pollen of three taxa was found: *Urtica dioica*, *U. urens*, and *Anchusa* sp. Their summary curve shows a slight culmination in layers VIg, VIf, and VIc_4

and a clear decrease in VIe. The curve of *Chenopodiaceae* is of similar shape and probably represents mainly ruderal species of *Chenopodium* (Wasylikowa, in print).

Species of *Onopordetalia* grew on dry to fresh soils (F 4·5) similar in this respect to the habitats of field weeds, but with a larger amount of nitrogen (N 7·6) (Tables 7 and 8).

Secali-Violetalia arvensis (Siss. (1943 ap. Br.-Bl. et R. Tx.) 1946)

Field weed communities are represented by 45 species. The number includes 38 characteristic species: 19 of *Centauretalia cyani*, 11 of *Polygono-Chenopodietalia*, and 8 of the order (Tables 6 and 11, Fig. 9). Three species *(Ranunculus arvensis*, *Consolida regalis*, and *Nigella arvensis)* were determined only on the basis of their pollen grains and three species were found both among macro- and microfossils *(Bupleurum rotundifolium*, *Centaurea cyanus*, and *Scleranthus annuus)*.

Two characteristic species of *Polygono-Chenopodietalia*, namely *Chenopodium polyspermum* and *Solanum nigrum*, were assigned to *Onopordetalia* on the basis of their occurrence in the profile.

At this point it should be stressed that diaspores of weeds (as well as those of cultivated plants) described here were scattered in each layer on the wide part of the entire excavated surface. They were not associated with special accumulations of cereal grains or of seeds or fruits of other cultivated plants, which means that they do not represent a real weed contamination of a definite crop. They reflect the continuous transport of weed diaspores with cultivated plants to the Hill, which was in progress while the culture layers were forming.

An interesting picture is obtained by the comparison of percentage numbers of species found in random samples from different layers and in archaeological objects (Fig. 11, Table 6). Samples from the lower part of pit 1, from house 3, and from the basket contained greater numbers of *Secali-Violetalia* species than random samples from any layer. This difference may be explained by the accumulation of material containing large amount of weeds (e.g. refuse from threshing) in or around these objects. In the top part of the pit the number of weed species decreased, thus indicating the cessation (or the change) of the use of the pit when it was filled. At this level the number of ruderal species increased.

The distribution of weeds in the samples is not uniform with respect to the number of specimens, as well. Two maxima can be seen in random samples (Fig. 10), the older one in VIg (and VIf) and the younger and more pronounced in VIe (together with the bottom part of VIc—d). In VIe and VIc—d a slight rise of weed pollen curve in also visible (Wasylikowa, in print). Certain differences between these two phases with abundant weeds may be indicated, but it is difficult to estimate their significance. In random samples, the percentage of weed species is higher in VIg and VIf than in VIe and VIc—d. The

number of weed diaspores, on the other hand, is higher in the younger phase. In the older phase species of *Polygono-Chenopodietalia* play a relatively more important role, in the younger one *Centauretalia* are more numerous. From among all the EM layers the ratio of the number of *Centauretalia* species to that of *Polygono-Chenopodietalia* is lowest in VIg and VIf. It equals up to 1·5 for VIg and 1·6 for VIf, while in other layers it varies from 1·8 to 4·0 and equals 2·0 for VIe layer. This change may be an indirect indication of a growing importance of wheat and rye as compared to millet in the younger phase.

To-day, communities of the suborder *Polygono-Chenopodietalia* grow mainly in root-crop cultivations, but they may develop also in gardens and sometimes in spring cereals, for instance in primitive millet cultivations. They are best developed in village gardens and in fields situated near settlements (Medwecka-Kornaś *et al.* 1972). *Setaria glauca*, *Echinochloa crus-galli*, and *Setaria viridis* or *S. verticillata*, species most common in the material from the Wawel, at present occur abundantly in the association *Echinochloëto-Setarietum* of the alliance *Panico-Setarion* (Kornaś 1950), which develops on light, sandy soils, usually poor in calcium carbonate. These species are cited by Dobrochotow (1961) as millet weeds. In subfossil material from other localities they were often found together with charred millet grains. Perhaps in prehistoric and early historic times they were common weeds in millet cultivations and were eaten with millet grains. Species of the root-crop communities of the alliance *Eu-Polygono-Chenopodion* are less abundant in the material from the Wawel, though they are represented by four characteristic species. To-day, these communities grow on heavier soils, usually rich in lime.

The suborder *Centauretalia* includes segetal communities which are best developed in winter cereals, though may also occur in spring cereals. Among 19 characteristic species of this suborder there are 11 characteristic species of the alliance *Caucalidion*, including 8 characteristic species of the association *Caucalido-Scandicetum*. *Melandrium noctiflorum*, *Stachys annua*, *Neslia paniculata*, and *Galium tricorne* are most frequent. To-day calciphilous and relatively thermophilous communities of *Caucalidion* rarely occur in Poland, and only in the south and south-central part. In the wide surroundings of Cracow they grow best on fertile rendzina soils formed on Cretaceous marl (Kornaś 1950), and avoid loess areas. Places nearest to Wawel with soils of this type, occur on the south bank of the Vistula, within the limits of the present-day city (Kostrze, Bodzów, Pychowice, Zakrzówek, Podgórze, Płaszów, Komornicki 1974). As late as in the late forties Kornaś found impoverished stands of *Caucalido-Scandicetum* in this area, and earlier authors have noted some of its characteristic species (Berdau 1859; Żmuda 1920; after Kornaś 1950). The well developed stands of *Caucalido-Scandicetum* found by Kornaś nearest to Cracow were in the vicinity of Miechów and Tunel, at a distance of about 40 km to the north-east. Good representation of *Caucalidion* species in the material from the Wawel suggests that cereal grains, chiefly wheat and rye, were at least partly brought to the Wawel from the Miechów Upland.

Alliance *Aperion*, which includes segetal associations growing on light soils, acid or poor in calcium carbonate, is represented by only 3 characteristic species, all found in small numbers. It seems that the communities of this alliance were of lesser importance in areas which provided the inhabitants of the Wawel Hill with cereals. But it is also possible that the role of these communities is underestimated, because our most common modern association of field weeds, *Vicietum tetraspermae*, is poorly defined floristically, and consequently, might be overlooked solely on the basis of characteristic species. Many species found on the Wawel Hill could grow in different weed communities and on different soils, for instance *Agrostemma githago*, *Polygonum convolvulus*, *P. persicaria*, *Thlaspi arvense*, *Melandrium album*, *Chenopodium album*, *Stellaria media*, and *Galeopsis tetrahit*, to mention only the most frequent plants.

The species listed in table 11 under the heading *Secali-Violetalia* could occur in communities of both suborders. Species listed as characteristic species of the class *Rudero-Secalietea* could appear as field weeds or as ruderals. Many species of *Polygono-Chenopodietalia* could also grow in ruderal communities.

In order to characterize the habitats of weed species found on the Hill, Ellenberg's figures for moisture, soil reaction and the occurrence of nitrogen obtained for the list of subfossil weeds were compared with the same figures calculated for the lists of plants found in four field associations described by Kornaś (1950) from the Cracow—Częstochowa and Miechów Uplands (Table 12). Moisture demands of weeds from the Wawel are described by figures F 3—8, usually F 3—5, with the mean value 4·4. The heterogeneity of material is indicated by two maxima in classes F 3 (indicators of dry soils) and F 5 (indicators of fresh soils). All characteristic species of *Caucalidion* from the Wawel have moisture figures of 3 and 4. In the relevés of *Caucalido-Scandicetum* published by Kornaś most species (not only the characteristic) are also grouped in these classes. Most of *Polygono-Chenopodietalia* species from the Wawel are grouped in classes F 5—8. The demands with regard to the pH of the soil are still more diversified. R figures vary from 2 to 9, indicating the growth of weeds on acid to calcareous soils. Most species have reaction figures R 7—9, pointing to soils from slightly acid to rich in calcium carbonate. This group includes all the characteristic species of *Caucalidion*. Most species of the present-day *Caucalido-Scandicetum* have the same indices. The average R value for weeds from the Wawel (R 6·7) is distinctly lower than for modern *Caucalido-Scandicetum* (R 7·5) because of the presence of species growing on sandy, acid soils. *Scleranthus arvensis* (R 2), *Spergula arvensis* var. *arvensis* (R 2), and *Aphanes arvensis* (R 4) probably grew in segetal communities similar to the present-day associations of the alliance *Aperion*.

Nitrogen figures have values of 3—9. Species growing on soils with low or moderate nitrogen content (N 3—5) form a dominating group (16 species) composed mainly of *Caucalidion* species (11 species). Plants of soils rich in nitrogen (N 7—9; 10 species) are fewer and the characteristic species of *Polygono-Chenopodietalia* make up about half of them.

Table 12
Tabela 12

Index numbers acc. to Ellenberg (1974) for soil moisture (F), pH (R), and nitrogen content (N) for present day associations of field weeds from Cracow-Częstochowa and Miechów Uplands (Kornaś 1950) and for Secali-Violetalia from the Wawel Hill

Wartości wskaźników wg Ellenberga (1974) dla wilgotności gleby (F), ph (R) i zawartości azotu (N) dla współczesnych zespołów chwastów polnych z Wyżyny Krakowsko-Częstochowskiej i Miechowskiej (Kornaś 1950) i dla Secali-Violetalia z Wawelu

Index numbers / Wartości wskaźnika	Present day associations Zespoły współczesne				Wawel		
	Centauretalia cyani		Polygono-Chenopodietalia				
	Violetum tetraspermae	Caucalido-Scandicetum	Echinochloëto-Setarietum	Lamio-Veronicetum politae	Secali-Violetalia	Centauretalia cyani	Polygono-Chenopodietalia
F 8	3	-	3	1	1	-	1
7	6	-	4	1	-	-	-
6	7	4	4	3	2	1	1
5	16	9	17	17	14	2	5
4	19	21	12	21	7	5	2
3	2	11	3	8	8	3	1
2	-	2	-	1	-	-	-
Number of species / Liczba gatunków	53	47	43	52	32	14	10
Mean F value / Średnia wartość F	5.1	4.0	5.1	4.4	4.4	3.8	5.0
Number of indifferent species / Liczba gatunków obojętnych	23	19	21	17	13	5	1
R 9	-	3	-	1	4	4	-
8	5	21	2	14	9	7	-
7	11	11	8	15	8	2	3
6	2	2	4	3	2	-	1
5	4	-	5	2	2	-	2
4	7	1	3	-	2	1	1
3	4	1	1	1	-	-	-
2	1	-	3	1	3	2	1
1	1	-	1	-	-	-	-
Number of species / Liczba gatunków	35	39	27	37	30	16	8
Mean R value / Średnia wartość R	5.5	7.5	5.3	7.0	6.7	7.2	5.4
Number of indifferent species / Liczba gatunków obojętnych	39	28	36	32	15	3	3
N 9	-	1	2	2	1	-	-
8	2	2	7	4	2	-	2
7	13	10	14	17	7	-	4
6	8	3	6	6	5	-	1
5	9	5	5	6	4	4	-
4	5	10	3	8	8	7	1
3	5	9	2	1	4	2	1
2	3	1	1	2	-	-	-
1	-	1	-	-	-	-	-
Number of species / Liczba gatunków	45	42	40	46	31	13	9
Mean N value / Średnia wartość N	5.3	4.8	6.3	5.9	5.4	4.1	6.3
Number of indifferent species / Liczba gatunków obojętnych	31	26	23	23	14	6	2

The analysis of the characteristic species and of Ellenberg's ecological indices points to the derivation of field weeds from two main types of cultivations and three types of habitats. One group, namely *Polygono-Chenopodietalia* species, may grow on fresh to moist soils, rich in nitrogen. It is difficult to

determine the cultivated plant they were connected with. To-day the most important factor in the development of root-crop weeds is the technic of cultivation (spring sowing, manual hoeing), which implies a short growing season. In the Middle Ages, similar conditions may have existed in gardens, perhaps on the Hill itself, or on small fields near the settlements, where legumes and millet were sown (for the discussion of this problem see Knörzer 1970). Two other groups were connected with the cultivation of cereals as winter or summer crop. The largest group of weeds *(Caucalidion)* came from drier soils, rich in lime, with low to moderate nitrogen content. Wider areas with soils suitable for them may be found on the Miechów Upland. The presence of three acidofilous species indicates that cereal fields occupied also sandy, acid soils.

Segetal communities registered in the material from the Wawel differed from the present day associations of the order *Centauretalia* in the almost complete absence of *Centaurea cyanus*. Two pollen grains were found in EM layers VIf (9—10th cent.) and VIc—d (11—12th cent.) and one fruit in LM layer Vb (15th cent.). The spread of *Centaurea cyanus* in the fields near Cracow probably took place in the second half of the 12th or in the first half of the 13th century, as is shown by pollen analysis from the two other sites in Cracow (Koperowa, unpubl.).

Comparison of the occurrence of weeds and of cultivated plants. The correlation in the occurrence of these two groups of plants, both with respect to the number of species and to the number of specimens does not present a clear picture. For instance, the number of species of weeds and of cultivated plants decreases in a similar way in pit 1 from the bottom toward the top. But the number of their species in individual EM layers varies independantly giving different pattern for each group (Fig. 11). In the seed diagram some of the peaks of the curve of cultivated plants (Fig. 10) are accompanied by an increase in the number of weeds while others are not. Parallel culminations are visible in the samples from the middle of layer VIf, in VIe, and at the bottom of VIc—d. The increase of weeds and cereals in VIe can be also seen in the pollen diagram. But, for instance, the top sample from VIf, showing an increase of the amount of *Triticum* and *Secale* grains, has a smaller number of weed diaspores than the sample below. Also the pronounced peak of weeds in the central part of pit 1 is not reflected in a similar change in the number of specimens of cultivated plants.

The occurrence of *Linum usitatissimum* in pit 1 and in layers VIg and VIe is associated with an increase of the number of diaspores of two weed species characteristic of flax cultivations, *Spegula arvensis* var. *maxima* and *Galium spurium*. The presence of *Spergula* is particularly interesting, because this is a highly specialized weed of flax.

Comparison of the occurrence of *Secali-Violetalia* and *Onopordetalia*. The order *Secali-Violetalia* is represented by a greater total number of species (45 species, 16·4%) than *Onopordetalia* (35 species, 12·8%). The predominance of weed species over ruderals can be seen in most layers. The ex-

ceptions are layers VIj and VIe_4 which contain almost the same numbers of species from both groups, and also the four top samples from pit 1 and the sample from house 3, where ruderal species exceed weed species in number (Fig. 11, Table 6). These relations are emphasized by the greater number of diaspores of ruderals in VIe_4, in the upper part of the pit and in the house. Most conspicuous change in the role played by ruderals and weeds takes place in layers VIe_4 — VIe — VIc—d. After their numerical predominance in layers VIf and VIe_4, ruderals decrease in VIe in absolute and percentage numbers and recover some of their previous importance in VIc—d. Weeds show different trend, with distinct prevalence in VIe (Fig. 10, Table 13). This change is overrated to some degree in the summary diagram (Fig. 10) by the exclusion of species

Table 13
Tabela 13

Comparison of the layers VIg, VIf, VIe_4, VIe, and VIc-d with regard to the number of seeds and fruits of species belonging to Onopordetalia, Secali-Violetalia, Molinio-Arrhenatheretea, and Festuco-Brometea found in the samples from these layers

Porównanie warstw VIg, VIf, VIe_4, VIe i VIc-d pod względem liczby owoców i nasion gatunków z Onopordetalia, Secali-Violetalia, Molinio-Arrhenatheretea i Festuco-Brometea znalezionych w próbach z tych warstw

Layer - Warstwa	Number of specimens in samples of the volume of 400 cm^3 Liczba okazów w próbach o objętości 400 cm^3				
	VIg	VIf	VIe_4	VIe	VIc-d
Onopordetalia	121 (43 - 236)	415 (90 - 854)	199 (97 - 261)	11 (2 - 22)	35 (2 - 85)
Secali-Violetalia	171 (3 - 456)	47 (42 - 50)	28 (21 - 40)	271 (49 - 582)	23 (2 - 96)
Molinio-Arrhenatheretea	40 (2 - 70)	29 (12 - 40)	25 (2 - 59)	82 (8 - 260)	5 (1 - 9)
Festuco-Brometea	5 (1 - 10)	3 (1 - 6)	1 (1 - 3)	10 (2 - 22)	1 (3)

which could belong both to ruderal and to weed communities (the group called *Rudero-Secalietea*). The important component of this group is *Chenopodium album*. The seed curve of this species (*C. album* s. str. and *C. album* s. l., Fig. 9) is similar to that of ruderals in pit 1 and in the upper part of VIc—d, while its two culminations in VIg and VIf are simultaneous with the culminations of weeds and its abundance in VIe also resembles that of weeds. It seems, therefore, that the species grew as a weed and also as a ruderal plant. *Polygonum persicaria*, on the other hand, and probably *Stellaria media* too, were connected mainly with weed communities (see their curves from pit 1, Fig. 9).

Comparing the habitats of weeds and ruderals on the basis of Ellenberg's figures for moisture, nitrogen content, and soil pH (Tables 7—9) it may be supposed that *Centauretalia* grew on drier soils, distinctly poorer in nitrogen than *Onopordetalia*, but with a similar content of calcium carbonate (more or less neutral soils). *Polygono-Chenopodietalia*, on the other hand, occupied slightly more damp soils, slightly acid, with a moderate nitrogen content (intermediate position between *Onopordetalia* and *Centauretalia* in this respect).

Atropetalia (Br.-Bl. et R. Tx. 1943, syn. *Epilobietea angustifolii* R. Tx. et Prsg. 1950)

Plants of this order may have occured on the Hill and some of them could have been gathered as edible fruits (Table 17). The presence of fruit-stones of *Rubus idaeus* and *Fragaria vesca* in most layers was certainly connected with the gathering of their fruits. The same perhaps may be said of *Sambucus nigra*. Continuous pollen curves of *Sambucus* sp. and *Rubus* sp. imply the growth of thickets composed of these genera on the Hill (Wasylikowa, in print). They were best developed during the formation of the upper part of layer VIc—d and layer VIb. At that time, the place was probably abandoned for an unknown period after destruction which took place in this part of the Hill and could be traced in layer VIc—d (Figs. 9 and 10).

Molinio-Arrhenatheretea (R. Tx. 1937)

The class of moist and fresh meadows is represented by 49 species, including 31 characteristic ones: 14 of *Molinietalia*, 8 of *Arrhenatheretalia*, and 9 of the class (Table 14). Besides the characteristic species, 8 meadow species were assigned to *Molinietalia*, which are classified by Ellenberg as indicators of moist soils, i.e. having moisture figures of 7 and 8. Similarly, species with moisture figures of 4 and 5, indicators of fresh soils, were included in *Arrhenatheretalia* together with characteristic species of the order. In addition, two characteristic species of *Agropyro-Rumicion crispi*, namely *Carex hirta* type and *Rumex crispus*, were listed among species of *Molinio-Arrhenatheretea*, on the basis of their occurrence in the diagram (Fig. 8).

A relatively high number of species was found in the pollen spectra, namely 16 species; 6 of them were identified only by their pollen grains.

On the basis of ecological indices habitats of these communities may be characterized as follows. Among all species included to *Molinio-Arrhenatheretea* there is a slight prevalence of plants with higher moisture demands compared with the stands of *Molinietum* and *Arrhenatheretum* described by Zarzycki (1958) from Czernichów, situated in the Vistula valley west of Cracow (Table 15). 46% (18 species) of the total number of *Molinio-Arrhenatheretea* species from the Wawel have moisture figures of 7 to 9. In the relevés from Czernichów 39% (32 species) of all species have F values of 7 to 10. This is reflected in slightly higher mean index value for the Wawel (F 6·2) than for Czernichów (F 5·8). The mean moisture figure for the material from the Wawel is even somewhat higher than the average moisture figure calculated only for *Molinietum* (F 6·0) from Czernichów. This indicates that in the Middle Ages moist meadows grew on wetter soils than stands of *Molinietum* which existed in Czernichów in 1958, or at least on soils with a high and more stable water level. They developed

on slightly acid to neutral soils with a small to moderate nitrogen content (Tables 8 and 9).

In all the EM layers the number of species of *Molinietalia* predominates over the number of species of *Arrhenatheretalia* and *Molinietalia* usually occur in a larger number of samples. In most of the samples they are also represented by a higher number of specimens. The number of species of *Arrhenatheretalia*

Table 15
Tabela 15

Moisture numbers for the present-day associations Molinietum and Arrhenatheretum from Czerniehów (Zarzycki 1958) and for Molinio-Arrhenatheretea from the Wawel Hill

Liczby wilgotności F dla współczesnych zespołów Molinietum i Arrhenatheretum z Czerniehowa (Zarzycki 1958) oraz dla Molinio-Arrhenatheretea ze Wzgórza Wawelskiego

Moisture numbers (Ellenberg 1974) Liczby wilgotności F	Czerniehów			Wawel		
	Molinietum coeruleae (releves 1–12) (zdjęcia 1–12)	Arrhenatheretum elatioris (releves 17–19) (zdjęcia 17–19)	Molinietum + Arrhenatheretum (releves 1–12 and 17–19) (zdjęcia 1–12 i 17–19)	Molinietalia	Arrhenatheretalia	Molinio-Arrhenatheretea
10	1	1	1			
9	2		2	1		1
8	10	4	13	9		9
7	14	8	16	8		8
6	10	4	12	1	1	8
5	13	13	18		5	5
4	12	12	16		8	8
3	3	2	4			
Number of species Liczba gatunków	65	44	83	19	14	39
Mean F value Średnia wartość F	6.0	5.5	5.8	7.5	4.5	6.2
Number of indifferent species Liczba gatunków obojętnych	28	20	31	1	1	10

exceeds that of *Molinietalia* only in the LM layer. The total number of species of *Molinio-Arrhenatheretea* shows three maxima in layers VIg, VIe, and Vb, caused mainly by the rise in the number of *Arrhenatheretalia* species (Table 6, Fig. 11). A small increase in the number of diaspores belonging to species of this class can be seen in the same levels (Table 13, Fig. 10).

In summing up it may be said that the material from the Wawel proves the existance of plant communities similar to those of the present-day meadows of the class *Molinio-Arrhenatheretea* in the near surroundings of the Hill, during the time from the 9—10th to 15th century. The higher number of *Molinietalia* species, compared with that of *Arrhenatheretalia* in the EM layers, indicates the wider spread of communities growing on moist soils on low river terraces in the Early Middle Ages. The presence of four characteristic species of *Fili-*

pendulo-Petasition and the relatively high moisture figure point to the importance of communities similar to the present day associations of this alliance which grow along rivers and streams, partly perhaps as natural, but mostly as secondary communities expanding after the clearance of riverside forests. Meadows of *Molinietalia* may have been irregularly cut.

Plants of meadows and pastures growing on fresh soils *(Arrhenatheretalia)* played slightly greater role only in the two EM layers — VIg and VIe — and dominated over plants of moist meadows in the LM layer Vb. Each increase of *Arrhenatheretalia* species may reflect more intense exploitation of fresh meadows by the inhabitants of the Hill (grazing, cutting) in the corresponding period. Weeds also indicate that the formation of these three layers was connected with intense economic activity carried on in this part of the Hill. However, whether these periods witnessed the expansion of fresh meadows, remains uncertain.

Festuco-Brometea (Br.-Bl. et R. Tx. 1943)

Communities of xerothermic grassland, represented by 27 species (Tables 16 and 6) belong to the four vegetation types most marked in the Wawel material, together with the communities of meadows *(Molinio-Arrhenatheretea)*, field weeds *(Secali-Violetalia)*, and ruderals *(Onopordetalia)*. Usually, however, diaspores of grassland species, contrary to those of the other three groups, are not numerous and occur in a small number of samples. *Fragaria viridis*, whose achenes are most frequent among macrofossils (24 fruits in 15 samples) is an exception probably due to its berries being gathered (Fig. 8). In the pollen spectra, *Centaurea scabiosa*, *Anthericum* sp., and *Cerinthe* sp. are most abundant, but the summary curve for all species of *Festuco-Brometea* does not exceed 1% of the total sum of AP + NAP in most of the samples (Wasylikowa, in print).

On the basis of the present-day distribution of xerothermic grassland species it may be supposed that they grew on the Hill as remnants of natural communities or as patches of secondary grazed grassland. Several species of this group might also have occurred in cereal fields and occasionally been brought to the Hill with cereal grain. The possibility of the derivation of pollen, fruits, and seeds of these plants from two different sources is to some extent supported by the analysis of fossil material.

The number of species shows three indistinct maxima in layers VIj, VIg, and VIe, with two minima in VIi and VIe_4 (Fig. 11). These minimum values are also reflected in the number of fruits and seeds (Fig. 10). In the layer VIj (and VIi) almost exclusively pollen was found, which may indicate the presence of species on the Hill, either in grassland communities or in the cereal field postulated here (see p. 183). The high number of species and of specimens in VIg and VIe may be partly explained by the transportation of diaspores with cereal grain (Table 13). The high number of species found in pit 1 (Table 6, Fig. 11)

may also result from this but the distribution of remains in the stratigraphic sequence of the pit does not confirm this suggestion as the only explanation. The curves of the number of species and those of the number of specimens (Figs. 10 and 9) show different trend for *Festuco-Brometea* compared to *Secali-Violetalia*. It seems, therefore, that during the formation of layer VIe, with which pit 1 was connected, some grassland species grew on the Hill. The constant appearance of a few species in the pollen spectra also indicates that patches of xerothermic grassland still existed on the Hill at least at the end of the 12th century, occupying rather dry, calcareous soils, poor in nitrogen (F 3·6, R 7·7, N 3·3, Tables 7—9). In the 15th century they were very limited in number, if not quite destroyed.

Sedo-Scleranthetea (Br.-Bl. 1955 em. Th. Müller 1961) and *Nardo-Callunetea* (Prsg. 1949)

Only a few species represent the communities of poor pastures *(Nardo-Callunetea)* and sand grasslands *(Sedo-Scleranthetea)*, which could develop as secondary communities on podsolized soils originally covered by oak-pine or pine forests (Table 16 and 6, Figs. 8, 10, and 11). Among macrofossils only *Rumex tenuifolius* and *Potentilla erecta* were frequent. In the pollen spectra the *Calluna vulgaris* and *Rumex acetosella* type formed continuous curves. The occurrence of *Rumex tenuifolius* is interesting (see p. 153).

Forest communities

Forest communities are represented by 53 species (19% of the total number of species), including 11 taxa identified only in pollen spectra. Wood and charcoal fragments belong to 11 taxa of trees or shrubs (Table 3). Among forest plants there are 27 characteristic species representing communities of three classes: *Querco-Fagetea* (20 species), *Alnetea glutinosae* (3 species), and *Vaccinio-Piceetea* (4 species, Table 17). An almost complete lack of forest plants in LM layer Vb is caused by the fact that no pollen spectra were analysed from this layer and should not be interpreted as a sign of deforestation.

Riverside forests

The largest group of forest species (21 species) is connected with communities of the alliances *Salicion*, *Alno-Padion*, and *Alnion* (Tables 17 and 6, Figs. 8, 10 and 11). All the eight species of *Salicion* (Soó 1943) were preserved among macrofossils, and two of them were found also in the pollen spectra. Most of these species appeared in several samples (6—21) and in a fairly large number of

specimens (7—159). *Humulus lupulus*, cf. *Malachium aquaticum*, *Rubus caesius*, and *Mentha* cf. *arvensis* were most frequent.

Of 10 species of *Alno-Padion* (Knapp 1942 em. Medwecka-Kornaś ap. Matuszkiewicz et Borowik 1957) two occurred only in the pollen spectra, two in pollen spectra and among pieces of wood and six were determined on the basis of a few diaspores (1—3 specimens) found in one or two samples.

The alliance *Alnion glutinosae* (R. Tx. 1937) was represented by three species, of which only *Lycopus europaeus* was found in several samples.

During the Middle Ages, river terraces probably offered a mosaic of habitats suitable for the development of forest communities of these three alliances (Kornaś & Medwecka-Kornaś 1974). Forest stands of different type bordered on each other and must have had many species in common. It is difficult, therefore, to estimate the actual role played by each type of forest, but it seems that communities of *Salicion* were either wider spread in the close surroundings of the Wawel or were exploited on a larger scale by the inhabitants of the Hill.

Economic penetration of riverside habitats may have taken various forms. Grazing moist meadows and cutting them for hay afforded the most likely opportunity for bringing large numbers of plants to the Hill. Fruits, stems or branches of many plants growing in wet places may have been collected for various purposes (*Humulus lupulus*, *Rubus caesius*, *Salix* sp., *Typha* sp.). Besides, roads traversing the low lying terrains favoured the unintentional bringing of plants.

Stratigraphic distribution of species connected with riverside habitats shows oscillations which can be traced in pollen and macrofossil diagrams. The number of diaspores of *Salicion* species (excluding cf. *Malachium aquaticum*) decreases in VIf and VIe_4 and increases again in VIe (Figs. 8 and 10). The course of the *Malachium* curve is the reverse. The decrease of the number of specimens in layer VIe can be seen also in *Bidentetalia* and *Potentillo-Polygonetalia*. In the pollen diagram two distinct peaks of the *Salix* curve appear in VIg and VIe together with a slight increase of *Humulus*, *Menyanthes*, and *Comarum* curves (Wasylikowa 1978, in print). The culmination of *Salix* curve in VIg is preceded by higher values of *Alnus* and *Fraxinus* pollen curves in VIj+i, which then show minimum values through all the younger layers and increase again in VIc—d, after the second culmination of *Salix* pollen curve. At the present stage of investigations no positive explanation of these changes can be offered. However, if the changes in the composition of plant material accumulated in cultural layers reflect, even indirectly, vegetational changes taking place in the Vistula valley, the possibility of this being the record of two phases of better development of riverside forests may be considered. In the older phase, first *Alnus*, *Fraxinus*, and *Populus* played considerable roles (VIj+i) and later were replaced by *Salix* (VIg). Younger phase began with an increase of *Salix* (VIe) followed by a slight increase of *Alnus* and *Fraxinus* (VIc—d). The phases were separated by the period of destruction of tree stands during the time correspond-

ing to the formation of layers VIf, VIe_4, and the beginning of VIe. Botanical analyses alone do not explain the causes of this change, but taking into account the results of archaeological studies the combined influence of water level fluctuations and of human activities may be regarded as responsible. Studies on the distribution of EM settlements (Radwański 1972, 1975) within the boundaries of present-day Cracow have shown that during the 9th and 10th century good conditions existed for settlements on relatively low-lying parts of the flood terrace (below 200·00 m a.s.l.). In the 11th century settlement moved to slightly higher ground following the rise of the water table. The next and more pronounced rise of water level took place in the 13th century and caused the shifting of larger habitation units to the areas situated above 203·00 m a.s.l.

The exploitation of low-lying terrains during low-water level may have caused the reduction of natural riverside forests. In the first stage secondary osier thickets would spread (layer VIg) and next they become reduced during the time corresponding to layers VIf and VIe_4. The rise of the water table in the 11th century would have set large parts of riverside habitats free from direct human occupation thus enabling renewed expansion of osier thickets (VIe) and perhaps even willow-poplar and alder-ash riverside forests (VIc—d). A better understanding of these phenomena requires further studies including pollen analysis of natural (not anthropogenic) sediments.

Other forests

Forests of drier sites are represented mainly by pollen of trees (Tables 17 and 6, Figs. 8, 10 and 11). Macroscopic remains are scarce with the exception of plants providing edible fruits *(Corylus avellana, Cerasus avium* or *C. vulgaris, C. fruticosa, Prunus spinosa, Malus* sp., *Pirus communis)*. The list (Table 17) includes representatives of all forest types which could have occurred in the area, namely of the oak-hornbeam, beech, oak-pine, and pine forests and of the xerothermic brush-wood (Kornaś & Medwecka-Kornaś 1974). Very little can be said, however, about their actual distribution at that time. High culminations of the pollen curve of *Tilia cordata* in layers VIe and VIc—d may be connected with the presence of this tree on the Hill. The same is true of perhaps *Acer* sp. in VIc—d and *Cerasus* type in VIj+i and VIc—d. *Hedera helix* may have grown on the Hill too, but its pollen is so abundant that gathering of flowering branches for fodder seems quite possible. Low, smooth curves of *Carpinus, Fagus, Corylus*, and *Quercus* may represent the influx of pollen from a wider area. The curve of *Pinus*, the dominating tree pollen type, shows the reverse trend to the *Salix* curve and probably reflects the overrepresentation of pine in a much deforested area (Wasylikowa, 1978, in print).

Cultivated plants and wild utilized plants

Cereals were present in all layers (Table 18, Figs. 9 and 11), but millet *(Panicum miliaceum)* was the only species which occurred abundantly as macrofossil in almost all samples. From among the other cereals bread wheat *(Triticum aestivum)* and rye *(Secale cereale)* were most common, represented by high, continuous pollen curves in all EM layers and by scattered caryopses found in all layers but VIj and VIi. The findings of oat (*Avena sativa* and *Avena* sp.) were scarce and limited to the layers VIf, VIe_4, VIe, VIc—d and Va. Still less frequent were macrofossils of barley *(Hordeum vulgare)*, only few specimens in VIf, VIc—d, and Vb, and pollen grains of *Hordeum* sp. were scattered, too. The low representation of oat and barley in pollen spectra may be misleading, because the determination of pollen grains of these genera is difficult and a part of their pollen was certainly included in the curve of *Triticum*. Nevertheless, macroscopic finds confirm that they were less important compared with wheat and rye.

In one sample from VIc—d pollen of *Fagopyrum* sp. was found. This is too little to prove that it was used by people living on the Wawel Hill, but it indicates its presence in the surroundings in cultivation or as a field weed.

To complete the list of cereals, known from the Wawel, a single finding of spikelets and leaves of *Sorghum vulgare* Pers. s.l. should be mentioned. This alien plant was found by Giżbert in a layer dated to the 9—10th century A. D., discovered in region X, excavation 1 (Giżbert & Żaki 1954). It was probably imported from the south (or east), but, according to these authors, an unreiterated local cultivation was also possible.

It results from the findings discussed above, that millet was the main cereal component of vegetable food, though bread wheat and rye were also continually used. The preponderance of millet probably resulted mainly from the fact that a kind of mush or gruel made of this plant was an item of the everyday diet of people inhabiting the south-west part of the Hill. However, certain overestimation of the role of millet, as against the role of wheat and rye, is also possible. Millet was stored with glumes, which were removed before preparing meals. Even small fragments of these very resistant glumes (palea and lemma) can be easily recognized in subfossil state. Bread wheat and rye were stored as more or less pure grain. Their glumes, broken during threshing, partly remained attached to the straw and partly fell on the threshing floor. They were less likely to be spread everywhere around the houses and, farthermore, their small, scattered fragments cannot be easily identified.

Pulse crops were represented by small numbers of the seeds of pea, *Pisum sativum*, and lentil, *Lens esculenta*. *Amaranthus lividus* cf. var. *lividus* was probably used as a vegetable, as was the cucumber, *Cucumis sativus*, found by Klichowska (1964). *Linum usitatissimum*, *Brassica campestris*, *Papaver somniferum*, and *Cannabis sativa* may have been cultivated for oil. Flax and hemp may also have served as sources of fiber, while hemp and poppy may

Table 18
Tabela 18

The occurrence of cultivated plants in the early and late medieval layers from the Wawel Hill

Występowanie roślin uprawnych w warstwach z wczesnego i późnego średniowiecza na Wzgórzu Wawelskim

Century A.D. - Wiek n.e.	9 - 10							10-11	11 - 12							10	11	15	Macrofossils Szczątki makroskopowe		Pollen and spores Pyłek i spory	Number of supplementary samples and samples of fruit-stones in particular layers Liczba prób dodatkowych oraz prób pestek w poszczególnych warstwach
Location of samples Lokalizacja prób	Region X, large-area excavation Rejon X, wykop szerokoprzestrzenny															Region XII Rejon XII		Region VIB Rejon VIB				
Archaeological layers and objects Warstwy i obiekty archeologiczne	Random samples Próby losowe							Archaeological objects Obiekty archeologiczne											Total number of samples Ogólna liczba prób	Total number of specimens Suma okazów		
	VIj	VIi	VIg	VIf	VIe$_4$	VIe	VI c-d	Basket Korobka	House 3 Chata 3	Pit 1 - Jama 1 Bottom Spąg	Middle Środek	Top Strop	Total Suma	Total in VIe Suma w VIe		VIe	VId	Vb				
Number of samples/Number of points Liczba prób/Liczba punktów	1/1	2/2	3/2	4/2	3/3	4/4	7/4	1/1	1/1	4/1	4/1	4/1	12/7	18/7		1/1	1/1	2/1				
Cereals - Zboża																						
Panicum miliaceum	1	1	3/2	3/2	3/3	4/4	6/4	1	1	4	4	4	12	18/7		1		1	45	2517f		VIf(9),VIe(21)
Triticum aestivum			1	3/2	3/3		5/3	1	1	2	3	2	7	9/31		1			26	123f		VIf(4),VIe(3)
T. sp.	+	+	1+	+	+	1+	+							1+			1		3	10f	+	
Secale cereale	+	+	2/2+	2/2+	3/3+	+	4/4+	1		1	3	1	5	6/2+		1		1	19	214f,3r	+	VI(4),VIe(1)
Avena sativa										1	2	1	4	4/1					4	8f		
A. sp.					1+	2/2+	1+	1	1	2	3		5	6/2+					11	13f	+	VIf(1)
Hordeum vulgare							1											1	2	1f,3r		VIf(1)
H. sp.	+	+		+		+	+							+							+	
Cerealia indet.				1			2/2		1		1		1	2/2				2/1	7	76f		
Fagopyrum sp.							+														+	
Various cultivated plants Różne rośliny uprawne																						
Brassica campestris		1	1	3/2	2/2	1			1	2	2	1	3	7/3					14	35s		
Cannabis sativa	+	+	1+		1+	2/2+	1+	1		2	3	1	6	9/4+					12	15f	+	VIf(1)
Linum usitatissimum			2/2+			1	+	1			3	1	4	6/3					8	28s,8c	+	VIf(1),VIe(1)
Amaranthus lividus cf. v.lividus					1	2/2				2			2	4/3					6	19s		
cf. Pisum sativum										1	1	1	3	3/1		1	1		5	5s		VIf(2)
Lens esculenta				1	1														2	3s		
Brassica nigra											1	1	2	2/1					2	2s		
Papaver somniferum								1						1					1	1s		
Nigella sativa						+	+							+							+	
Fruit trees and shrubs Drzewa i krzewy owocowe																						
Prunus insititia																						Va(7)
Vitis vinifera		1																	1	1s		Va(4)
Prunus persica																						VIf(4)
P. domestica						1					1		1	2/2					2	2f		Va(1)
Juglans regia			+		+	+								+							+	

c - capsule (torebka), r - fragment of ear rachis (fragment osadki kłosa). Other explanations as in table 5 (Pozostałe objaśnienia jak w tabeli 5)

have been used as drug plants. *Brassica nigra* and *Nigella sativa* were known as spices (Table 18, Fig. 9).

Five species of trees and shrubs were planted for their edible fruits: *Vitis vinifera*, *Juglans regia*, *Prunus domestica*, *P. insititia*, and *P. persica* (Table 18). *Malus* sp., *Pirus communis*, and *Cerasus avium* or *C. vulgaris* were cultivated or their fruits were collected from wild plants, as were the fruits of *Fragaria vesca*, *F. viridis*, *Vaccinium* sp., *Rubus idaeus*, *R. caesius*, *Prunus spinosa*, *Cerasus fruticosa* and *Corylus avellana* (Table 17, Fig. 8). Many other wild growing plants were certainly gathered for various purposes, but only four species (besides mosses and wood) were found in large accumulations directly indicating their use, namely *Hedera helix*, *Typha* sp., *Abies alba*, and *Pteridium aquilinum*. Mosses were studied by K. Karczmarz (in print), the use of wood was not examined.

BOTANICAL DESCRIPTION OF ARCHAEOLOGICAL LAYERS

Layers distinguished by the excavators during the field work and later on dated on the basis of pottery may be characterized by their plant content. The distribution of plants in particular layers is illustrated in the diagrams showing the number of species (Table 6; Fig. 11), and the number of fruits and seeds (Fig. 10). The question was discussed in detail elsewhere (Wasylikowa 1978, in print) and only the main points of these considerations will be summarized here.

The oldest layer VIj (and to some degree VIi) is characterized by such a large amount of cereal pollen (and almost no macroscopic remains — only one caryopsis of *Panicum*), that the existence of cereal cultivation (rye and wheat) on the Hill seems very probable. So far this suggestion has not been confirmed by archaeological studies. In the layer VIg an increase of macroscopic remains of cereals and of other cultivated plants can be seen, followed by an increase of the number of diaspores of meadow plants. The number of species representing meadow communities reach its first culmination. These phenomena may be interpreted as a result of the accumulation of cereals and meadow plants by people living in this part of the Hill during the formation of layer VIg. The plant composition of layers VIf and VIe_4, with respect to the number of species and the number of their diaspores, indicates the time of expansion of ruderal communities growing on untrodden places. This change may have been caused by the temporary withdrawal of habitation from this place.

Layer VIe has a distinctly different character. Ruderal communities became very impoverished and more or less limited to the surroundings of pit 1 and house 3 (Fig. 11). At the same time an increase of field weeds and meadow species took place. Most probably at the time corresponding to layer VIe habitation was renewed in this place with all the activities in it involved such as the storage of cereals with weeds, carrying of hay, keeping of animals, which

grazed on meadows around of the Hill, and the destroying the tall ruderals which had developed here in the preceding period.

Layer VIc—d originated at a time when some kind of destruction took place (traces of fire). Human habitation moved to another part of the Hill and abundant ruderal communities developed again, though poorer in species than in layers VIf—VIe_4. Thickets of *Rubus idaeus* and *Sambucus nigra* probably spread near this area.

The LM period is represented only by 2 samples from layer Vb. They contrast sharply with all the EM layers in the high number of species of pastures and fresh meadows *(Arrhenatheretalia)*, of field weeds and of plants growing on various wet habitats (Fig. 11) accompanied by the fall in number of ruderals *(Onopordetalia)* and of dry grassland species *(Festuco-Brometea)*. These changes may reflect the increasing importance of animal husbandry and of the storage of cereal grain with weeds. At the same time, the development of habitation over the whole Hill surface left little space for ruderals and destroyed the remnants of dry grassland. The high number of species growing on wet soils may be connected with their expansion in the valley, due to the rise of the water level.

The analysis of plant material from pit 1 suggests that the pit was used for garbage and the refuse from cereal threshing was thrown out there. When the pit was filled up to about 2/3 of its depth its use was abandoned and it became overgrown with ruderals.

SUMMARY AND CONCLUSIONS

Plant remains were studied (pollen and macrofossils) from the medieval culture layers dated from the 9—10th to the 12/13th and to the 15th centuries A. D. A total number of 340 taxa was identified. This includes 249 species of flowering plants, 6 species of vascular cryptogams, 12 species of mosses, and one species of *Fungus*. All taxa were listed in the chapter dealing with the description of plant remains. Phytosociological affiliations and ecological requirements were established with various degree of accuracy for 273 taxa of wild plants. These taxa were listed in plant community tables and presented in the diagrams. Mosses were not discussed in the present paper, as they were the subject of special studies (Karczmarz, in print).

Most of the species appeared rarely in the material. From among 246 taxa included in plant community tables and identified on the basis of macroscopic remains, the majority (202 taxa, 82% of the total) occurred in less than 25% of the total number of soil samples (in 1—13 samples). In this group 58 taxa (24%) appeared only in one sample, 90 taxa (37%) in 2—5 samples, and 54 taxa (22%) in 6—13 samples. Most of the cultivated plants belonged to this category (11 species). 30 taxa (12%) were rather frequent, they occurred in 25—50% of all samples (in 14—27 samples). This number included 3 cultivated species, *Triticum aestivum*, *Secale cereale*, and *Brassica campestris*. Only 14 taxa (6%)

were frequent, they were found in over 50% of the samples (in more than 27 samples). Two of them, *Chenopodium album* and *Panicum miliaceum*, occurred in more than 75% of the samples. The frequent species were also represented by the highest numbers of diaspores (over 100). The following species belonged to this group (in parentheses first the number of samples, next the number of specimens are given): *Chenopodium album* (46, 5133), *Panicum miliaceum* (45, 2517), *Typha* sp. (35, ∞), *Urtica dioica* (35, 1693), *Polygonum convolvulus* (35, 591), *Chenopodium hybridum* (35, 155), *Rubus idaeus* (35, 167), *Setaria glauca* (31, 846), *Scirpus silvaticus* (30, 174), *Agrostemma githago* (29, 865), *Galeopsis tetrahit* and *G. tetrahit* type (29, 264), *Solanum nigrum* (29, 263), *Rumex tenuifolius* (28, 115). Among the less frequent species there were 12 taxa represented by over 100 fruits or seeds: *Setaria viridis* or *S. verticillata* (27, 350), *Echinochloa crus-galli* (27, 301), *Polygonum persicaria* (26, 402), *Triticum aestivum* (26, 123), *Hypericum perforatum* (26, 109), *Chenopodium urbicum* (24, 176), *Hyoscyamus niger* (23, 192), *Polygonum aviculare* (22, 192), *Secale cereale* (19, 214), cf. *Malachium aquaticum* (19, 159), *Ranunculus repens* (18, 283), *Galium spurium* (17, 106). In the group classified here as rare species two were rather abundant, namely *Ranunculus sceleratus* (10, 107) and *Atriplex* cf. *nitens* (7, 101).

As can be seen from the above lists, the great majority of species frequent and abundant among macrofossils are synanthropic plants. Part of them grew on ruderal habitats *(Onopordetalia, Polygonum aviculare)* and part occurred as weeds in gardens and field cultivations *(Secali-Violetalia)*. Ruderals probably occurred on the Hill. Some garden weeds may also have grown within the settlement but the majority of weeds was brought together with crops of cultivated plants, mainly cereals, from the fields situated outside of the Hill. Many of these species were still known as common contamination of cereal grain in modern times, for instance *Agrostemma githago*, *Galeopsis tetrahit* and other species of this genus, *Setaria viridis* (more seldom *S. verticillata*), *S. glauca*, *Echinochloa crus-galli*, *Polygonum convolvulus*, *P. persicaria*, and *Chenopodium album* (Dobrochotow 1961; Mowszowicz 1955).

Besides cereals, two frequent species were directly used by the inhabitants, *Rubus idaeus*, collected for its edible fruits and *Typha* sp. gathered for unknown purpose.

The remaining six frequent species were connected with two types of habitats, as far as soil moisture is concerned. *Scirpus silvaticus* and *Ranunculus repens* included here in *Molinietalia*, cf. *Malachium aquaticum* of the alliance *Salicion*, and *Ranunculus sceleratus* of *Bidentetalia* grew on wet soils, which could be found in low lying parts of the river valleys. Their diaspores were probably brought to the Hill together with plants of moist meadows. *Rumex tenuifolius* of *Sedo-Scleranthetea* and *Hypericum perforatum* of *Arrhenatheretalia* may have grown in meadows which occupied drier soils on slightly higher grounds and were grazed and used for harvesting hay.

The description of the vegetation presented in this paper was based on

the hypothetical occurrence of plant communities reconstructed from the appearance of species known to-day as their characteristic species or those most frequently growing in them. Four types of communities were best represented: meadows of the class *Molinio-Arrhenatheretea*, field weeds of the order *Secali-Violetalia*, ruderal communities of the order *Onopordetalia* and xerothermic grasslands of the class *Festuco-Brometea*. Each group of plant communities was described and possible places of their occurrences were indicated.

It may be of interest to compare the results of the analysis of plant material from the Wawel with the reconstruction of the potential natural vegetation of the Cracow area presented by Kornaś and Medwecka-Kornaś (1974). These authors distinguished six plant-community complexes occupying different soils in different topographic situations and for each complex indicated the primary and the secondary, anthropogenic communities.

In the subfossil material from the Wawel the largest group of plants is formed of species connected with communities of the oak-hornbeam forest complex. They constitute 38% of the total number of species and they dominate over the species of other complexes in all layers with the exception of the LM layer Vb (Table 6). They are more numerous in samples from special objects than in random samples because of the greater proportion of field weeds in the first group of samples. Species of the habitats of this complex represent almost exclusively the secondary plant communities, which expanded after the destruction of natural forests *(Arrhenatheretalia, Secali-Violetalia, Onopordetalia, Atropetalia)*. Only 4% of species belong to the natural communities of the alliance *Carpinion*.

Plants of the complex of riverside forests are the second largest group constituting 30% of the total number of species. The highest percentage number of species is found in the LM layer Vb, the smallest number occurs in the samples from archaeological objects. Contrary to the relations among the species of oak-hornbeam forest complex, in the riverside forest complex plants of natural communities play a more important role than those of secondary communities *(Potametea, Phragmitetalia, Isoëto-Nanojuncetea, Bidentetalia, Salicion, Alno-Padion, Alnion*, and perhaps partly *Potentillo-Polygonetalia* and *Molinietalia)*.

Xerothermic brushwood complex is represented by 12·8% of species, with its distinct minimum in the LM layer Vb and maximum in pit 1. Species of the class *Festuco-Brometea*, which are the main representatives of this complex, may have grown in primary or secondary communities.

A small number of species is connected with other complexes. Four per cent of species were assigned here to the complexes of oak-pine and pine forests. The higher proportion of them in random samples as compared to archaeological objects is caused by the fact that several species were found only in the pollen spectra.

Analysis of the plant material has proved useful in the characterization

of archaeological layers. It was possible to infere the predominance of certain types of human activities during the formation periods of certain layers. It was also possible to demonstrate the uneven spatial distribution of several plant communities within one layer (VIe), probably reflecting the distribution of human activities in this part of the settlement. This question could not be discussed in greater detail as no detailed archaeological studies have been made.

It was attempted to connect some of the changes in the stratigraphic appearance of plants of the riverside forest complex with the possible oscillations of water table. Certain changes in the pollen and macrofossil diagrams were interpreted as the result of the lowering of water level during the formation of layers VIf (9—10th century) and VIe_4 (10—11th century) and of its rise during the accumulation of the layer VIe (11—12th century). This hypothesis should be checked in farther studies, but it agrees with the observation of Radwański (1972, 1975) that in the 11th century the medieval settlement of the Cracow area withdrew to ground slightly higher than that which it occupied in the 9—10th century A. D.

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STRESZCZENIE

SZCZĄTKI ROŚLINNE Z WCZESNEGO I PÓŹNEGO ŚREDNIOWIECZA ZNALEZIONE NA WZGÓRZU WAWELSKIM W KRAKOWIE

WSTĘP

Początki badań nad średniowieczną roślinnością Krakowa sięgają lat trzydziestych naszego stulecia, kiedy to w wykopach na Rynku Głównym stwierdzono występowanie bogatej i stratygraficznie zróżnicowanej flory (Szafer, nie publ.). Po drugiej wojnie światowej, wraz z dynamicznym rozwojem badań archeologicznych, nastąpiło ożywienie zainteresowania szczątkami roślin zachowanymi w warstwach osadniczych. Ukazało się wiele prac opisujących rośliny znajdowane w wykopaliskach rozrzuconych na terenie całego miasta, a pochodzące z różnych okresów pradziejów. M. in. pojawiły się także opracowania wczesnośredniowiecznych szczątków roślinnych ze Wzgórza Wawelskiego (Burchardówna 1953; Giżbert & Żaki 1954; Giżbert 1960; Klichowska 1955, 1956, 1964). Najpełniejsza lista roślin opublikowana przez Klichowską (1964) obejmowała 21 gatunków roślin dzikich i 19 gatunków roślin uprawnych.

Obecne badania rozpoczęto w 1955 r. z inicjatywy prof. dra W. Szafera i doc. dra A. Żakiego. W pierwszym etapie, poświęconym zebraniu materiału i wstępnym oznaczeniom, w badaniach tych oprócz autorki wzięli udział doc. dr M. Reymanówna, która wykonała analizy węgli i drewien oraz prof. dr B. Szafran, który oznaczył kilka gatunków mchów. Po dłuższej przerwie badania podjęto ponownie w 1972 r. przy współudziale dr W. Koperowej, która wykonała analizę pyłkową i prof. dra K. Karczmarza, który zajął się szczegółowym opracowaniem mchów. Podobne badania na materiale roślinnym z Rynku Głównego przeprowadziła A. Wieserowa (w druku). Oba opracowania, dotyczące materiału roślinnego z Wawelu i z Rynku Głównego, tworzą pewną całość i uzupełniają się wzajemnie, szczególnie w części systematycznej. Duża część oznaczeń szczątków makroskopowych została przedyskutowana przez obie autorki, a opisy morfologiczne i rysunki tych samych gatunków podano zasadniczo tylko w jednej z prac, chyba że po-

wtórzenie uznano za celowe. W rezultacie tych dwu opracowań, uzupełnionych przez oznaczenia mchów (Karczmarz, w druku), średniowieczna flora Krakowa, licząca ponad 400 taksonów, należy do najlepiej zbadanych flor miejskich z tego okresu.

POŁOŻENIE WZGÓRZA WAWELSKIEGO, OSADNICTWO, DATOWANIE WARSTW ARCHEOLOGICZNYCH

Położenie Wzgórza ilustruje ryc. 1, a jego zabudowę średniowieczną ryc. 2[1] (Jamka 1963; Radwański 1975; Żaki 1956). Datowanie warstw archeologicznych oparte na ceramice zostało sprawdzone przez dra S. Kozieła w 1975 r. Wiek warstw podano w tabelach i diagramach. Dokładniejsze określenie charakteru warstw archeologicznych nie było możliwe ze względu na to, że materiał archeologiczny z tej części Wzgórza nie został w pełni opracowany.

Określenia wczesne średniowiecze używano w pracy w odniesieniu do okresu od około 550 do 1257 r. n.e. (data wielkiej lokacji Krakowa), późne średniowiecze — w stosunku do okresu od 1257 do 1492 r.

METODA

Zbieranie prób i ich przygotowanie laboratoryjne

Próby do badań botanicznych pochodzą z rejonów VB, VIB, X i XII (ryc. 3, tab. 1, 2, 3). Większość z nich zebrano w wykopie szerokoprzestrzennym z rejonu X. Serie prób ziemi do badań makroskopowych pobrano ze ścian wykopu w 13 punktach (ryc. 4, 5, 6[1]). Opracowano tylko po 1—5 prób z każdej warstwy. Próby te nie były związane z rozpoznanymi w terenie obiektami archeologicznymi i są określone w tabelach jako próby losowe z warstw, reprezentujące przeciętny skład każdej warstwy. Oprócz prób losowych zbadano próby z obiektów archeologicznych: 12 prób z jamy 1, jedną próbę z chaty 3 i jedną z korobki. Łącznie ze wszystkich rejonów zbadano dokładnie pod względem składu ilościowego i jakościowego 55 prób ziemi oraz 43 próby złożone wyłącznie z pestek lub łupin orzechów. Ponadto pobieżnie przejrzano 48 prób ziemi (próby dodatkowe) oznaczając tylko dominujące zboża i niektóre bardziej interesujące gatunki. Węgle i drewna opracowano z 44 prób (M. Reymanówna) oraz wykonano analizę pyłkową 16 prób pochodzących z jednego profilu zebranego w punkcie II (W. Koperowa).

Do laboratoryjnego przygotowania prób użyto metod normalnie stosowanych w badaniu flor czwartorzędowych.

Tabele i diagramy

W tabelach i diagramach zestawiono tylko te taksony, które można było powiązać z określonymi zbiorowiskami roślinnymi (oznaczenia gatunkowe i niektóre rodzajowe). Pełna lista roślin oznaczonych z Wawelu ukaże się w oddzielnej pracy (Wasylikowa, w druku).

[1] Ryc. 2, 5, 6 i tab. 3 zamieszczono na końcu zeszytu.

Tabele 5, 10, 11, 14, 16—18[2] pozwalają zorientować się w występowaniu gatunków w poszczególnych warstwach archeologicznych i w zbadanych obiektach archeologicznych. Pozycje w rubryce „Liczba prób / liczba punktów" podają ogólną liczbę prób zbadanych z każdej warstwy i liczbę punktów na planie wykopu, z których te próby zostały zebrane. Dla każdego taksonu pierwsza cyfra oznacza liczbę prób, w których znaleziono szczątki makroskopowe danego taksonu, druga liczbę punktów, z których te próby pochodzą. „Suma w VIe" obejmuje wszystkie próby z warstwy VIe w rejonie X, tzn. próby losowe, próby z jamy 1, z chaty 3 i z korobki. „Ogólna liczba prób" obejmuje wszystkie próby zawierające szczątki makroskopowe danego taksonu (łącznie z próbami ubogimi w szczątki i próbami z warstw przejściowych pominiętymi w środkowej części tabeli), z wyjątkiem dodatkowych prób ziemi oraz prób pestek i orzechów. „Suma okazów" obejmuje liczbę owoców i nasion (w kilku przypadkach innych szczątków makroskopowych) znalezionych w próbach objętych ogólną liczbą prób.

Tabela 6 podaje dla wyróżnionych jednostek fitosocjologicznych i dla kompleksów zbiorowiskowych liczbę taksonów znalezionych w poszczególnych warstwach i obiektach. Kompleksy zbiorowiskowe przyjęto według Kornasia i Medweckiej-Kornaś 1974, z uzupełnieniami z Trzcińskiej-Tacik i Wieserowej (1976). „Suma w VIe" obejmuje taksony znalezione we wszystkich próbach z warstwy VIe w rejonie X (patrz wyżej). „Suma gatunków" obejmuje taksony znalezione we wszystkich zbadanych próbach, łącznie z dodatkowymi próbami ziemi. Procenty dla wszystkich grup, z wyjątkiem roślin uprawnych, obliczono w stosunku do sumy gatunków roślin dzikich znalezionych w danej warstwie lub obiekcie. Procenty dla ogólnej sumy gatunków (przedostatnia kolumna) oparto na ogólnej sumie gatunków (bez roślin uprawnych) znalezionych w całym materiale. Procenty roślin uprawnych obliczono w stosunku do tych samych sum z włączeniem do nich roślin uprawnych.

Diagramy na ryc. 8, 9, 10[2] ilustrują procentowy udział owoców i nasion w poszczególnych próbach. W części górnej diagramów podano próby z poszczególnych warstw archeologicznych. Próby z rejonu X zostały uporządkowane na osi pionowej w ten sposób, że próby z tej samej warstwy, choć z różnych części wykopu, narysowano jedna nad drugą, mniej więcej zgodnie z ich głębokościami. Ta część diagramów ilustruje udział procentowy diaspor poszczególnych gatunków w ośmiu warstwach z wczesnego i w jednej z późnego średniowiecza. W dolnej części diagramów umieszczono serię prób z jamy 1 i z warstw nadległych zebraną jako jeden ciągły profil. Próby z warstw nadległych (nr 3a, 3b, 3c, 3d, 3e) zostały powtórzone w górnej części diagramów. Poniżej podano próbę z chaty 3, z korobki i dwie próby z rejonu XII.

Głębokość prób mierzono w stosunku do poziomów „0", które dla poszczególnych rejonów znajdowały się na wysokościach:

[2] Tab. 5, 6, 10, 11, 14, 16 i 17 oraz ryc. 8—11 zamieszczono na końcu zeszytu.

rejon X, wykop szerokoprzestrzenny — 223,84 m n.p.m.
rejon VIB — 225,035 m n.p.m.
rejon VB — 228,535 m n.p.m.
rejon XII — 229,74 m n.p.m.
Diagram na ryc. 11 jest graficzną ilustracją tabeli 6.

OPIS OZNACZONYCH SZCZĄTKÓW

W rozdziale tym wymieniono wszystkie taksony oznaczone z Wawelu na podstawie owoców, nasion i liści (autorka), na podstawie węgli i drewien (M. Reymanówna, nie publ.), na podstawie pyłku i spor (W. Koperowa, nie publ.), oraz mchy oznaczone przez B. Szafrana (nie publ.). Nie uwzględniono wyników analizy mchów, wykonanej ostatnio przez K. Karczmarza (w druku). Opisy morfologiczne dotyczą tylko taksonów oznaczonych przez autorkę. W każdym opisie podano ogólną liczbę okazów znalezionych we wszystkich próbach zbadanych dokładnie pod względem ilościowym i jakościowym oraz liczbę prób, w których dany takson wystąpił. Ponadto zanotowano (bez podania ilości) występowanie gatunków w próbach dodatkowych. Większość szczątków była nie zwęglona, znalezienie okazów zwęglonych zaznaczono w opisie. Pomiary na ogół wykonano na okazach suchych. W kilku przypadkach mierzono okazy wilgotne tuż po szlamowaniu, a po kilku latach pomiar powtórzono na okazach suchych. We wszystkich tych przypadkach stwierdzono skurczenie okazów. Przy końcu opisu podano przynależność fitosocjologiczną, o ile można ją było ustalić, oraz numer tabeli, w której dany takson został umieszczony. Występowanie tych taksonów w poszczególnych warstwach można odczytać z tabel, natomiast rozmieszczenie taksonów o nieokreślonej przynależności fitosocjologicznej, które pominięto w tabelach, podano przy opisach morfologicznych.

Nazwy roślin (z kilku wyjątkami) przyjęto według „Roślin polskich" (Szafer *et al.* 1953), nazwy obowiązujące według „Flora europaea" podano w nawiasach. Klasyfikację fitosocjologiczną przyjęto wg „Szaty roślinnej Polski" (Medwecka-Kornaś *et al.* 1972) z uzupełnieniami z Ellenberga (1974).

REKONSTRUKCJA ŚREDNIOWIECZNYCH ZBIOROWISK ROŚLINNYCH

Rekonstrukcję roślinności oparto na podstawach fitosocjologicznych wychodząc z założenia, że średniowieczne zespoły roślin były podobne do dzisiejszych. Do danej jednostki fitosocjologicznej zaliczono gatunki uważane obecnie za charakterystyczne dla tej jednostki i dla należących do niej jednostek niższego rzędu oraz gatunki, które obecnie najczęściej występują w zespołach tej jednostki (Trzcińska-Tacik & Wieserowa 1976). W przypadku 11 gatunków zastosowano inne kryteria klasyfikacyjne, mianowicie kierowano się ich przypuszczalnym występowaniem na siedliskach naturalnych lub przebiegiem krzywych ich diaspor w diagramach.

Ekologiczne warunki występowania znalezionych roślin scharakteryzowano

dodatkowo na podstawie liczb wilgotności (F, tab. 7), zasobności w azot (N, tab. 8) i odczynu gleby (R, tab. 9) wprowadzonych przez Ellenberga (1974).

Opisano około 20 zbiorowisk roślinnych, z których mogły pochodzić gatunki znalezione w materiale (tab. 6). Niektóre z nich rozwijały się na miejscu, ale większość występowała poza terenem Wzgórza.

Przedstawiono dokładniejszą charakterystykę najliczniej reprezentowanych zbiorowisk z rzędów *Secali-Violetalia* i *Onopordetalia* oraz z klas *Molinio-Arrhenatheretea* i *Festuco-Brometea*.

Wśród chwastów (tab. 11) stwierdzono występowanie 11 gatunków charakterystycznych dla *Caucalidion* i na tej podstawie wyrażono przypuszczenie, że część zboża sprowadzano na Wawel z terenu Wyżyny Miechowskiej, gdzie zespół ten mógł mieć najlepsze warunki rozwoju. Analiza gatunków charakterystycznych chwastów i analiza liczb wskaźnikowych Ellenberga pozwala przypuszczać, że chwasty pochodziły z dwu typów upraw i trzech typów siedlisk. Chwasty z *Polygono-Chenopodietalia* mogły rosnąć na glebach świeżych do wilgotnych, bogatych w azot. Były przypuszczalnie związane z uprawami ogrodowymi i z uprawą prosa. Mogły rosnąć na Wzgórzu w ogródkach. Chwasty z *Centauretalia* były związane głównie z ozimą, a częściowo i z jarą uprawą zbóż, większość (przede wszystkim gatunki ze związku *Caucalidion*) rosła na glebach suchszych, bogatych w węglan wapnia, o niskiej zawartości azotu. Natomiast obecność trzech gatunków acidofilnych (*Scleranthus arvensis*, *Spergula arvensis* var. *arvensis*, *Aphanes arvensis*) wskazuje, że część pól znajdowała się na glebach kwaśnych, piaszczystych. Wyraźną różnicę w stosunku do dzisiejszych zespołów chwastów polnych stanowił niemal zupełny brak *Centaurea cyanus*. Rozprzestrzenienie się bławatka w okolicy Krakowa nastąpiło przypuszczalnie około przełomu 12 i 13 wieku n.e., ponieważ w warstwach z tego okresu z Rynku Głównego wyraźnie zwiększył się udział pyłku tego gatunku (Koperowa, nie publ.). Chwasty z podrzędu *Centauretalia* prawdopodobnie nie rosły trwale na Wzgórzu Wawelskim, ale dostawały się tam jako zanieczyszczenie zboża.

Duży udział gatunków zaliczonych do klasy *Molinio-Arrhenatheretea* we wszystkich warstwach wskazuje na znaczne rozprzestrzenienie się łąk świeżych i wilgotnych w okolicy (tab. 14). Rośliny tych łąk były zawlekane na Wzgórze przypadkowo przez ludzi i zwierzęta, albo przynoszone celowo jako pasza dla zwierząt. We wczesnym średniowieczu ważniejszą rolę odgrywały łąki wilgotne z rzędu *Molinietalia*, które mogły być nieregularnie ścinane. Nieco większy udział gatunków łąk świeżych z *Arrhenatheretalia* zaznaczył się w dwu warstwach wczesnośredniowiecznych VIg i VIe, a wyraźną przewagę nad gatunkami łąk wilgotnych uzyskały one w warstwie Vb z 15 w. Łąki świeże użytkowano jako pastwiska i łąki kośne, więc wzrost liczby ich gatunków w warstwach osadniczych może wskazywać na bardziej intensywne użytkowanie tych łąk, a tym samym na większą rolę hodowli zwierząt domowych (przynajmniej w tej części Wzgórza).

W przeciwieństwie do dwu poprzednich grup, rośliny ruderalne z rzędu *Onopordetalia* (tab. 10) rosły na samym Wzgórzu, w miejscach wzbogaconych

w azot przez odpadki i odchody, ale nie narażonych na ustawiczne deptanie (por. duża liczba gatunków i okazów w chacie 3 i w stropie jamy 1, ryc. 10 i 11). Gatunki z klasy *Festuco-Brometea* mogły pojawiać się na Wzgórzu w niewielkich płatach muraw, a częściowo mogły być zawlekane ze zbożem (tab. 16).

Z roślin leśnych wśród szczątków makroskopowych najlepiej były reprezentowane gatunki łęgów wierzbowo-topolowych lub wtórnych zarośli wierzbowych *(Salicion)*. Z gatunków grądowych w większej liczbie zachowały się tylko te, które dostarczały jadalnych owoców (tab. 17).

Rośliny uprawne reprezentowane są przez 20 gatunków (tab. 18). Wśród zbóż dominuje proso znalezione niemal we wszystkich próbach. Na drugim miejscu wystąpiły pszenica i żyto, znacznie mniej było owsa, a tylko sporadycznie pojawił się jęczmień. Przewaga prosa wskazuje, że było ono pospolitym składnikiem pożywienia mieszkańców tej części Wzgórza. Wydaje się jednak, że przy ocenie roli, jaką odgrywało proso w pożywieniu, trzeba także uwzględnić wybiórczość materiału dostępnego badaniom, działającą na korzyść prosa. Odmienny niż w przypadku pszenicy i żyta sposób przechowywania i obróbki ziarna sprawiał, że oplewione ziarniaki lub puste plewki prosa były rozsypywane na ziemi w obrębie niemal całego obejścia. Z kolei zaś odporność plewek na rozkład i łatwość ich oznaczania przyczyniały się do tego, że były one częściej znajdowane w średniowiecznych warstwach kulturowych aniżeli pozostałe zboża, zachowane niemal wyłącznie w stanie zwęglonym.

CHARAKTERYSTYKA BOTANICZNA WARSTW ARCHEOLOGICZNYCH

Stwierdzono, że warstwy archeologiczne wyróżnione w trakcie prac wykopaliskowych różnią się składem gatunkowym roślin (ryc. 11, tab. 6) i ilościowym występowaniem diaspor różnych gatunków (ryc. 10). Warstwy VIg i VIe charakteryzuje większy udział chwastów i roślin łąkowych, przypuszczalnie w wyniku prowadzonej na miejscu działalności gospodarczej związanej z gromadzeniem zbóż z chwastami, trzymaniem zwierząt domowych pasących się na łąkach i gromadzeniem dla nich paszy. Warstwy VIf, VIe_4 i górna część VIc—d charakteryzuje duży udział roślin ruderalnych z *Onopordetalia*, wskazując na czasowe opuszczenie terenu przez mieszkańców. W obrębie warstwy VIe, przy ogólnym uporządkowaniu terenu (mała liczba gatunków roślin ruderalnych w próbach losowych), zbiorowiska ruderalne rozwijały się bujnie przy chacie 3 i przy jamie 1 (ryc. 11).

Zawartość jamy 1 pozwoliła na wyróżnienie 3 faz rozwoju jamy: dwu dolnych faz użytkowania jej jako jamy odpadkowej (dużo chwastów, ryc. 10 i 11) oraz fazy najmłodszej, gdy po wypełnieniu jamy do 2/3 została ona zarośnięta przez rośliny ruderalne z *Onopordetalia*.

PODSUMOWANIE I WNIOSKI

Z Wawelu opisano łącznie 340 taksonów, w tym 249 gatunków roślin kwiatowych, 6 gatunków paprotników, 12 gatunków mchów i 1 gatunek grzyba. Przynależność fitosocjologiczną ustalono dla 273 taksonów.

Przeprowadzono analizę częstości występowania gatunków stwierdzonych na podstawie szczątków makroskopowych. Spośród 246 taksonów oznaczonych na podstawie szczątków makroskopowych, dla których ustalono przynależność fitosocjologiczną, większość, tj. 202 taksony (82%), należała do form dość rzadkich, znalezionych w mniej niż 25% zbadanych prób (w 1—13 próbach). W obrębie tej grupy ponad połowa gatunków wystąpiła tylko w 1—5 próbach. 30 gatunków (12%) było dość częstych, tzn. wystąpiły w 14—27 próbach (w 25—50% prób). Jako częste można określić 14 taksonów (6%) znalezionych w ponad 50% prób (w ponad 27 próbach), a dwa z nich, *Chenopodium album* i *Panicum miliaceum*, wystąpiły niemal we wszystkich próbach (w ponad 75% prób). Gatunki częste były reprezentowane także przez największą liczbę diaspor (ponad 100, niektóre ponad 1000 okazów). Większość gatunków, których szczątki makroskopowe wystąpiły często i obficie, należała do roślin synantropijnych.

Nawiązując do kompleksów zbiorowiskowych roślinności potencjalnej opisanych przez Kornasia i Medwecką-Kornaś (1974) stwierdzono, że większość gatunków znalezionych w stanie subfosylnym wiąże się z kompleksem grądów (38%, tab. 6), nieco mniej z kompleksem łęgów (30%). Dość dobrze reprezentowany jest kompleks ciepłych zarośli (12,8%). W obrębie kompleksu grądów przeważają zdecydowanie zbiorowiska antropogeniczne *(Onopordetalia, Secali-Violetalia, Arrhenatheretalia, Atropetalia)*, w obrębie łęgów większą rolę odgrywają zbiorowiska naturalne lub na pół naturalne *(Potametea, Phragmitetalia, Isoëto-Nanojuncetea, Bidentetalia, Salicion, Alno-Padion, Alnion, Molinietalia* i częściowo *Potentillo-Polygonetalia)*.

Przeprowadzono próbę powiązania pewnych zmian w występowaniu gatunków kompleksu łęgowego z wahnieniami poziomu wody i wskazano na możliwość obniżenia się poziomu w czasie formowania się warstw VIf (9—10 wiek n.e.) i VIe_4 (10—11 wiek) oraz ponownego jego podniesienia się w czasie tworzenia się warstwy VIe (11—12 wiek).

PLATES

TABLICE

Plate I

Tablica I

1, 2, 3. *Pteridium aquilinum*, three fragments of tertiary leaves (trzy fragmenty listków trzeciego rzędu)
4. *Alisma plantago-aquatica*, seed (nasienie)
5. *Amaranthus lividus* cf. var. *lividus*, seed (nasienie)
6. *Cerinthe minor*, fruit (owoc)
7, 8. *Lithospermum arvense*, 7. fruit with outer layer of pericarp (owoc z zewnętrzną warstwą owocni), 8. one fruit without outer layer of pericarp, from ventral and lateral sides (jeden owoc bez zewnętrznej warstwy owocni, od strony brzusznej i z boku)
9. *Symphytum officinale*, fruit (owoc)
10. *Campanula persicifolia*, seed and its cross-section (nasienie i jego przekrój poprzeczny)
11. *C. patula*, seed and its cross-section (nasienie i jego przekrój poprzeczny)
12. *C. trachelium* type, one seed from two sides (jedno nasienie z dwu stron)
13, 14. *Cannabis sativa*, 13. fruit with remnants of outer layer of pericarp (owoc z resztką zewnętrznej warstwy owocni), 14. fruit without outer layer of pericarp (owoc bez zewnętrznej warstwy owocni)
15. *Atriplex* cf. *nitens*, seed (nasienie)
16. *Chenopodium album* s. str., seed (nasienie)
17. *C.* cf. *opulifolium*, seed (nasienie)
18. *C.* cf. *viride*, seed (nasienie)

Each scale line equals 1 mm. Figs. 15—18 are at the same magnification (Podziałka oznacza 1 mm. Ryc. 15—18 są w tym samym powiększeniu)

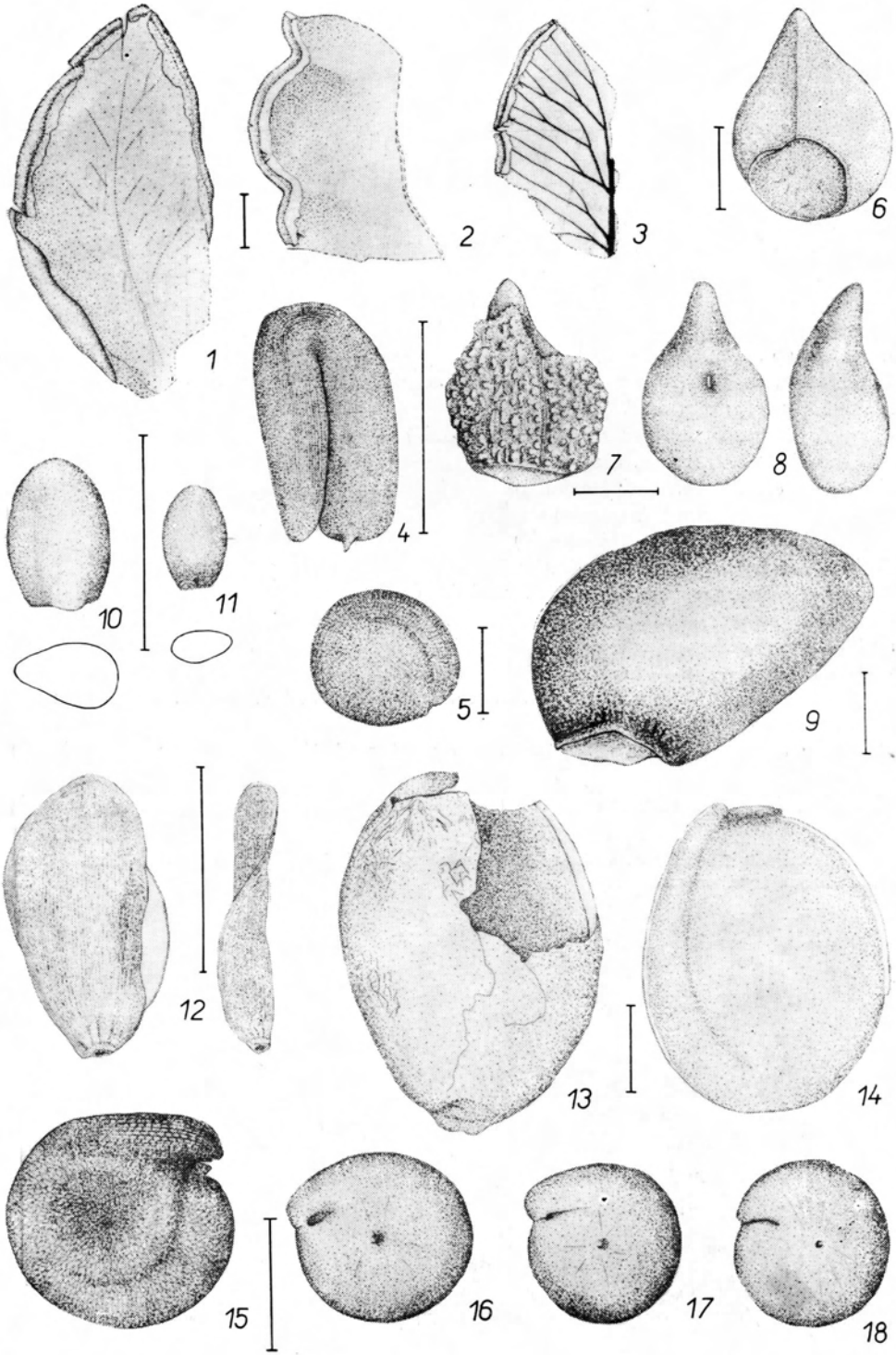
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Plate II

Tablica II

1. *Dianthus* sp., seed (nasienie)
2. *D. armeria*, seed and fragment of testa (nasienie i fragment testy)
3. *Moehringia trinervia*, seed (nasienie)
4. *Spergula arvensis* var. *arvensis*, seed (nasienie)
5. *S. arvensis* var. *maxima*, seed (nasienie)
6. *Cerastium silvaticum*, seed (nasienie)
7. cf. *Silene inflata*, seed (nasienie)
8. *Saponaria officinalis*, seed (nasienie)
9. *Melandrium rubrum*, seed (nasienie)
10. *Camelina microcarpa* ssp. *sylvestris*, seed (nasienie)
11. *Conringia orientalis*, subfossil seed and fragment of testa showing a — outer layer of pericarp and b — under layer (subfosylne nasienie i fragment testy z widoczną a — zewnętrzną warstwą owocni i b — warstwą leżącą poniżej)
12. *C. orientalis*, two fragments of testa from one extant seed (dwa fragmenty testy z jednego współczesnego nasienia)
13. *Camelina alyssum*, fragment of testa of extant seed (fragment testy ze współczesnego nasienia)
14. *C. sativa*, fragment of testa of extant seed (fragment testy ze współczesnego nasienia)

Each scale line equals 1 mm. Figs. 3—9 are at the same magnification (Podziałka oznacza 1 mm. Ryc. 3—9 są w tym samym powiększeniu)

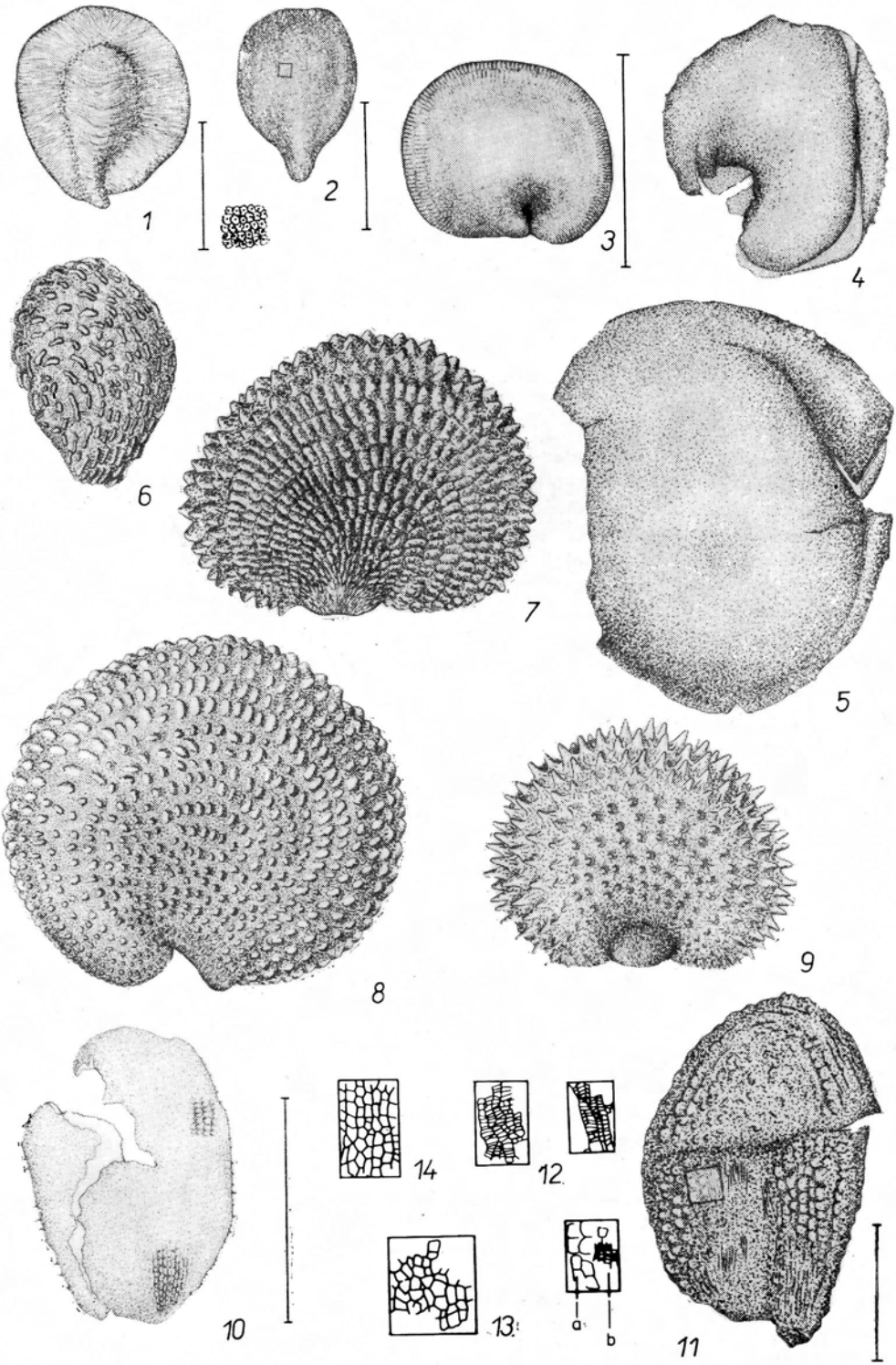
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Plate III

Tablica III

1, 2. *Centaurea* cf. *austriaca*, 1. involucral bracts (łuski okrywy koszyczka), 2. fruit (owoc)
3. *C. jacea*, fruit (owoc)
4. *C. scabiosa*, fruit (owoc)
5, 6. *C.* sp., two fruits without outer layer of pericarp (dwa owoce bez zewnętrznej warstwy owocni), 5. uncharred specimen (okaz niezwęglony), 6. charred specimen (okaz zwęglony)
7. *Carduus crispus* or *C. acanthoides*, fruit (owoc)
8. *C.* cf. *nutans*, fruit (owoc)
9. *Cirsium arvense*, fruit (owoc)
10. *C. oleraceum* type, fruit (owoc)
11. *Knautia arvensis*, fruit (owoc)
12. *Convolvulus arvensis*, seed (nasienie)
13. *Brassica campestris*, one seed from two sides (jedno nasienie z dwu stron)

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

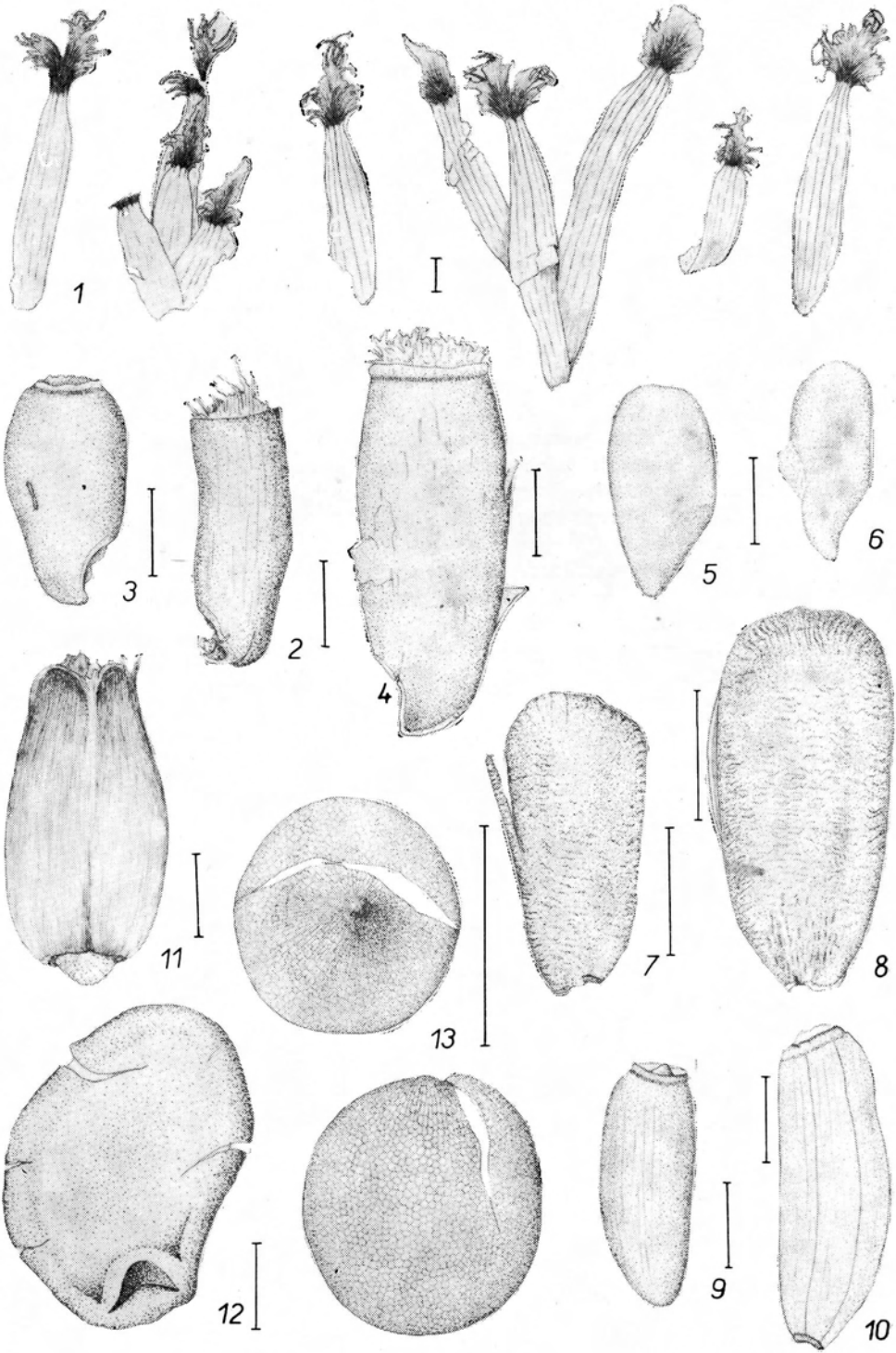
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Plate IV

Tablica IV

1, 1. *Heleocharis palustris*, two fruits (dwa owoce)
3. *Cyperus flavescens*, fruit (owoc)
4, 5. *Carex leporina*, 4. fruit (owoc), 5. fruit with utricle (owoc z pęcherzykiem)
6, 7. *C.* cf. *vulpina*, 6. utricle (pęcherzyk), 7. fruit (owoc)
8, 9. *C. vesicaria*, 8. utricle (pęcherzyk), 9. fruit (owoc)
10. *C. caryophyllea* type, fruit (owoc)
11. *C. fusca*, fruit (owoc)
12, 13. *C.* sect. *Muehlenbergianae*, 12. fruit with remnants of utricle (owoc z resztkami pęcherzyka), 13. fruit without utricle (owoc bez pęcherzyka)
14, 15. *C. hirta*, 14. utricle (pęcherzyk), 15. fruit (owoc)
16, 17. *C. rostrata*, 16. utricle (pęcherzyk), 17. fruit (owoc)
18, 19. *Scirpus silvaticus*, 18. fruit (owoc), 19. seed (nasienie)
20. *Blysmus compressus*, fruit (owoc)

Each scale line equals 1 mm. Figs. 3—17 are at the same magnification (Podziałka oznacza 1 mm. Ryc. 4—17 są w tym samym powiększeniu)

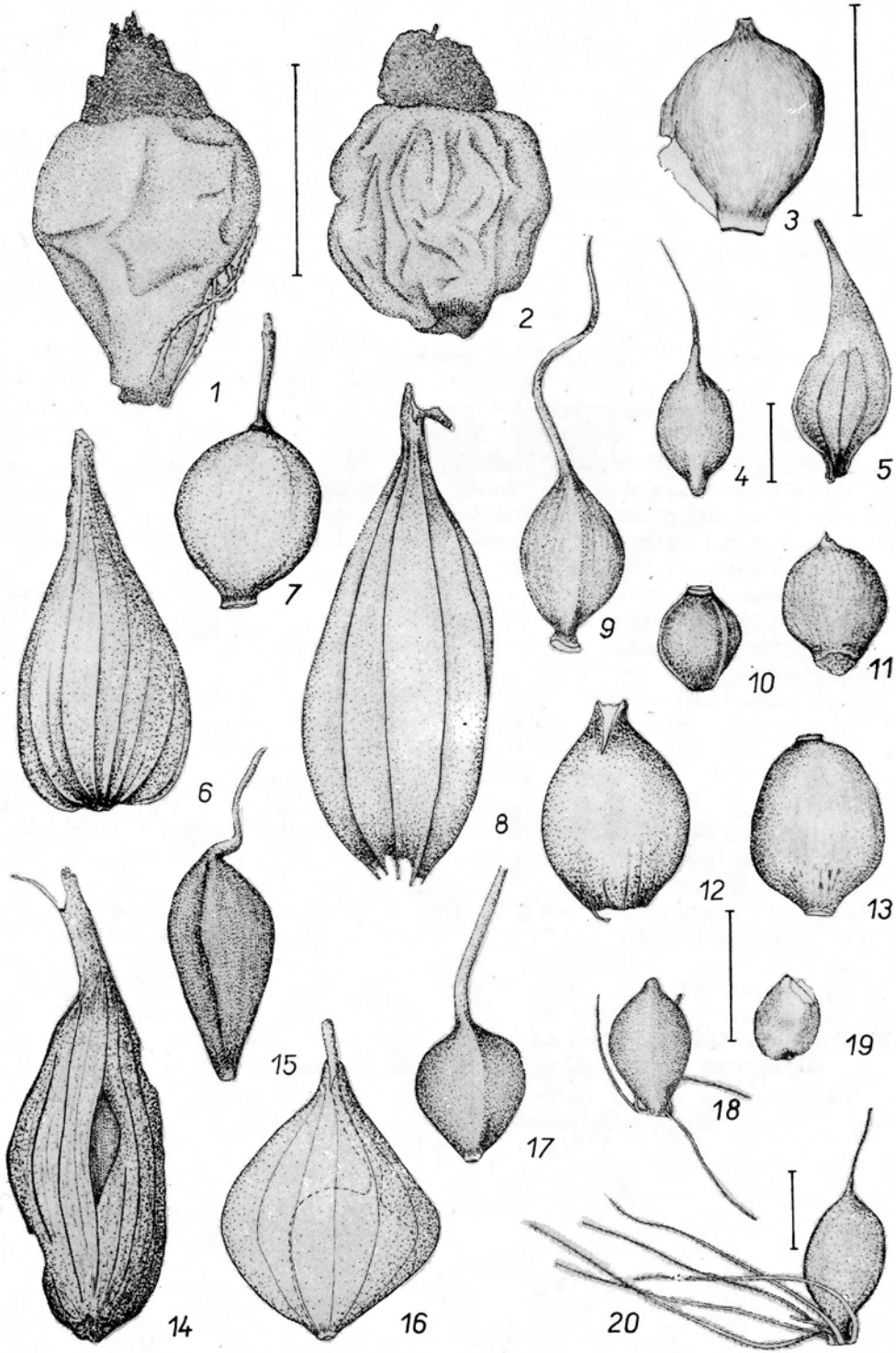
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Plate V

Tablica V

1. *Euphorbia platyphyllos*, one seed from ventral and lateral sides (jedno nasienie od strony brzusznej i z boku)
2. *E.* sp., one seed from ventral and lateral sides (jedno nasienie od strony brzusznej i z boku)
3. *Geranium* cf. *silvaticum*, seed (nasienie)
4. *Avena* sp., one charred caryopsis from ventral, dorsal and lateral sides (jeden zwęglony ziarniak od strony brzusznej, grzbietowej i z boku)
5. *Avena sativa*, uncharred caryopsis with remnants of lemma and floret base (niezwęglony ziarniak z resztką plewki dolnej i nasadą kwiatka)
6. *Bromus secalinus*, one charred caryopsis from ventral and lateral sides (jeden niezwęglony ziarniak od strony brzusznej i z boku)
7. *Agropyron repens*, one charred caryopsis from ventral and lateral sides (jeden zwęglony ziarniak od strony brzusznej i z boku)
8. *Digitaria ischaemum*, one charred caryopsis from ventral and dorsal sides (jeden zwęglony ziarniak od strony brzusznej i grzbietowej)
9, 10. *D. sanguinalis*, 9. uncharred spikelet from ventral side (niezwęglony kłosek od strony brzusznej), 10. charred caryopsis from dorsal side with remnants of lemma (zwęglony ziarniak od strony grzbietowej z resztką plewki dolnej)
11. *Poa* sp., one charred caryopsis with remnants of palea and lemma, from ventral and lateral sides (jeden zwęglony ziarniak z resztkami plewek, od strony brzusznej i grzbietowej)
12. *Phleum pratense*, uncharred caryopsis from lateral side (niezwęglony ziarniak z boku)
13. *Secale cereale*, one charred caryopsis from ventral, dorsal, and lateral sides (jeden zwęglony ziarniak od strony brzusznej, grzbietowej i z boku)
14. cf. *Festuca pratensis*, one charred caryopsis from ventral, dorsal, and lateral sides (jeden zwęglony ziarniak od strony brzusznej, grzbietowej i z boku)
15, 16. *Triticum aestivum* s. l., two charred caryopses from dorsal, ventral, and lateral sides (dwa zwęglone ziarniaki od strony grzbietowej, brzusznej i z boku)

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

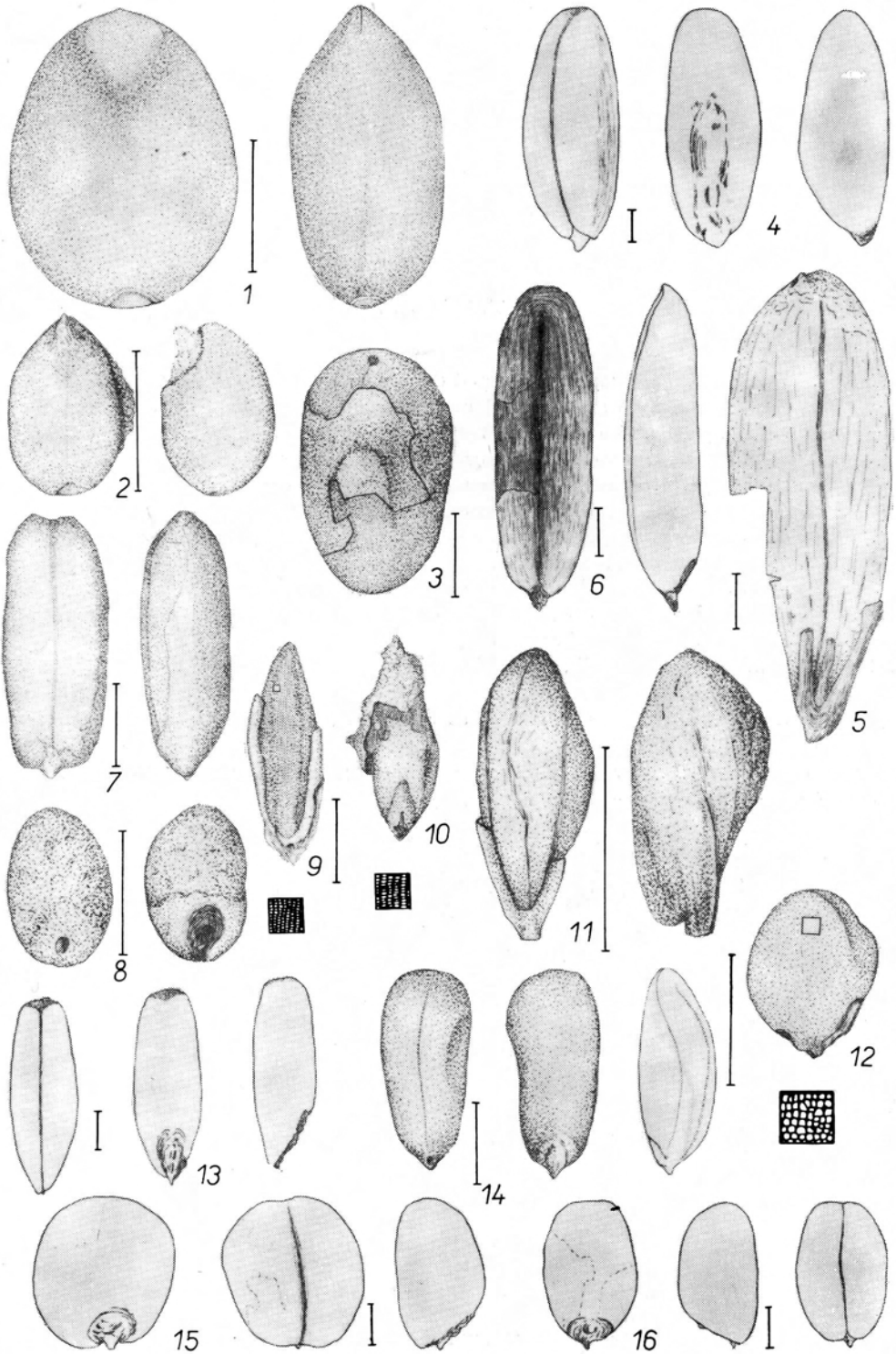
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Plate VI

Tablica VI

1, 2, 3, 4. *Panicum miliaceum*, four charred caryopses from ventral, dorsal, and lateral sides (cztery zwęglone ziarniaki od strony brzusznej, grzbietowej i z boku)

5, 6. *Setaria glauca*, two caryopses from ventral, dorsal and lateral sides (dwa ziarniaki od strony brzusznej, grzbietowej i z boku), 5. uncharred specimen (okaz niezwęglony), 6. charred specimen (okaz zwęglony)

7, 8, 9, 10. *S. viridis* or *S. verticillata*, four charred caryopses from ventral, dorsal and lateral sides (cztery zwęglone ziarniaki od strony brzusznej, grzbietowej i z boku), 7. specimen with remnants of lemma and palea, typical damage caused by carbonization visible at the apex of grain from lateral side (okaz z resztkami plewek, charakterystyczne zniekształcenie wywołane zwęgleniem widoczne na szczycie ziarniaka od strony bocznej)

11, 12, 13. *Echinochloa crus galli*, three charred caryopses from ventral, dorsal, and lateral sides (trzy zwęglone ziarniaki od strony brzusznej, grzbietowej i z boku), 13. specimen with remnants of glumes at the apex (okaz z resztkami plew na szczycie)

Scale line equals 1 mm. All figures are at the same magnification (Podziałka oznacza 1 mm. Wszystkie ryciny są w tym samym powiększeniu)

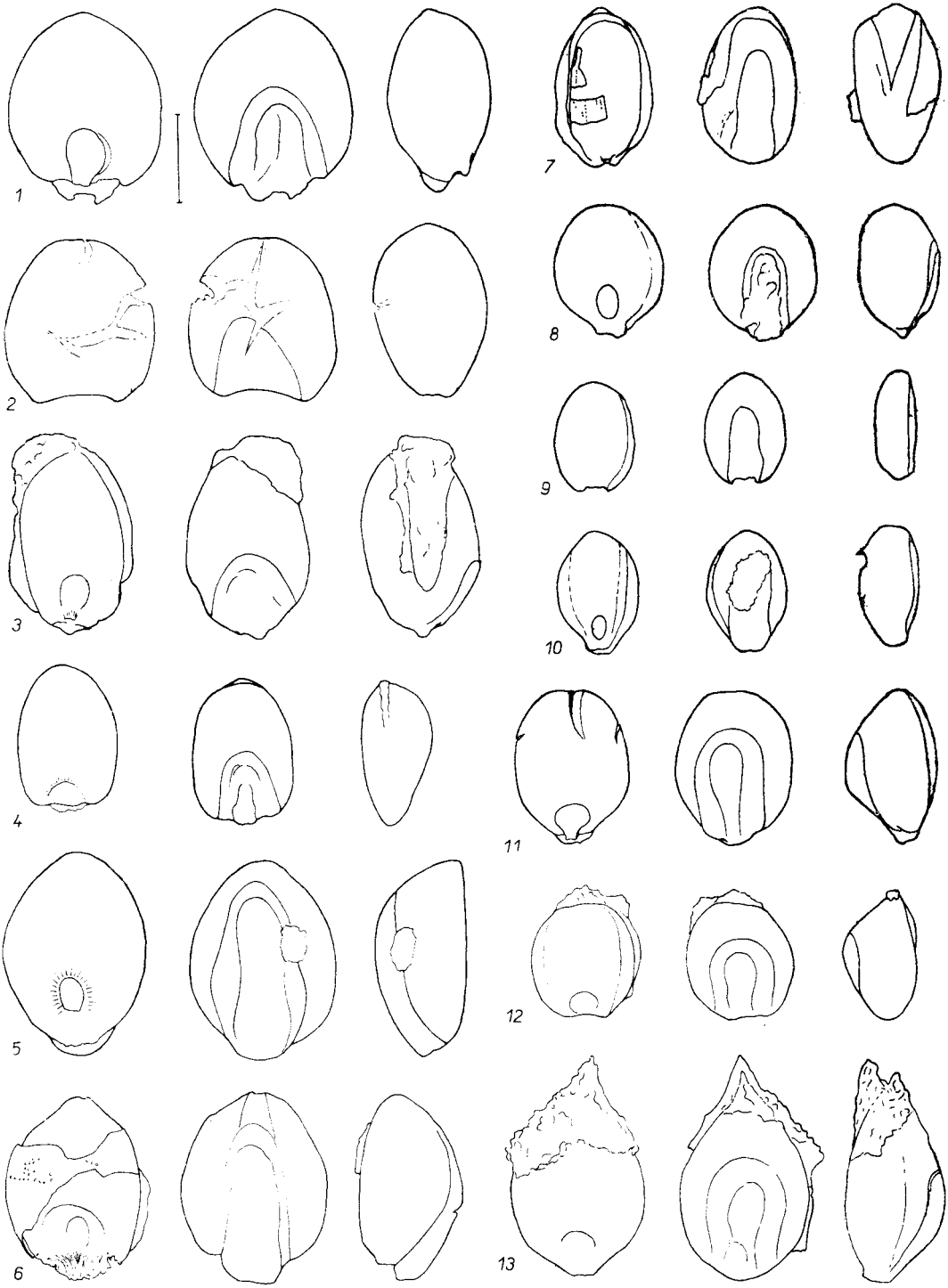
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Plate VII

Tablica VII

1. *Luzula* cf. *multiflora*, capsule (torebka)
2. *L.* cf. *nemorosa*, seed (nasienie)
3, 4. *Linum usitatissimum*, seed and fragment of capsule (nasienie i fragment torebki)
5, 6. *Lythrum* cf. *salicaria*, 5. one seed from two sides (jedno nasienie z dwu stron), 6. seed with papillae visible (nasienie z widocznymi brodaweczkami)
7. *Betonica officinalis*, one fruit with partly damaged outer layer of pericarp, from dorsal and ventral sides (jeden owoc z częściowo zniszczoną zewnętrzną warstwą owocni od strony grzbietowej i brzusznej)
8. *Ballota nigra*, one fruit from ventral and dorsal sides (jeden owoc od strony brzusznej i grzbietowej)
9. *Galeopsis* cf. *ladanum*, fruit (owoc)
10. *G.* cf. *angustifolia*, fruit (owoc)
11. *Chaiturus marrubiastrum*, fruit (owoc)
12. *Lamium* cf. *album*, fruit with damaged outer layer of pericarp (owoc ze zniszczoną zewnętrzną warstwą owocni)
13. *L. purpureum*, fruit (owoc)
14. *Marrubium vulgare*, one fruit from ventral and dorsal sides, fragment of testa shows the sculpture (jeden owoc od strony brzusznej i grzbietowej, fragment owocni ukazuje typ skulptury)
15. *Nepeta* cf. *nuda*, fruit (owoc)
16. *N. cataria*, fruit (owoc)
17. *Mentha* cf. *arvensis*, fruit (owoc)
18. *Salvia* cf. *pratensis*, fruit (owoc)
19. *S. verticillata*, fruit (owoc)
20. *S.* cf. *nemorosa*, fruit (owoc)
21. *Stachys silvatica*, one fruit from ventral and lateral sides (jeden owoc od strony brzusznej i z boku)
22. *S. palustris*, fruit (owoc)
23. *S. recta*, fruit (owoc)
24. *S. annua*, fruit (owoc)
25. *Malva alcea* or *M. moschata*, seed with broken testa (nasienie z pękniętą łupiną)
26. *M. crispa*, seed (nasienie), L — length, B — breadth for figs. 25, 26, and 27 (L — długość, B — szerokość dla ryc. 25, 26 i 27)
27. *Lavatera thuringiaca*, seed (nasienie)
28. *Plantago lanceolata*, seed (nasienie)
29. *Primula* sp., seed (nasienie)
30. *Rumex* cf. *maritimus*, fruit (owoc)
31. *Papaver rhoeas* type, seed (nasienie)
32. *Fumaria officinalis*, fruit from the apex and from the lateral side (owoc od szczytu i od strony bocznej), L — length (długość), B — breadth (szerokość)

Each scale line equals 1 mm. Figs. 7—14 and 21—27 are at the same magnification (Podziałka oznacza 1 mm. Ryc. 7—14 i 21—27 są w tym samym powiększeniu)

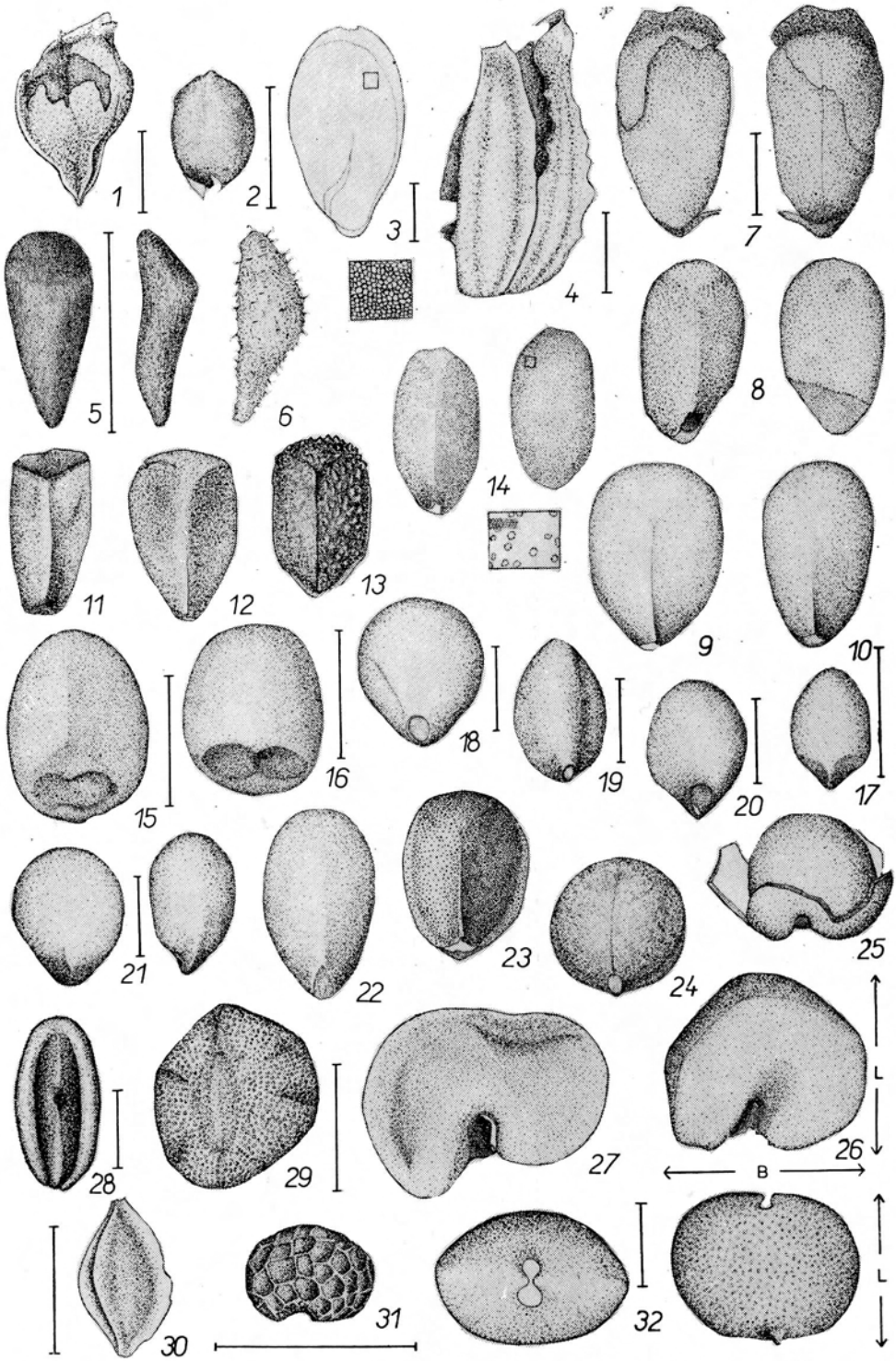
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Plate VIII

Tablica VIII

1. *Coronilla varia*, charred seed (zwęglone nasienie)
2. *Lens esculenta*, charred seed (zwęglone nasienie)
3. *Trifolium* cf. *repens*, charred seed (zwęglone nasienie)
4. *Medicago lupulina*, legume (strąk)
5. *Thalictrum minus*, fruit and its cross-section (owoc i jego przekrój poprzeczny)
6. *T.* cf. *lucidum*, fruit and its cross-section (owoc i jego przekrój poprzeczny)
7, 8. *T. flavum* type, two fruits and their cross-sections (dwa owoce i ich przekroje poprzeczne), 7. broad-oval type (typ szerokoowalny), 8. narrow-oval type (typ wąskoowalny)
9. cf. *Asperula cynanchica*, fruit (owoc)
10. *Galium uliginosum*, fruit (owoc)
11. *G.* cf. *silvaticum*, fruit (owoc)
12, 13. *Filipendula ulmaria*, 12. fruit (owoc), 13. seed (nasienie)
14. *Fragaria vesca*, fruit (owoc)
15, 16. *F. viridis*, two fruits (dwa owoce)
17. *Potentilla recta*, fruit (owoc)
18. *P. reptans*, fruit (owoc)
19. *P. supina*, fruit (owoc)
20. *P. anserina*, fruit from dorsal side (owoc od strony grzbietowej)
21. *Frangula alnus*, fruit-stone (pestka)
22, 23, 24. *Sparganium ramosum*, 22. fruit-stone (pestka), 23, 24. two fruits (dwa owoce)

Each scale line equals 1 mm. Figs. 14—20 are at the same magnification (Podziałka oznacza 1 mm. Ryc. 14—20 są w tym samym powiększeniu)

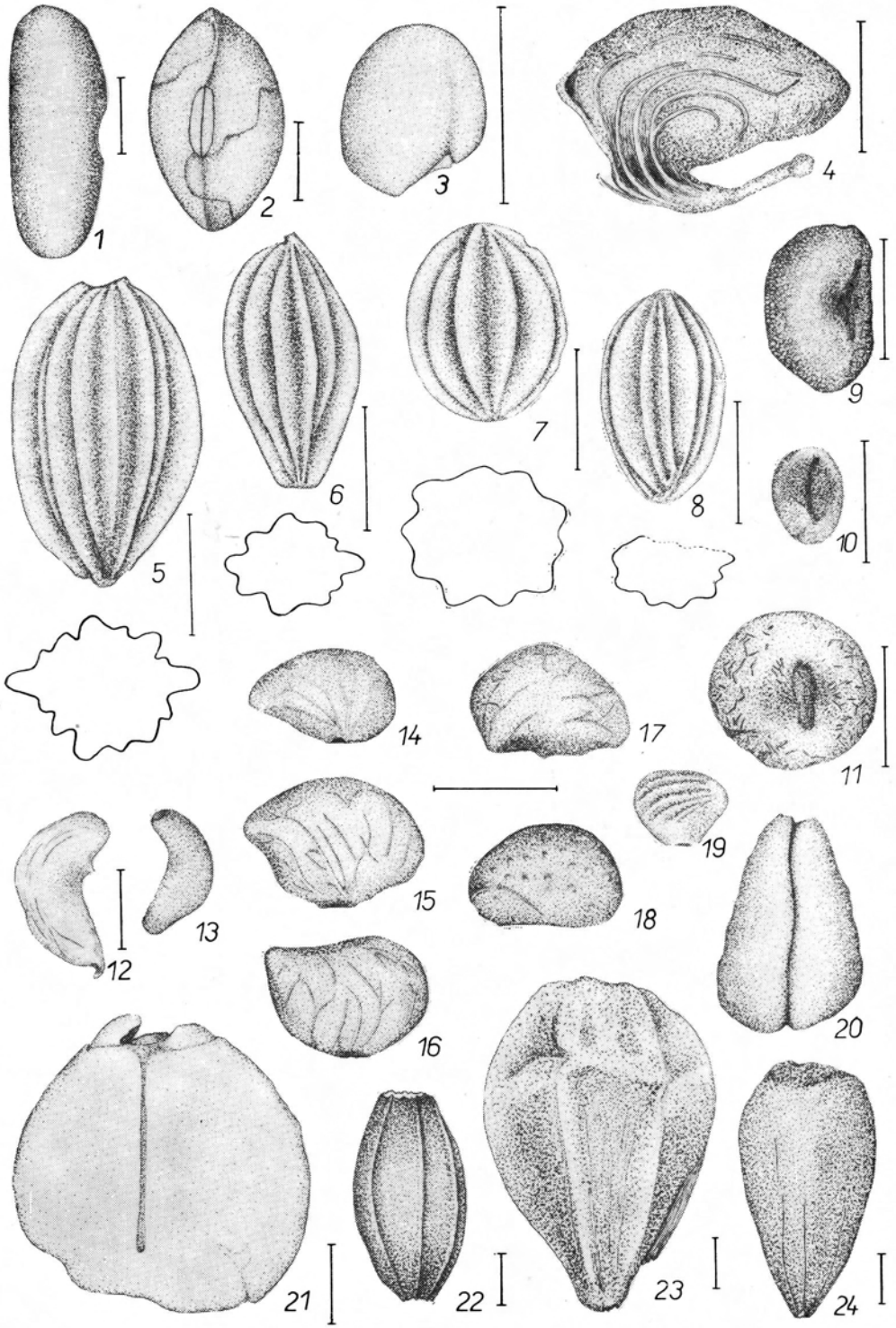
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Plate IX

Tablica IX

1, 2. *Verbascum* cf. *nigrum*, capsule and one seed from another capsule (torebka i nasienie z innej torebki)

3. *Pedicularis palustris*, seed and fragment of testa showing sculpture (nasienie i fragment testy ze skulpturą)

4. cf. *Odontites* sp., seed (nasienie)

5. *Caucalis daucoides*, fragment of fruit from dorsal side (fragment owocu od strony grzbietowej)

6. *Angelica silvestris*, fruit from dorsal side (owoc od strony grzbietowej)

7. *Chaerophyllum aromaticum*, fruit from dorsal side (owoc od strony grzbietowej)

8. *Astrantia maior*, fruit from dorsal side (owoc od strony grzbietowej)

9. *Torilis japonica*, fruit from dorsal side (owoc od strony grzbietowej)

10. *Pastinaca* cf. *sativa*, fruit from dorsal side (owoc od strony grzbietowej)

11. cf. *Carum carvi*, fruit without outer layer of pericarp, dorsal side (owoc bez zewnętrznej warstwy owocni, strona grzbietowa)

12. *Pimpinella* cf. *maior*, fruit from ventral side (owoc od strony brzusznej)

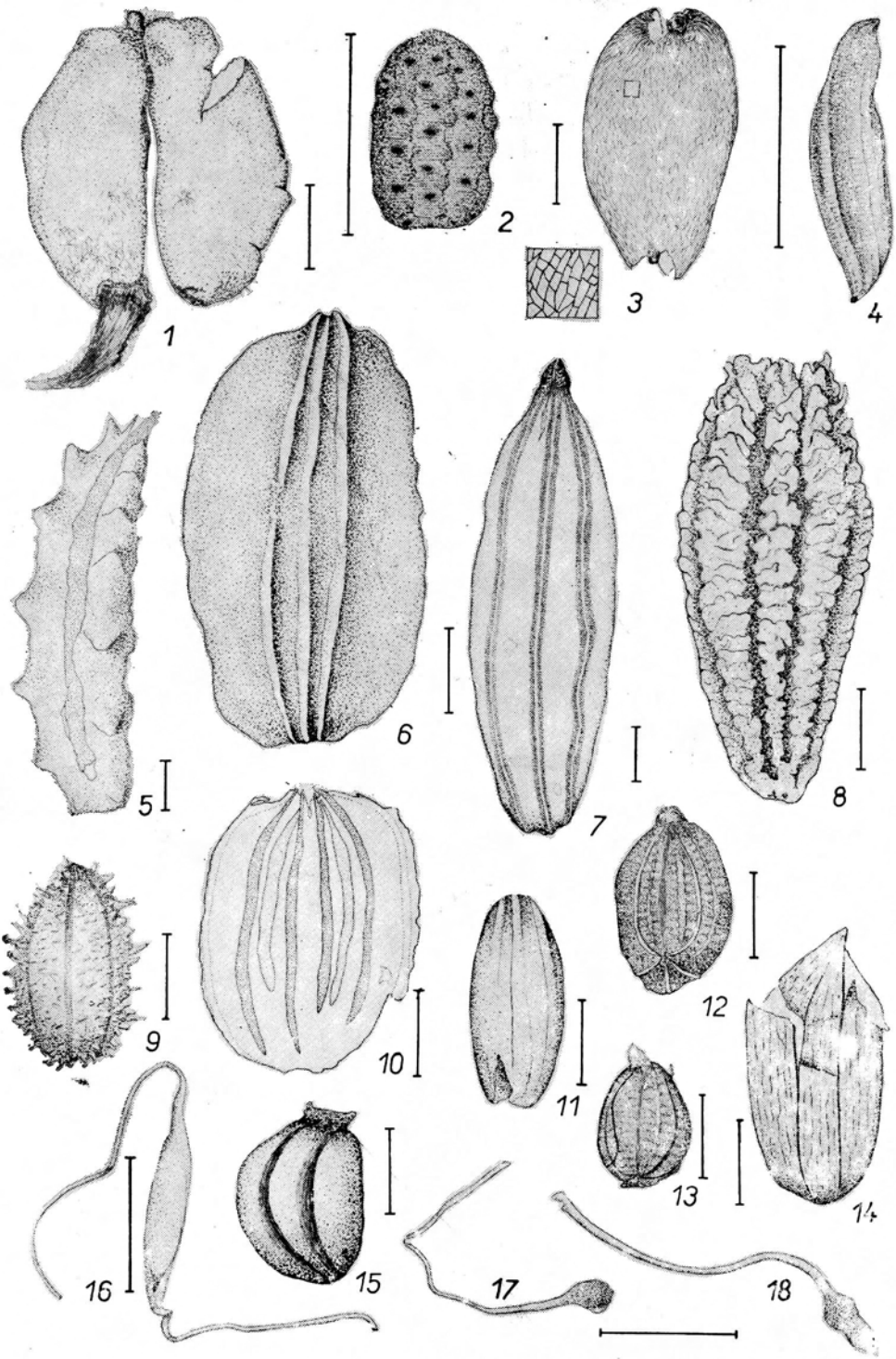
13. *P.* cf. *saxifraga*, fruit from ventral side (owoc od strony brzusznej)

14. *Conium maculatum*, fruit without outer layer of pericarp, dorsal side (owoc bez zewnętrznej warstwy owocni, strona grzbietowa)

15. *Cicuta virosa*, fruit from dorsal side (owoc od strony grzbietowej)

16, 17, 18. *Typha latifolia*, 16. fruit with stype and style with broken ends (owoc z szypułką i szyjką słupka o ułamanych końcach), 17, 18. styles with stigmas (szyjki słupków ze znamionami)

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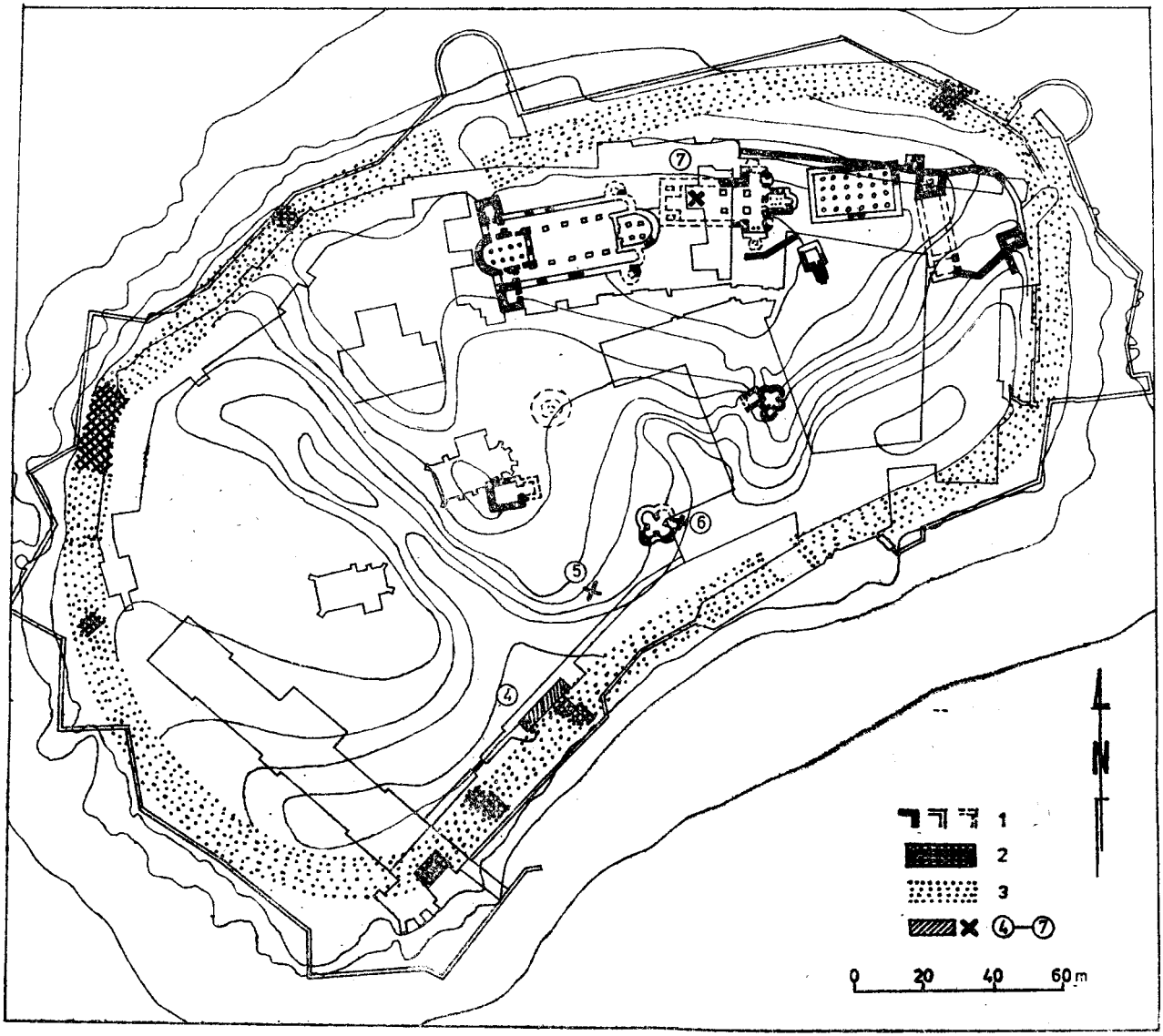

Fig. 2. Map of the Wawel Hill (from Radwański 1975). 1 — pre-Romanesque and Romanesque stone buildings: preserved, reconstructed, and assumed, 2 — discovered parts of timber-stone-earth rampart from early medieval times, 3 — probable plan of the whole rampart, 4—7 — places where samples for botanical studies were collected

Ryc. 2. Plan Wzgórza Wawelskiego (z Radwańskiego 1975). 1 — przedromańskie i romańskie budowle kamienne: zachowane, zrekonstruowane i domniemane, 2 — stwierdzone części drewniano-kamienno-ziemnego wału obronnego z okresu wczesnego średniowiecza 3 — przypuszczalny przebieg wału 4—7 — miejsca zebrania prób do badań botanicznych

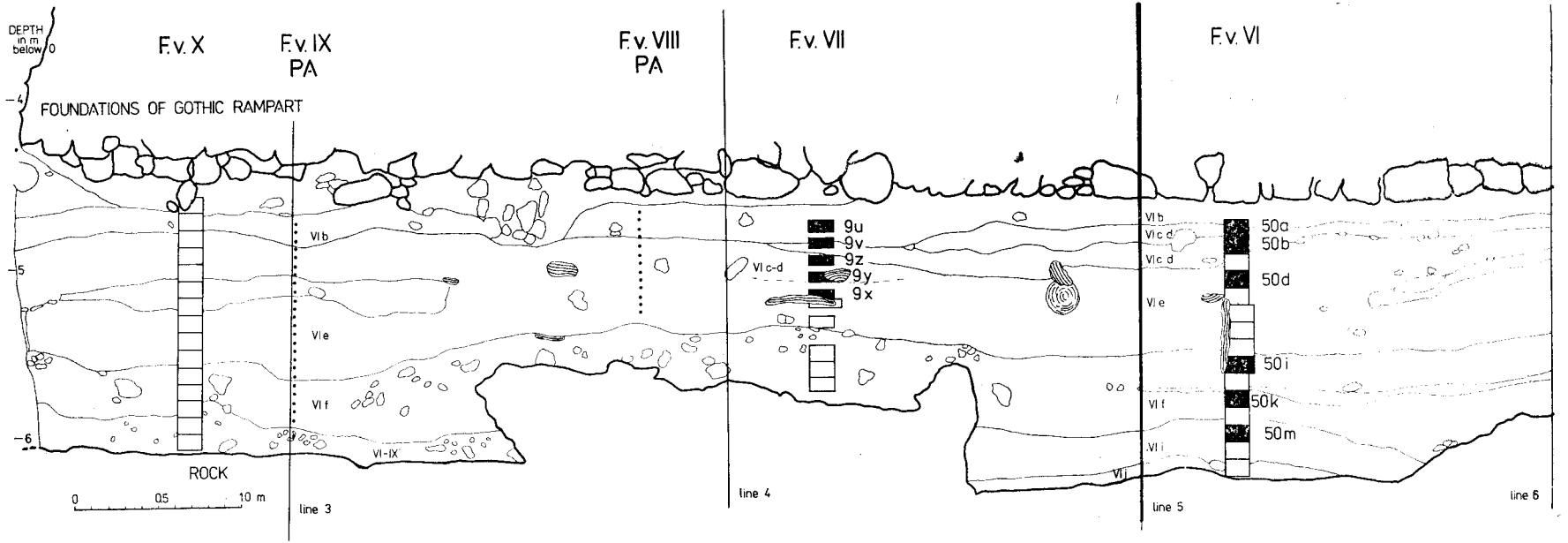

Fig. 5. Fragment of profile A of large-area excavation from region X showing the location of samples, simplified. Explanations as in Fig. 6

Ryc. 5. Fragment ściany A wykopu szerokoprzestrzennego w rejonie X z zaznaczonym położeniem prób, uproszczone. Objaśnienia jak na ryc. 6

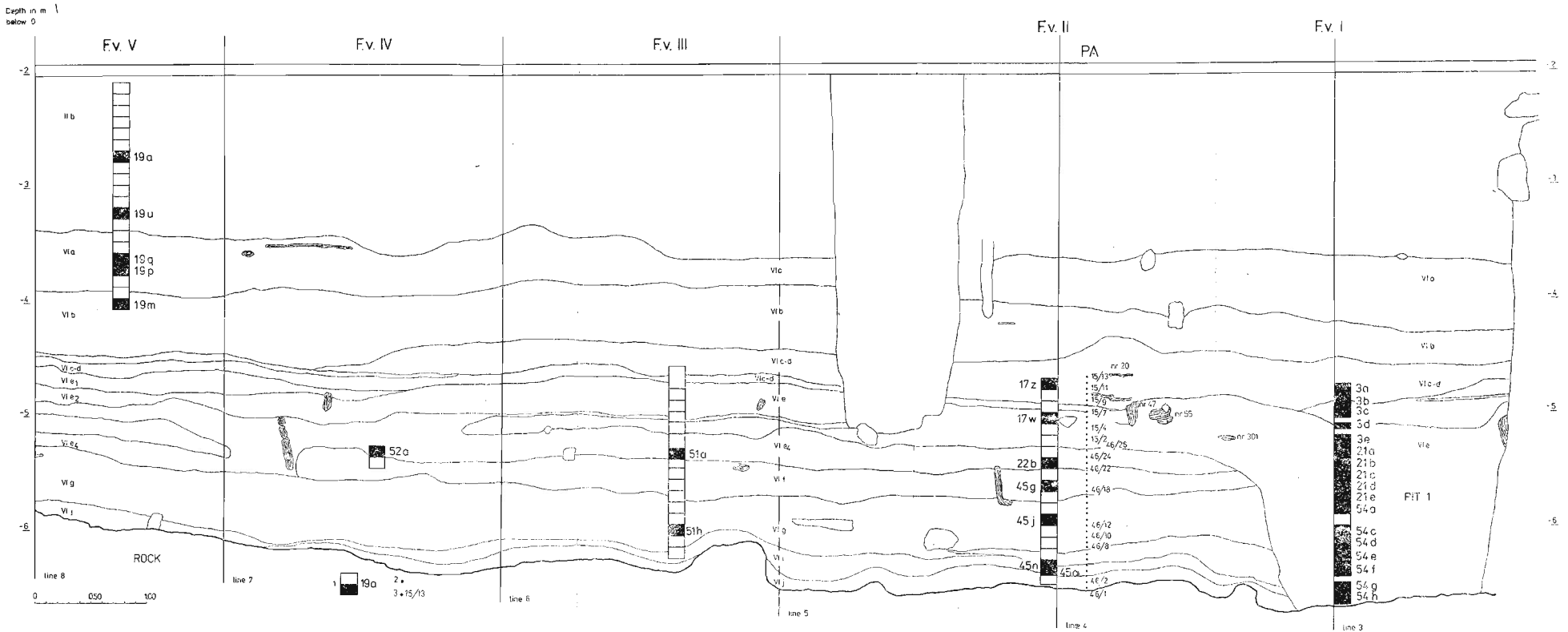

Fig. 6. Fragment of profile C of large-area excavation from region X showing the location of samples (simplified). 1 — macrofossil samples: collected (white) and examined (black with sample number), 2 — pollen samples collected 3 — pollen samples examined, F.v. I—X —points where sample series were taken

Ryc. 6. Fragment ściany C wykopu szerokoprzestrzennego w rejonie X z zaznaczonym położeniem prób (uproszczone). 1 — próby szczątków makroskopowych: zebrane (białe) i opracowane (czarne z numerem próby), 2 — zebrane próby palinologiczne, 3 — zbadane próby palinologiczne, F.v. I—X — punkty, w których zebrano serie prób

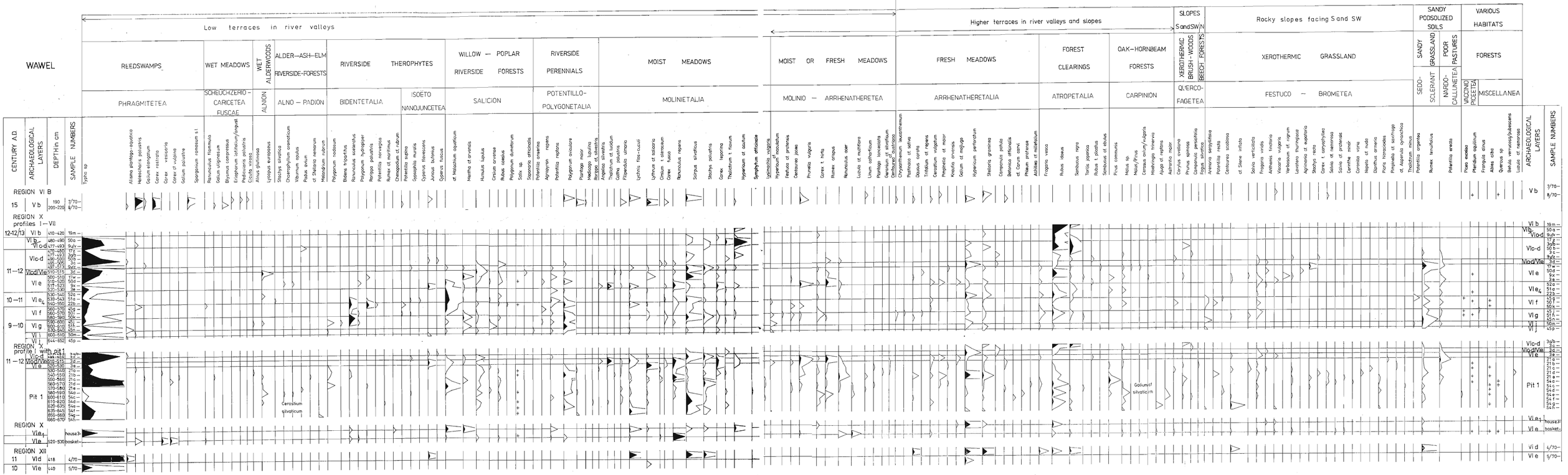

Fig. 8. Wawel Hill, 9—10th to 15th century A. D. Fruit and seed diagram of plants growing in primary and secondary communities at the bottom of river valleys, on the slopes, and on higher river terraces. Curves illustrate percentage numbers of diaspores of each taxon. Other explanations in the text

Rys. 8. Wzgórze Wawelskie, 9—10 do 15 w. n.e. Diagram owocowonasienny roślin występujących w pierwotnych i wtórnych zbiorowiskach na dnie dolin rzecznych, na zboczach i na wyższych terasach. Krzywe ilustrują procentowy udział diaspor poszczególnych taksonów. Pozostałe objaśnienia w tekście

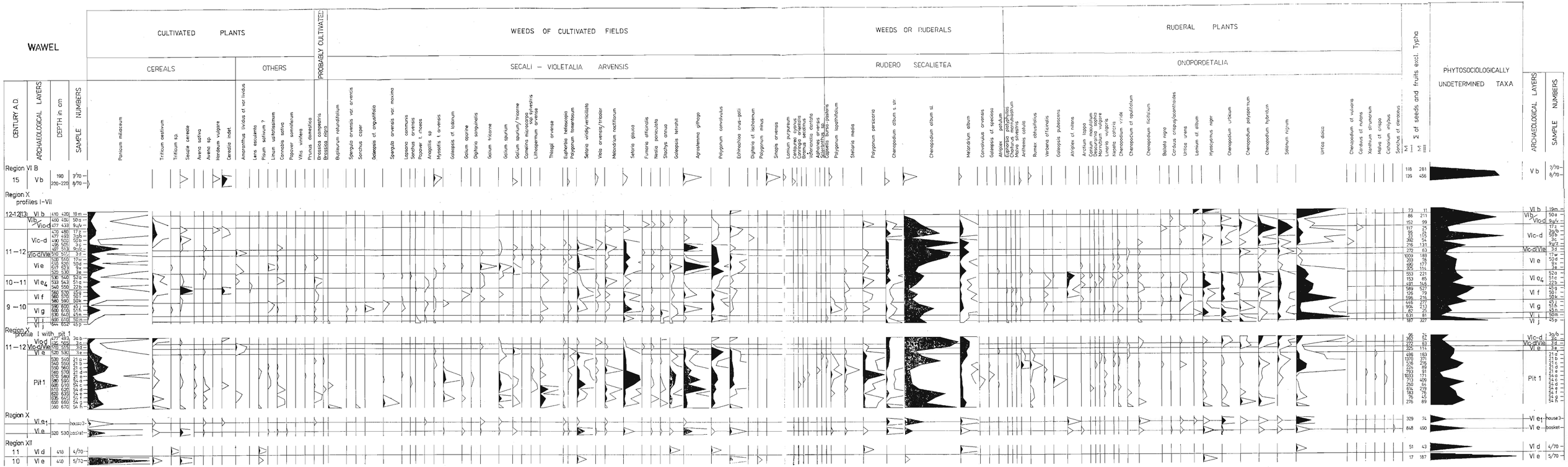

Fig. 9. Wawel Hill, 9—10th to 15th century A. D. Fruit and seed diagram of cultivated plants, field weeds, and ruderals. Curves illustrate percentage numbers of diaspores of each taxon. Other explanations in the text

Ryc. 9. Wzgórze Wawelskie, 9—10 do 15 w. n.e. Diagram owocowo-nasienny roślin uprawnych, chwastów polnych i roślin ruderalnych. Krzywe ilustrują procentowy udział diaspor poszczególnych taksonów. Pozostałe objaśnienia w tekście

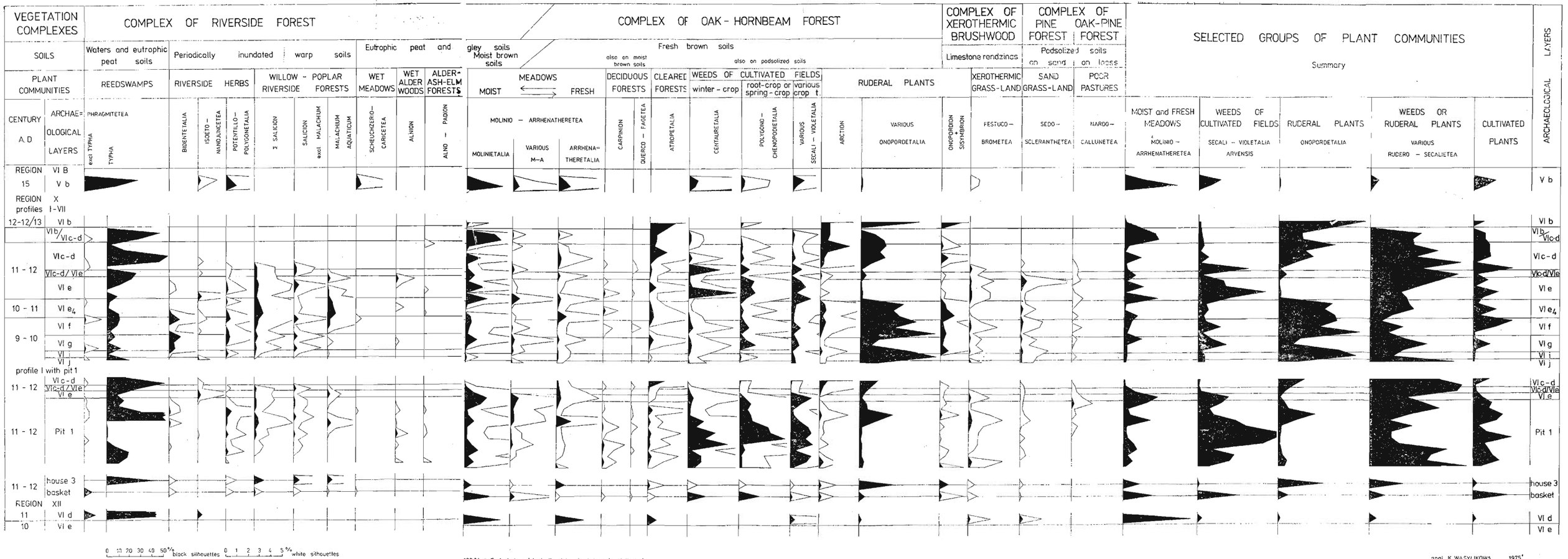

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Fig. 10. Wawel Hill. Summary diagram showing the percentage numbers of seeds and fruits of plants included in particular syntaxonomic units. Explanations in the text
Ryc. 10. Wzgórze Wawelskie. Syntetyczny diagram obrazujący udział procentowy owoców i nasion roślin zaliczonych do poszczególnych jednostek fitosocjologicznych. Objaśnienia w tekście

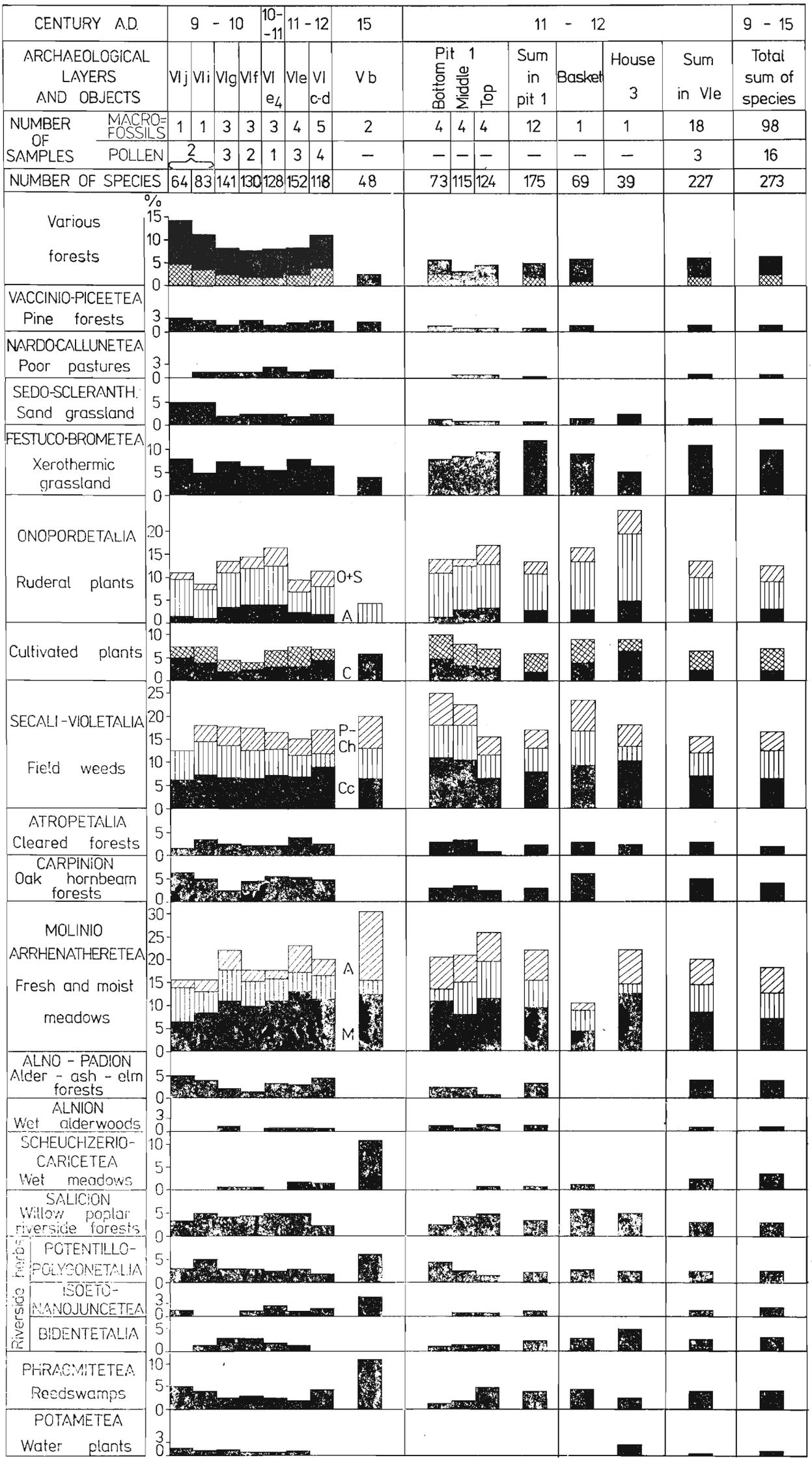

Fig. 11. Percentage numbers of taxa representing plant communities of different syntaxonomic units in particular archaeological layers and objects. Explanations in the text

Ryc. 11. Wzgórze Wawelskie. Procentowy udział taksonów reprezentujących zbiorowiska roślin z różnych jednostek fitosocjologicznych w poszczególnych warstwach i obiektach archeologicznych. Objaśnienia w tekście

Table 3
Tabela 3

Results of the analysis of wood found in the region X (M. Reymanówna, unpubl.)

Wyniki analizy drewna pochodzącego z rejonu X (M. Reymanówna, niepubl.)

Species - Gatunek	Laths - Dranice		Posts and pegs Słupy i kołki		Other wooden elements Inne elementy drewniane		Fragments of wood (w) or charcoal (ch) Fragmenty drewna (w) lub węgli drzewnych (ch)		Bark fragments Fragmenty kory	
	Location Lokalizacja	Number of specimens Liczba okazów	Location Lokalizacja	Number of specimens Liczba okazów	Location Lokalizacja	Number of specimens Liczba okazów	Location Lokalizacja	Number of Specimens Liczba okazów	Location Lokalizacja	Number of specimens Liczba okazów
Abies alba Mill.	no. 216 layer VIb/VIc-d no. 76	1 1	no. 65 no. 276	1 1			layer VIc-d basket	1 w 5 w		
Alnus sp.							layer VIc-d	5 w		
Betula sp.					broom no. 2 made of twigs layer VIe,VIc-d	1	basket VIc-d	1 w 1 w	layer VIc-d layer VIe ?	11 1 2
Picea excelsa (Lam.) Lk. or Larix sp.					no. 230, layer VIa	1	layer VIc-d	1 w		
Pinus silvestris L.							layer VIc-d	7 w		
Populus sp. ?	no. 137	1								
Quercus sp.	no. 53, depth 443 cm, layer VIe no. 231, layer VIe and VIc-d no. 261, layer VIc-d no. 132, layer VIc-d no. 153, layer VIc-d no. 60, layer VIc-d	1 1 1 1 1 1	no. 222 layer VIe, depth 525 cm	1 1	no. 220a no. 69, depth 493.5 cm no. 262, layer VIe no. 264, layer VIe wooden object, depth 515 cm, layer VIa wood found with broom no. 2	1 1 1 1 1 1	basket layer VIc-d	5 w 4 ch 1 w		
Salix sp.			no. 237, layer VIe and VIc-d no. 159, layer VIe and VIc-d	1 1						
Taxus baccata L.					bow	1				
Tilia sp.									basket	1
Ulmus sp.					no. 245, depth 502 cm, layer VIe/VIc-d no. 186a no. 233, layer VIe and VIc-d	1 1 1	layer VIc-d	1 w 1 w partly charred		
Undetermined Nieoznaczone	no. 263, layer VIc-d	1					layer VIc-d	2 w	layer VIc-d	several

Table 5
Tabela 5

The occurrence of species of Potametea, Phragmitetalia, Scheuchzerio-Caricetea, Isoëto-Nanojuncetea, and Bidentetalia in the early and late medieval layers from the Wawel Hill

Występowanie gatunków Potametea, Phragmitetalia, Scheuchzerio-Caricetea, Isoëto-Nanojuncetea i Bidentetalia w warstwach z wczesnego i późnego średniowiecza na Wzgórzu Wawelskim

Century A.D. - Wiek n.e.		9 - 10				10-11	11 - 12							10	11	15	Macrofossils Szczątki makroskopowe		
Location of samples Lokalizacja prób		Region X, large-area excavation Rejon X, wykop szerokoprzestrzenny												Region XII Rejon XII		Region VIB Rejon VIB			
Archaeological layers and objects Warstwy i obiekty archeologiczne	Characteristic species Gatunki charakterystyczne	Random samples Próby losowe							Archaeological objects Obiekty archeologiczne										Pollen and spores Pyłek i spory
		VIj	VIi	VIg	VIf	VI e4	VIe	VI c-d	Basket Kerobka	House 3 Chata 3	Pit 1 - Jama 1 Bottom Spąg	Middle Środek	Top Strop	Total Suma	Total in VIe Suma w VIe	VIe	VId	Vb	Total number of samples Ogólna liczba prób	Total number of specimens Suma okazów	
Number of samples/Number of points Liczba prób/liczba punktów		1/1	2/2	3/2	4/2	3/3	4/4	7/4	1/1	1/1	4/1	4/1	4/1	12/7	18/7	1/1	1/1	2/1			
Potametea																					
Potamogeton sp.		+	+	+	+	+	+								+						✧
Batrachium sp.				+			+			1					1+				1	1f	+
Phragmitetalia																					
Typha sp.	ch	1	1	3/2	3/2	3/3	3/3	5/3		1	4	3	4	11	15/5	1	1		35	88 s	
T. latifolia	ch	+	+	+	+	+	+	+					1	1	1+				1	8 f	+
T. angustifolia/Sparganium		+	+	+	+	+	+	+							+						+
Alisma plantago-aquatica + A.sp.	ch	1		1	+	1+	+	1+				1		1	1+		1	1	7	8s	✧
Heleocharis palustris + H. sp.	ch		1		1				1				1	1	2/2			2	7	69f	
Galium elongatum	ch M-n							1					1	1	1			2	4	4f	
Carex rostrata	ch M-n																	2	2	35f	
C. vesicaria	ch M-n								1				1	1	2/2				2	29f	
C. cf. vulpina	ch M-n								1				1	1	2/2				2	19f	
Sparganium ramosum	ch																	2	2	8f	
Galium palustre	ch M-n												1	1	1		1		2	4f	
Scheuchzerio-Caricetea fuscae																					
Ranunculus flammula	ch				1				1						1				2	4f	
Galium uliginosum													1	1	1			1	2	2f	
Blysmus compressus	ch																	1	1	4f	
Cicuta virosa																		1	1	1f	
Eriophorum latifolium/angustif.	ch																	1	1	1g	
Pedicularis palustris	ch																	1	1	1s	
Menyanthes trifoliata	ch			+			+	+							+						+
Comarum palustre	ch						+	+							+						+
Parnassia palustris	ch						+								+						+
Isoëto-Nanojuncetea																					
Juncus bufonius	ch	1					1	1					1	1	2/2		1	1	6	17s	
Gypsophila muralis	ch				1	1						1		1	1				4	4s	
Potentilla supina	ch				2/2													1	3	7f	
Cyperus flavescens	ch					1													1	1f	
C. fuscus	ch							1											1	1f	
Plantago paucifiora	ch					+	+								+						+
Bidentetalia																					
Ranunculus sceleratus	ch P-B			2/2	3/2	1			1	1			2	2	4/3				10	107f	
Polygonum nodosum	ch		1	1								1	3	4	4/1				6	32f	
Rorippa palustris	ch P-B				1	1	1					1		1	2/2				4	27s	
Polygonum hydropiper	ch			1	1		1		1						2/2				4	7f	
Potentilla norvegica					1														1	3f	
Bidens tripartitus	ch P-B			1															1	2f	
Rumex cf. maritimus	ch P-B										1			1	1				1	1f	
Chenopodium cf. rubrum	ch P-B									1					1				1	1s	

ch characteristic species of a unit indicated in the heading for each group of taxa or of lower syntaxonomic units (gatunek charakterystyczny dla jednostki fitosocjologicznej wymienionej przy każdej grupie taksonów lub dla należących do niej niższych jednostek), + pollen or spores (pyłek lub spory), f fruit (owoc), s seed (nasienie). M-n Magnocaricion, P-B Polygono-Bidentetum. Other explanations in the text (Pozostałe objaśnienia w tekście).

Table 10
Tabela 10

The occurrence of species of Potentillo-Polygonetalia and Onopordetalia in the early and late medieval layers from the Wawel Hill

Występowanie gatunków Potentillo-Polygonetalia i Onopordetalia w warstwach z wczesnego i późnego średniowiecza na Wzgórzu Wawelskim

Century A.D. - Wiek n.e.		9 - 10				10--11	11e - 12								10	11	15	Macrofossils Szczątki makroskopowe		
Location of samples Lokalizacja prób		Region X - large-area excavation Rejon X - wykop szerokoprzestrzenny													Region XII Rejon XII		Region VIB Rejon VIB			
Archaeological layers and objects Warstwy i obiekty archeologiczne	Characteristic species Gatunki charakterystyczne	Random samples Próby losowe							Archaeological objects Obiekty archeologiczne											
		VIj	VIi	VIg	VIf	VIe_4	VIe	VI e-d	Basket Kerobka	House 3 Chata 3	Pit 1 - Jama 1 Bottom Spąg	Middle Środek	Top Strop	Total Suma	Total in VIe Suma w VIe	VIe	VId	Vb	Total number of samples Ogólna liczba prób	Total number of specimens Suma okazów	Pollen and spores Pyłek i spory
Number of samples/Number of points Liczba prób/Liczba punktów		1/1	2/2	3/2	4/2	3/3	4/4	7/4	1/1	1/1	4/1	4/1	4/1	12/1	18/7	1/1	1/1	2/1			
Potentillo-Polygonetalia																					
Polygonum aviculare	ch P-n	+	1+	3/2+	2/2+	2/2+	2/2+	1+	1		2	3	4	9	12/4+			1	22	160f	+
Potentilla reptans	ch A-R		1	1	2/2	2/2	1		1	1		1		1	4/4				11	33f	
Plantago maior	ch	+	+	+	+	+	+	+			1	1	1	3	3/1+			1	4	14s	+
Agropyron repens	ch A-R			1	1		1								1				3	4f	
Potentilla anserina	ch		1																1	1f	
Rorippa silvestris	ch A-R										1			1	1				1	1s	
Medicago lupulina																		1	1	1f	
Onopordetalia																					
Urtica dioica		+	2/2+	3/2+	3/2+	3/3+	4/4+	4/3+	1	1	3	3	4	10	16/7+		1		35	1693f	+
Chenopodium hybridum	ch A-n	1	2/2	3/2	3/2	3/3	2/2	5/3	1	1	3	3	3	9	13/5				35	155s	
Solanum nigrum	ch P-Ch		1	3/2	3/2	3/3	3/3	4/3	1	1		3	4	7	12/6				29	263s	
Chenopodium urbicum		1	1	2/2	3/2	3/3		4/3	1	1	3	1	2	6	8/3				24	176s	
Hyoscyamus niger	ch O-n			3/2	3/2	3/3	1	2/2	1	1	3	2	1	6	9/4	1			23	192s	
Chenopodium polyspermum	ch P-Ch	1	1	2/2		3/3	1	3/2		1	2		2	4	6/3				19	87s	
C. ficifolium		1		2/2	2/2	2/2	1	1	1	1	1	1	1	3	6/4				15	41s	
Rumex obtusifolius	ch				1		1				3	3	4	10	11/2			1	13	37f	
Urtica urens	ch S-n	+	+	2/2+	3/2+	3/3+	+	2/2+	1	1			1	1	3/3+				13	56f	+
Chenopodium viride				1		1	2/2	1			1	2	2	5	7/3				10	23s	
C. cf. opulifolium	ch S-n				1	1	2/2				2		1	3	5/3				9	14s	
Verbena officinalis	ch			2/2	1	3/3						1	1	2	2/1				8	14f	
Nepeta cataria	ch A-n			1		2/2	2/2					1	2	3	5/2				8	9f	
Atriplex cf. nitens					2/2	3/3			1	1					2/2				7	101s	
Anthemis cotula	ch			1	1		1						3	3	3/1			1	7	35f	
Linaria vulgaris	ch			1			1				1	2	1	4	5/2				6	7s	
Arctium lappa	ch A-n				1	2/2	1		1						2/2				5	12f	
Malva silvestris	ch A-n			1	1								3	3	3/1				5	9s	
Ballota nigra	ch A-n			1	1	1		1					1	1	1				5	6f	
Carduus crispus/acanthoides	ch		1		1	1			1						1				5	5f	
Caleopsis pubescens	ch			1		1						2		2	2/1				4	21f	
Lamium cf. album	ch A-n			1						1					1				3	8f	
Cichorium intybus												2	1	3	3/1				3	6f	
Conium maculatum	ch A-n				1	1						1		1	1				3	5f	
Marrubium vulgare	ch O-n					1							2	2	2/1				3	3f	
Malva cf. crispa	ch											1	1	2	2/1				2	3s	
Chaitarus marrubiastrum				1	1														2	3f	
Euphorbia platyphyllos		1			1														2	2s	
Descurainia sophia	ch S-n					1							1	1	1				2	2s	
Chenopodium cf. vulvaria								1											1	3s	
Carduus cf. nutans	ch O-n							1											1	1f	
Xanthium cf. strumarium	ch S-n											1		1	1				1	1l	
cf. Sonchus oleraceus	ch								1						1				1	1f	
Chelidonium maius	ch A-n																				
Anchusa sp.	ch O-n			+			+	+							+						+

*In one sample from VIa in region XII (W jednej próbie z VIa w rejonie XII)

A-n Arction, A-R Agropyro-Rumicion crispi, O-n Onopordion, P-Ch Polygono-Chenopodietalia, P-n Polygonion, S-n Sisymbrion, i involucr- (koszyczek) Other explanations as in table 5 (Pozostałe objaśnienia jak w tabeli 5).

The occurrence of species of Centauretalia, Polygono-Chenopodietalia, Secali-Vieletalia, and Rudero-Secalietea in the early and late medieval layers from the Wawel Hill

Występowanie gatunków Centauretalia, Polygono-Chenopodietalia, Secali-Vieletalia i Rudero-Secalietea w warstwach z wczesnego i późnego średniowiecza na Wzgórzu Wawelskim

Century A.D. - Wiek n.e.	Characteristic species Gatunki charakterystyczne	9 - 10				10--11	11 - 12									10	11	15	Macrofossils Szczątki makroskopowe		Pollen and spores Pyłek i spory
Location of samples Lokalizacja prób		Region X, large-area excavation Rejon X, wykop szerokoprzestrzenny														Region XII Rejon XII		Region VIB Rejon VIB			
Archaeological layers and objects Warstwy i obiekty archeologiczne		Random samples Próby losowe							Archaeological objects Obiekty archeologiczne						Total in VIe Suma w VIe	VIe	VIf	Vb	Total number of samples Ogólna liczba prób	Total number of specimens Suma okazów	
		VIj	VIi	VIg	VIf	VI e_4	VIe	VI c-d	Basket Koszyk	House 3 Chata 3	Pit 1 - Jama 1 Bottom Spąg	Pit 1 - Jama 1 Middle Środek	Pit 1 - Jama 1 Top Strop	Pit 1 - Jama 1 Total Suma							
Number of samples/Number of points Liczba prób/Liczba punktów		1/1	2/2	3/2	4/2	3/3	4/4	7/4	1/1	1/1	4/1	4/1	4/1	12/1	18/7	1/1	1/1	2/1			
Centauretalia cyani																					
Agrostemma githago	ch		1	1	2/2	1	4/4	3/2	1	1	4	4	4	12	18/7			2	29	865s	
Melandrium noctiflorum	ch C-Sc		1	2/2	1	2/2	2/2	2/2	1	1	3	2	3	8	12/5				21	59s	
Galium spurium	ch L-n				1	1	2/2	2/2	1	1	2	4	2	8	12/5				17	106f	
G. spurium/tricorne	ch						3/3	1	1		2	2		4	8/5			1	10	41f	
G. tricorne	ch C-Sc				1	3/3	1		1	1					3/3				8	31f	
Stachys annua	ch C-Sc	1	1	1		1		1	1		1	3	1	5	7/2				12	20f	
Neslia paniculata	ch C-Sc		1	1	1		1		1		1	2	1	4	6/3				11	14f	
Lithospermum arvense	ch						1	1				4	1	5	6/2				7	15f	
Spergula arvensis v. maxima	ch L-n			2/2		1					2	1		3	3/1				6	12s	
Bupleurum rotundifolium + B. sp.	ch C-Sc	1				+	+	+			1	1		2	2/1+				3	12f	+
Conringia orientalis	ch C-Sc											1		1	1				1	3s	
Bromus secalinus	ch Ap-n											1		1	1				1	2f	
Centaurea cyanus	ch				+			+										1	1	2f	+
Aphanes arvensis	ch Ap-n												1	1	1				1	1f	
Scleranthus annuus + S. sp.	ch Ap-n	+	+	+	+	+	+	+					1	1	1+				1	1f	+
Valerianella dentata	ch C-n											1		1	1				1	1f	
Caucalis daucoides*	ch C-Sc																				
Consolida regalis	ch C-Sc	+	+	+																	+
Ranunculus arvensis	ch C-n			+	+	+	+	+							+						+
Nigella arvensis	ch C-n			+			+	+							+						+
Polygono-Chenopodietalia																					
Setaria glauca	ch P-S-n		1	2/2	2/1	3/3	4/4	4/3	1		3	4	4	11	16/6			2	31	846f	
Echinochloa crus-galli	ch P-S-n			2/2	3/2	2/2	4/4	3/3	1		2	4	4	10	17/6	1			27	301f	
Setaria viridis/verticillata	ch		1	2/2	3/2	3/3	3/3	2/2	1	1	2	4	4	10	15/6	1			27	350f	
Polygonum tomentosum	ch			2/2			2/2	1	1			2	3	5	7/3			1	12	36f	
Euphorbia helioscopia	ch Eu-P-Ch-n		1		1	1	1	1	1	1	2		1	3	6/4				10	6s	
Digitaria sanguinalis	ch P-S-n				1							3		3	3/1				4	7f	
Fumaria officinalis	ch Eu-P-Ch-n			1															3	4f	
Sonchus asper	ch Eu-P-Ch-n			1							1			1	1				2	3f	
Digitaria cf. ischaemum	ch							1											1	1f	
Polygonum minus	ch															1			1	1f	
Lamium purpureum	ch Eu-P-Ch-n																	1	1	1f	
Secali-Violetalia arvensis																					
Polygonum convolvulus	ch		1	2/2	3/2	3/3	4/4+	5/4+	1		4	4	4	12	17/6+		1		35	591f	+
Galeopsis tetrahit + G.tetr.type		1	1	3/2	3/2	3/3	3/3		1		4	4	4	12	16/5		1		29	264f	
Thlaspi arvense	ch		1	2/2	1	3/3	2/2	1			4	2	2	8	10/3				18	84s	
Viola arvensis/tricolor	ch			2/2	2/2	2/2		2/2	1			1	2	3	4/2			2	14	20s	
Myosotis arvensis type		1		2/2	1	1	1					1	2	3	4/2			2	11	17f	
Galeopsis cf. ladanum + G. ladanum type	ch Th-ea			1			1		1		2	2	2	6	7/3				9	57f	
Anagallis sp.	ch	1	1	2/2	1	2/2				1					1				8	12s	
Galium aparine	ch R-S				2/1		1		1		1	2		3	5/3				7	12f	
Lapsana communis	ch			2/2	1	1						1		1	1				5	9f	
Papaver rhoeas type		1	1		1														3	51s	
Sonchus arvensis	ch					1						2		2	2				3	4f	
Sinapis arvensis	ch																	2	2	7s	
Spergula arvensis v. arvensis	ch		1	1															2	3s	
Galeopsis cf. angustifolia	ch Th-ea			1															1	12f	
Camelina cf. microcarpa ssp. sylvestris							1								1				1	1s	
Rudero-Secalietea																					
Chenopodium album s.l.	ch	1	2/2	3/2	3/2	3/3	4/4	7/4	1	1	4	4	4	12	18/7	1		2	45	4736s	
C. album s. str.	ch	1	1	3/2	3/2	3/3	4/4	5/3	1	1	3	4	4	11	17/7			1	37	397s	
Melandrium album	ch	1	1	3/2	3/2	3/3	4/4	6/3	1	1	4	4	4	12	18/7		1	1	41	573s	
Polygonum persicaria	ch	+	+	1+	2/1	2/2+	3/3+	+	1		4	4	4	12	16/5+		1		26	402f	+
Stellaria media	ch		1	2/2	2/2	1	1		1			3	3	6	8/3				14	30s	
Polygonum lapathifolium	ch			2/2	1				1		1	3	4	8	9/2			1	13	61f	
Galeopsis cf. speciosa	ch											2	1	3	3/1				3	7f	
Capsella bursa pastoris	ch		1										2	2	2/1				3	5s	
Convolvulus arvensis	ch				+	+		+				2		2	2/1				2	10s	
Atriplex patulum	ch						1					1		1	2/2				2	2s	

*In one supplementary sample from VIf in region X (w jednej próbie dodatkowej z VIf w rejonie X)
Ap-n Aperion, C-n Caucalidion, C-Sc Caucalido-Scandicetum, Eu-P-Ch-n Eu-Polygono-Chenopodion, L-n Linion, P-S-n Panico-Setarion, R-S Rudero-Secalietea, Th-ea Thlaspeetea. Other explanations as in table 5 (Pozostałe objaśnienia jak w tabeli 5).

Note: *Papaver rhoeas* type — for 51 s read 5 s (zamiast 51 s ma być 5 s).

Table 14
Tabela 14

The occurrence of species of Molinietalia, Arrhenatheretalia, and Molinio-Arrhenatheretea in the early and late medievel layers from the Wawel Hill
Występowanie gatunków Molinietalia, Arrhenatheretalia i Molinio-Arrhenatheretea w warstwach z wczesnego i późnego średniowiecza na Wzgórzu Wawelskim

Century A.D. - Wiek n.e.		9 - 10				10-11	11 - 12								10	11	15	Macrofossils Szczątki makroskopowe	
Location of samples Lokalizacja prób		Region X, large-area excavation Rejon X, wykop szerokoprzestrzenny													Region XII Rejon XII		Region VIB Rejon VIB		
Archaeological layers and objects Warstwy i obiekty archeologiczne	Characteristic species Gatunki charakterystyczne	Random samples Próby losowe							Archaeological objects Obiekty archeologiczne									Total number of samples Ogólna liczba prób	Total number of specimens Suma okazów	Pollen and spores Pyłek i spory
		VIj	VIi	VIg	VIf	VI e4	VIe	VI c-d	Basket Kosz	House 3 Chata 3	Pit 1 - Jama 1 Bottom Spąg	Pit 1 - Jama 1 Middle Środek	Pit 1 - Jama 1 Top Strop	Pit 1 - Jama 1 Total Suma	Total in VIe Suma w VIe	VIe	VId	Vb			
Number of samples/Number of points Liczba prób/Liczba punktów		1/1	2/2	3/2	4/2	3/3	4/4	7/4	1/1	1/1	4/1	4/1	4/1	12/1	18/7	1/1	1/1	2/1			
Molinietalia																					
Scirpus silvaticus	ch		1	2/2	3/2	2/2	3/3	2/2		1	4	4	3	11	15/5		1	1	30	174f	
Stachys palustris	ch F-P-n		1	2/2	1	1	2/2	1		1	3	4	2	9	12/4		1		22	64f	
Ranunculus repens				1	3/2	2/2	3/3	1	1			3	4	7	11/5				18	283f	
Lychnis flos cuculi + L. type	ch	+	1+	1	1	1	1+		1	1	3	2	3	8	11/4+		1	1	18	60s	+
Lythrum cf. salicaria + L. sp.	ch F-P-n			1+	2/2+	1+	2/2	+		1	1	1	3	5	8/4	1		1	15	81s	+
Hypericum cf. acutum	ch F-P-n			1	1	1	1	2/2		1			1	1	3/3			1	13	78s	
Carex leporina			1	2/2	1	2/2	2/2						3	3	5/3				13	46f	
Thalictrum flavum type	ch Mo-n			1	1	1	1	1			1	1	1	3	4/2				10	15f	
Filipendula ulmaria + F. sp.	ch F-P-n	+	+	+	+	+	2/2+	+			1	2	3	6	8/3+			1	9	14f	+
Carex fusca	ch Soh-C			2/2	1	1	1	1					1	1	2/2			1	8	15f	
Cirsium oleraceum type								1	1				2	2	3/2				4	6f	
Thalictrum cf. lucidum	ch						1				1		1	2	3/2				3	23f	
Lysimachia vulgaris + L. sp.	ch			+		+	+	+			1	2		3	3/1+				3	4s	+
Angelica silvestris	ch						1						1	1	2/2				2	3f	
Caltha palustris + C. type	ch			+		+	1						1	1	2/2				2	2s	+
Symphytum officinale + S. sp.					+		+	+				1		1	1+				1	1s	+
Sanguisorba officinalis	ch	+	+	+	+		+	+							+						+
Gentiana pneumonanthe type		+	+	+		+	+								+						+
Polygonum cf. bistorta	ch	+	+	+	+	+	+	+													+
Succisa pratensis	ch Mo-n			+	+	+	+	+							+						+
Arrhenatheretalia																					
Hypericum perforatum			1	2/1	3/2	2/2	2/2	3/3		1	1	2	4	7	10/4	1	1	1	26	109s	
Stellaria graminea		1	-1	2/2	2/2	3/3	2/2	1		1	2	3	4	9	12/4		1	-2	26	56s	
Cerastium vulgatum	ch M-A				2/2		1		1		1		3	4	5/2			1	9	14s	
Daucus carota	ch Ar-n			1			1				1		1	2	3/2		1	1	6	9f	
Pimpinella cf. maior	ch						1					2	1	3	4/2			1	5	11f	
Betonica officinalis												1	2	3	3/1			1	4	7f	
Knautia arvensis + K. sp.							1+	+				1	1	2	3/2+				3	5f	+
Galium cf. mollugo							1			1			1	1	3/3				3	4f	
Chrysanthemum leucanthemum	ch Ar-n			2/2														1	3	4f	
Campanula patula	ch Ar-n							1											2	3s	
Trifolium cf. repens	ch Cy-n			1			1							1	1				2	2s	
cf. Carum carvi	ch Ar-n										1			1	1				1	2f	
Pastinaca cf. sativa	ch Ar-n			1															1	1f	
Achillea cf. millefolium	ch Ar-n											1		1	1				1	1f	
Phleum pratense	ch M-A											1		1	1				1	1f	
Molinio-Arrhenatheretea																					
Carex hirta type	ch A-R			2/2	1	1	2/2			1	2	2	2	6	9/4				14	30f	
Prunella vulgaris	ch			2/2	1		1		1			2	4	6	8/3			2	13	42f	
Ranunculus acer	ch					2/2	1	1	1			3	4	7	9/3				12	46f	
Rumex crispus	ch A-R			1		+	3/3+	1+			1	3	3	7	10/4				12	20f	+
Centaurea jacea	ch	+	+	2/2+	1+	+	1+	+				2	1	3	4/2+				7	11f	+
Hypericum cf. maculatum		1		2/1	1								1	1	1				5	11s	
Luzula cf. multiflora									1			3		3	3/2				4	19s,1c	
Centaurea cf. austriaca													3	3	3/1				3	3f,21,1b	
Linum catharticum												1	1	2	2/1			1	3	3s	
Plantago lanceolata	ch	+	+	+	+	+	+	+				1	1	2	2/1+				2	2s	+
cf. Festuca pratensis	ch			1															1	1f	
Geranium cf. silvaticum													1	1	1				1	1s	
Rumex acetosa	ch	+	+	+	+	+	+	+							+						+
Trifolium pratense type	ch			+	+	+	+	+							+						+

A-R Agropyro-Rumicion crispi, Ar-n Arrhenatherion, Cy-n Cynosurion, F-P-n Filipendulo-Petasition, M-A Molinio-Arrhenatheretea, Mo-n Molinion, Soh-C Scheuchzerio-Caricetea fuscae; c capsule (torebka), i involucre (koszyczek), ib involucral bracts (łuski okrywy koszyczka). Other explanations as in table 5 (Pozostałe objaśnienia jak w tabeli 5).

The occurrence of species of Festuco-Brometea, Sedo-Scleranthetea, and Nardo-Callunetea in the early and late medieval layers from the Wawel Hill

Występowanie gatunków Festuco-Brometea, Sedo-Scleranthetea i Nardo-Callunetea w warstwach z wczesnego i późnego średniowiecza na Wzgórzu Wawelskim

Century A.D. - Wiek n.e.		9 - 10				10--11	11 - 12							10	11	15	Macrofossils Szczątki makroskopowe		Pollen and spores Pyłek i spory
Location of samples Lokalizacja prób		Region X, large-area excavation Rejon X, wykop szerokoprzestrzenny												Region XII Rejon XII		Region VIB Rejon VIB			
Archaeological layers and objects Warstwy i obiekty archeologiczne	Characteristic species Gatunki charakterystyczne	Random samples Próby losowe							Archaeological objects Obiekty archeologiczne										
		VIj	VIi	VIg	VIf	VI e4	VIe	VI c-d	Basket Koróbka	House 3 Chata 3	Pit 1 - Jama 1 Bottom Spąg	Pit 1 - Jama 1 Middle Środek	Pit 1 - Jama 1 Top Strop	Pit 1 - Jama 1 Total Suma	Total in VIe Suma w VIe	VIe	VId	Vb	Total number of samples Ogólna liczba prób	Total number of specimens Suma okazów	
Number of samples/Number of points Liczba prób/Liczba punktów		1/1	2/2	3/2	4/2	3/3	4/4	7/4	1/1	1/1	4/1	4/1	4/1	12/1	18/7	1/1	1/1	2/1			
Festuco-Brometea																					
Fragaria viridis				2/2	1	2/2	2/2	1	1		1	2	2	5	8/4				15	24f	
cf. Silene inflata				1			2/2		1		3		1	4	8/4		1		9	11s	
Lavatera thuringiaca							1	1	1		1	2	1	4	6/3				7	8s	
Arenaria serpyllifolia		1		1	3/2						1			1	1				6	11s	
Viscaria vulgaris							1		1	1	1			1	4/4			1	5	6s	
Anthemis tinctoria	ch					1	1			1			1	1	3/3				5	5f	
Salvia cf. nemorosa	ch											2	1	3	3/1			1	4	8f	
S. verticillata	ch			1			1						2	2	3/2				4	6f	
Pieris hieracioides											1	3		4	4/1				4	5f	
Stachys recta	ch						1					2		2	3/2				3	26f	
Centaurea scabiosa	ch	+	+	+	1+	+	+	+				2		2	2/1+				3	3f	+
Salvia cf. pratensis	ch								1			1		1	2/2				2	3f	
Potentilla recta					1								1	1	1				2	3f	
Carex caryophyllea type	ch							1					1	1	1				2	2f	
cf. Asperula cynanchica	ch												2	2	2/1				2	2f	
Cerinthe minor + C. sp.				+	+	+	+	+	1			1		1	2/2				2	2f	+
Verbascum cf. nigrum							1								1				1	1f	
Dianthus armeria													1	1	1				1	2f	
Agrimonia cf. eupatoria + A.sp.	ch			+		+	1+								1				1	1f	+
Pimpinella cf. saxifraga	ch												1	1	1				1	1f	
Thalictrum minus	ch											1		1	1				1	1f	
Coronilla varia												1		1	1				1	1f	
Nepeta cf. nuda													1	1	1				1	1f	
Anthericum sp.	ch	+	+	+	+	+	+	+							+						+
Plantago media	ch	+	+	+		+	+	+							+						+
Helianthemum sp.	ch	+	+	+	+			+													+
Scabiosa sp.					+																+
Sedo-Scleranthetea																					
Rumex tenuifolius	ch	1	1	3/2	3/2	3/3	4/4	1	1	1	2	2	4	8	14/7				28	115f	
R. acetosella type	ch	+	+	+	+	+	+	+							+						+
Potentilla argentea	ch		1		1														2	9f	
Trifolium arvense type	ch	+	+	+	+	+	+	+							+						+
Jasione montana	ch	+	+	+		+	+	+							+						+
Nardo-Callunetea																					
Potentilla erecta			1	2/2	1	2/2	3/3	2/2				2	3	5	8/4				17	43f	
Calluna vulgaris	ch			+	+	+	+	+							+						+
Lycopodium clavatum	ch					+															+

Explanations as in table 5 (Objaśnienia jak w tabeli 5)

Table 17
Tabela 17

The occurrence of species of Alnion, Salicion, Alno-Padion, Carpinion, Querco-Fagetea, Vaccinio-Piceetea, Atropetalia, and of species of various forests in the early and late medieval layers from the Wawel Hill

Występowanie gatunków Alnion, Salicion, Alno-Padion, Carpinion, Querco-Fagetea, Vaccinio-Piceetea, Atropetalia i gatunków różnych lasów w warstwach z wczesnego i późnego średniowiecza na Wzgórzu Wawelskim

Century A.D. - Wiek n.e.		9 - 10				10-11	11 - 12								10	11	15	Macrofossils Szczątki makroskopowe		Pollen and spores Pyłek i spory	Number of supplementary samples and samples of fruit-stones or nuts in particular layers Liczba prób dodatkowych oraz prób pestek i orzechów w poszczególnych warstwach
Location of samples Lokalizacja prób		Region X, large-area excavation Rejon X, wykop szerokoprzestrzenny													Region XII Rejon XII		Region VIB Rejon VIB				
		Random samples Próby losowe							Archaeological objects Obiekty archeologiczne												
											Pit 1 - Jama 1										
Archaeological layers and objects Warstwy i obiekty archeologiczne	Characteristic species Gatunki charakterystyczne	VIj	VIi	VIg	VIf	VI e/4	VIe	VI c-d	Basket Kosz	House 3 Chata 3	Bottom Spąg	Middle Środek	Top Strop	Total Suma	Total in VIe Suma w VIe	VIe	VId	Vb	Total numbers of samples Ogólna liczba prób	Total number of specimens Suma okazów		
Number of samples/Number of points Liczba prób/liczba punktów		1/1	2/2	2/2	4/2	3/3	4/4	7/4	1/1	1/1	4/1	4/1	4/1	12/1	18/7	1/1	1/1	2/1				
Alnion																					
Lycopus europaeus	ch			1		1	2/2				1	3	1	5	8/3				9	33f	
Alnus glutinosa	ch			1									1	1	1				2	2s	+
Osmunda regalis	ch							+													
Salicion																					
Humulus lupulus	ch	+	1	2/2+	2/2+	1+	3/3+	1+	1		2	3	4	9	13/5				21	76f	+	
cf. Malachium aquaticum			1	1	3/2	3/3	2/2		1	1		3	3	6	10/5				19	159s		
Rubus caesius	ch			1	1	1	3/3	2/1	1			3	2	5	9/5				14	18f		
Mentha cf. arvensis			2/2	3/2	1	2/2	2/2			1			1	1	4/4				12	32f		
Salix sp.		+	+	+	1+	+	1+	+	1		3	1	2	6	8/3				9	10b	+	w*
Circium arvense type	ch R-S			2/2		1	1					1	1	2	3/2				6	7f		
Saponaria officinalis	ch						1								1				1	3s		
Polygonum dumetorum					1														1	1f		
Alno-Padion																					
Padus avium	ch							1				1		1	1				2	3f		
Cerastium silvaticum	ch										2			2	2				2	2s		
Viburnum opulus + V. sp.	ch F-a						1	+				1		1	2/2				2	2f	+	
Chaerophyllum aromaticum							1					1		1	2/2				2	2f		
Melandrium rubrum											1			1	1				1	2s		
Stachys silvatica	ch					1													1	1f		
cf. Stellaria nemorum													1	1	1				1	1s		
Fraxinus excelsior	ch F-a	+	+	+		+		+													+	
Ulmus sp.		+	+	+	+	+	+	+							+						+	w
Alnus sp.		+	+	+	+	+	+	+							+						+	w
Carpinion																						
Malus sp.					1	1	2/2	1	1		3	3	2	8	11/4				14	18s		Va(3)
Pirus communis					1	1	1					3	2	5	6/2				8	22s		
Malus sp./Pirus communis							1								1				1	1s		
Astrantia maior												1	1	2	2/1				2	6f		
Cerasus avium/vulgaris							1		1						2/2				2	2f		Va(6)
C. type		+	+	+	+	+	+	+							+						+	
Ajuga cf. reptans									1		1			1	2/2				2	2f		
Galium cf. silvaticum	ch											2		2	2/1				2	4f		
Moehringia trinervia	ch Q-F						1								1				1	1s		
Tilia cordata	ch	+	+	+	+	+	+	+							+						+	
T. platyphyllos	ch Q-F	+	+			+	+	+							+						+	
T. sp.									1										1	1w		
Carpinus betulus	ch	+	+	+	+	+	+	+							+						+	
Hedera helix	ch F-a			+	+	+	+	+							+						+	
Querco-Fagetea																						
Prunus spinosa	ch						1	1			1	2	1	4	5/2				6	11f		Va(6)
Corylus avellana	ch	+	+	+	1+	+	+	1+	1				1	1	2/2				4	6f	+	VIf(3),VIg/e(1) VIe(21),VIc-d(4) VIb(1),Va(5)
Campanula persicifolia	ch							1			1			1	1				2	2s		
Fagus silvatica	ch	+	+	+	+	+	+	+					1	1	1+				1	1s	+	
Cerasus fruticosa	ch																					Va(7)
Acer sp.	ch	+	+	+	+	+	+	+							+						+	
Cornus sanguinea	ch			+																	+	
Vaccinio-Piceetea																						
Pteridium aquilinum	ch	+	+	1	1+	1+	1+	+	1			2	2	4	6/3+			1	10	16l	+	VIf(1),VIe(4)
Picea excelsa	ch	+	+	2/2+	1+	+	+	+			1		1	1	1+				4	18s,14n	+	VIf(1),VIe(1),w
Lycopodium complanatum	ch				+																+	
Vaccinium sp.	ch						+	+							+						+	
Various forests - Różne lasy																						
Abies alba		+	+	+	2/1+	+	+	+	1		2	3	1	6	7/2+				9	16n	+	VIf(1),w
Quercus sp.		+	+	+	+	+	+	+	1			2		2	3/2+			1	4	31,4w	+	VIb(3),w
Betula verrucosa/pubescens											1			1	1				1	1f		
B. sp.		+	+	+	+	+	+	+	1						1+				1	1w	+	w
Frangula alnus		+	+	1+	+	+	+								+				1	1f	+	
Luzula cf. nemorosa													1	1	1				1	1s		
Pinus silvestris		+	+	+	+	+	+	+							+						+	VIf(1),VIe-d(3),w
Populus sp.		+	+	+	+	+	+	+							+						+	w?
Polypodium vulgare				+	+	+	+	+							+						+	
Sorbus sp.							+	+							+						+	
Ribes sp.								+													+	
Atropetalia																						
Rubus idaeus	ch		1	2/2	2/2	3/3	3/3	6/3	1	1	3	4	3	10	15/6		1		35	167f		Va(1)
R. sp.				2/2+	+	+	1+	2/2+			1			1	2/2+				6	6f	+	
Sambucus nigra	ch			2/2	1	3/3	2/2	5/4	1		2	1		3	6/4		1		21	37f		VIb(1)
S. sp.		+	+	+	+	+	+	+							+	1			1	1f	+	Va(1)
Fragaria vesca	ch		1	2/2	1	1	2/2					3		3	5/3		1		11	24f		
Torilis japonica	ch			1			1					1		1	2/2				3	3f		
Rubus plicatus type							1	1							1				2	2f		
Sambucus cf. ebulus							1								1				1	1f		

*Separate findings of wood and charcoal are listed in table 3 (Oddzielne znaleziska drewna i węgli są zestawione w tabeli 3).
F-a Fagetalia, Q-F Querco-Fagetea, R-S Rudero-Secalietea; b bud scales (łuski pąkowe), l leaf (liść), n needle (szpilka), w wood and charcoal (drewno i węgle drzewne). Other explanations as in table 5 (Pozostałe objaśnienia jak w tabeli 5).