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Are sporomorphs collected from the Wawel renaissance Gardens indicative of herbs cultivated by Queen Bona Sforza (1494–1557)?

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ABSTRACT. Palynological investigations were carried out at a depth of 40 cm from sediments, associated with the former Royal Gardens on the Wawel Hill. Small numbers of sporomorphs persisted, providing information on nearby plant associations near the surroundings. However, firm evidence for the herbaceous plants cultivated in the garden of Queen Bona Sforza during the Renaissance period has still proved elusive.

KEY WORDS: palynology, renaissance Royal Gardens, Wawel, Poland

HISTORY OF WAWEL HILL

The Wawel Hill (Phot. 1), situated on the left bank of the Wisła river, rises up *ca* 228 m a.s.l. and is formed of Jurassic limestone rock. It is a dominant feature in the landscape of Kraków, standing 20–25 m above the surrounding terrain. This isolated hill is one of the southernmost hills of the Kraków-Częstochowa uplands (Jura Krakowsko-Częstochowska, Fig. 1).

Phot. 1. The Wawel Castle, behind the Wisła River (phot. A. Walanus)

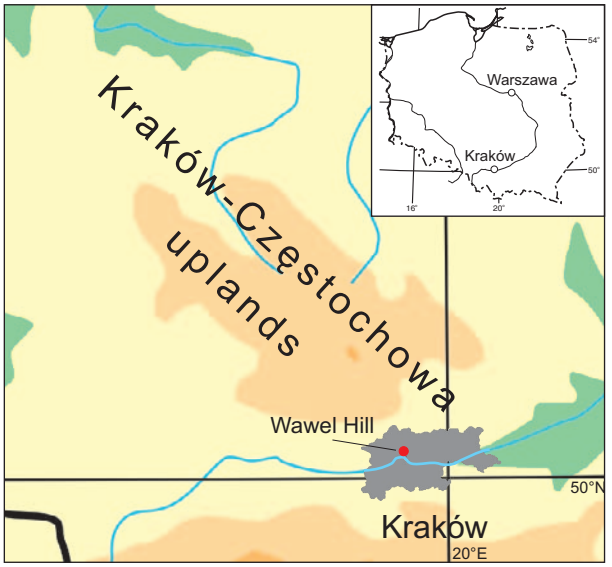

Fig 1. Location of the Wawel Hill

The first traces of human activity at the site come from the Palaeolithic Age, dating from about 70 thousand years ago (Rydzewski 2005). It is thought that Slavic people started living on the Wawel Hill as early as the 7th century AD. Towards the end of the first millennium AD, the Wawel began to play a central role in political power and, during the 9th century, it became the principal fortified castrum of the Wiślanie (Vislane) tribe. The first historical ruler of Poland, Mieszko I (Miesco I, 965–992) of the Piast dynasty, as well as his successors Bolesław Chrobry (Boleslas the Brave, 992–1025) and Mieszko II (Miesco II, 1025–1034), chose the Wawel Hill as one of their residences. At that time the Wawel became one of the main Polish centres of Christianity and sacred buildings, including a stone cathedral, were built there, alongside a royal castle (Fig. 2). At the initiative of Władysław Łokietek (Ladislas the Short, 1306–1333) the castle was expanded and brick constructions replaced the old wooden and earthen fortifications. The Italian Renaissance arrived at Wawel in the early 16th century. King Aleksander (Alexander, 1501–1506) and his brother Zygmunt Stary (Sigismund I the Old, 1506–1548) commissioned the construction of a new palace in place of the Gothic residence. In 1518, close artistic and cultural relations with Italy were strengthened by the king's marriage to Bona Sforza d'Aragona (1494–1557), a member of the House of Sforza. Alongside Italian artists, German architects, wood workers, painters and metal smiths worked for the king. During later centuries, the Wawel lost much of its significance, as Warszawa (1596) became the

Fig 2. Historical and sacred buildings on the Wawel Hill (satellite photo by Zumi): **1** – the cathedral, **2** – the Wawel castle. The sites of palaeobotanical researches: **3** – the upper terrace of the restored renaissance Royal Gardens, **4** – the early medieval culture layer analysed by Koperowa (publ. in Wasylikowa 1991a, b), **5** – the Medieval culture layers analysed by Wasylikowa (1978), **6** – the soil sample connected with the early medieval fortifications by Wasylikowa et al. 2006

capital of Poland and the royal court relocated there. After Poland lost its independence in 1795, the troops of the partitioning nations, Russia, Prussia and Austria, occupied the Wawel, which finally passed into the hands of the Austrians. The new owners converted the castle and some of the secular buildings into a military hospital, and demolished some others, including churches. When Poland regained its independence in 1918, the castle served as an official residence of the Head of State, and as a museum of historic interiors. During Nazi occupation, the castle was the residence of the German Governor-general (http://www.wawel.krakow.pl/en/). After the Second World War, the Wawel Hill was in very poor condition and extensive restoration was undertaken. At the same time, archaeological excavations were started on the Wawel Hill and are continuing to this day (http://www.wawel.krakow.pl/en/).

EXAMINATION OF WAWEL HILL PLANT COVER

The vegetation of the Wawel Hill in historical times has been analysed by Gwizdałówna (1995, 1997). She conducted an exhaustive examination of historical archives, examining documents collected since medieval times. However, there are significant gaps in the documentation. To elucidate the former history of vegetation on the Wawel Hill palaeobotanical investigations (plant micro- and macroremains) have been conducted intermittently since the 1950s. From the Wawel Hill Krystyna Wasylikowa made analyses of macroremains in 1970s (1978a, b, 1991) and Wanda Koperowa made the first pollen diagram in the early 1970s, which were included to K. Wasylikowa publications (1978a, 1991).

Human activity through time has caused many changes in the natural plant cover on the Wawel Hill, and many anthropogenic plant associations have developed here. The plant cover has altered considerably and developed into a complex mosaic of natural, semi natural and secondary plant communities (Wasylikowa 1991).

The eastern part of the Wawel Hill is currently a subject of archaeological investigation. In the 16th century here were located the Royal Gardens (Gwizdałówna 1995) and the aim of the current excavations is to elucidate more details about them and to restore them for public presentation (Fig. 2).

RESEARCH AT THE ROYAL GARDENS

In 1999, a section of renaissance paths from the upper terrace of the Royal Gardens were discovered and the archaeological department of the Royal Castle, under the supervision of Prof. Zbigniew Pianowski and Dr. Janusz Firlet, started conservation work in front of the eastern elevation of the castle. From the 16th to 18th centuries this area was occupied by the Royal Gardens. During the first part of the excavations, stairs near the castle wall, also attributable to the Renaissance period, were discovered and rebuilt. Subsequently, fragments of brick garden paths and the supporting wall of the terrace were uncovered. The brick paths, laid out in a rectangular pattern, are relatively wide, and bedded in their original contemporary mortar (Fig. 3, Phot. 2).

From 2001–2003, further archaeological research revealed the extent of the uniformly planned paths and rectangular areas of soil, interpreted as flowerbeds, in the northern part of the terrace. Invoices from the building of the castle provided evidence that this garden arrangement was created in 1541. The southern part of the garden was altered later in the 16th century and more stone paving was laid.

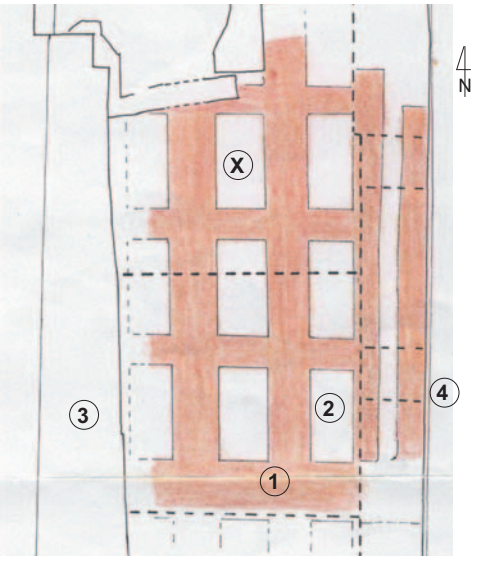

Fig. 3. The upper terrace of the renaissance Royal Gardens. Fragment of uncovered brick paths: **1** – bricks paths, **2** – flowerbeds, **3** – the renaissance Palace, **4** – the supporting wall. **X** – sampling point in 2003 (the scheme according to Firlet & Pianowski 2008)

Phot. 2. View of the area excavated in 2003. Wide bricks paths surround rectangular areas of soil (phot. A. Walanus)

During this phase of archaeological investigations, samples for palaeobotanical analysis were collected.

The aim of the palaeobotanical research was to obtain information on plant composition and to establish whether or not there was wooden boxing around the flowerbeds. The first samples for palaeobotanical examination presented here were collected from one region only, on the eastern slope of the Wawel Hill. Subsequent materials were collected from the wider area, including the whole of the archaeological site.

THE ROYAL GARDENS – HISTORY AND ARCHAEOLOGICAL RESULTS

The remains of the Royal Gardens discovered during the archaeological excavation permitted the arrangement of brick paths and regular flowerbeds to be very faithfully reconstructed. The brick paths are laid out in a regular pattern, east-west and north-south, around rectangular small areas filled by dark humus. Undoubtedly, these are the remnants of the renaissance Royal Gardens in front of the east facade of the castle (Gwizdałówna 1995). They were constructed there probably after the castle fire in 1536. There are invoices from 1541 for bricklaying in the garden near a tower called Jordanka. Also at that time, wagons of soil (chernozem) were transported probably from the village of Czarna Wieś (Gwizdałówna 1995 after Chmiel 1913).

Wide and narrow bricks paths enclosed relatively small areas of soil in three rows parallel to the castle facade. The size of the flowerbeds (110 cm × 220 cm) is recorded in archival data from 1542, which also record the use of wooden boxes for the "herbal" part of the gardens (Gwizdałówna 1995 after Chmiel 1913). What plants were cultivated in them was the question asked of the palaeobotanists. From historical records we know that Bona Sforza, the wife of King Zygmunt Stary (Sigismund I the Old), when she came to Poland, brought with her the knowledge about cultivation of some vegetables and some culinary herbs and some spices, which were unknown at this time in the territory of Poland (Gwizdałówna 1995 after Chmiel 1913).

MATERIAL AND METHODS

PALAEOBOTANICAL SAMPLING

In 2001, the small rectangular areas between the paths were excavated. Two months later, a series of palaeobotanical samples were taken from one part of the site. The material was heterogeneous, unconsolidated and dry. Grey silt was the principal constituent with sand and a few pebbles. As additional elements, there were fragments of bricks, bones and pieces of wood. This suggested that the material was reworked and would not contain any sporomorphs (pollen grains and spores) or diatoms because the material was aerated.

In 2003, archaeologists excavated larger area inside the former gardens on the upper level (Phot. 2). From this area samples were taken from the centre of one of the former flowerbeds (Phot. 3) on the day following exposure. The sediment was homogenous, consolidated and humid, and therefore potentially more promising for palaeobotanical analysis. Dark brown silt with fine sand was the principal constituent. Palaeobotanical sampling was supervised by

Phot. 3. View of the sample trench (phot. A. Walanus)

Table 1. Description of the excavated profile of the former flowerbed

Depth [cm]	Sediment description	Archaeological dating
0.0–12.0	Mixed size inclusions of brick, bone, pottery, stones, and pebbles fairly consolidated by sand and clay. Light brown and dark in colour. Structure heterogeneous	Probably after the renaissance Royal Gardens fell into disuse, but not in the 20th century
12.0–26.0	Clay with an admixture of sand and a few small inclusions of pebbles, brick, bone and charred pieces of wood. Yellow-brownish, rather light colour. Structure compacted, but heterogeneous. Lighter and slightly more compact than the upper layer and much lighter than the lower layer	Possibly Renaissance age
26.0–45.0	Clay with an admixture of sand and a large amount of charred pieces of wood. The dimensions of them differ from large, up to 20 cm length and 5 cm in diameter, to very small, microscopic fragments. Structure fairly compacted, but heterogeneous. Colour almost black because of the charred particles. Only a few pebbles and bones are present	This layer is the remnants of the medieval embankment. Part of it was destroyed when the renaissance Royal Gardens were established here

Dr. J. Firlet and K. Żółciak MSc. eng. from the Wawel Royal Castle the National Art Collection.

A small trench (100.0 cm length, 20.0–30.0 cm width and ± 45.0 cm deep) was excavated in the centre of one of the rectangular areas between the paths, i.e. a former flowerbed (Phot. 3).

Table 1 contains lithological description of the excavated profile. Samples for pollen analysis were collected from the deepest to the uppermost layers directly into plastic bags. The samples were not thicker than 2.0–3.0 cm each and the volume was ca. 0.25 dm^3. During excavation, a few extra samples of archaeological material were collected: from the 30.0 cm level – fragments of ceramics, charcoal, teeth and bones were stored in separate bags; and, from the 45.0 cm level, two large fragments of charred wood were collected in two separate bags. Unfortunately, one of the fragments of charred wood disintegrated during packing. Finally, a monolith from the central section of the trench (15.0–23.0 cm) was collected in a sediment sampling tin (35.0 cm × 8.0 cm × 5.0 cm). This material has been stored for any further examinations.

LABORATORY PREPARATION FOR POLLEN ANALYSIS

Eight samples for pollen analysis were prepared using standard procedures. Each sample of 5 cm^3 was treated with Erdtman acetolysis (Faegri et al. 1989), together with the addition of a known number of indicator spores of *Lycopodium* (Stockmarr 1971). Mineral components were removed by boiling in 10% KOH, decantation and boiling in hydrofluoric acid. Additional mineral elements were removed by treating with hot tetrasodium pyrophosphate $Na_4P_2O_7$ (sodium diphosphate) and ultrasound disaggregation. The material was then mounted in glycerine. Pollen analysis was performed using a Nikon microscope with phase contrast and magnification from 600 up 1000. Sporomorphs were counted on at least two slides for each sample. From each slide an area 0.22 × 0.22 cm was examined. Analysed samples contained very low numbers or badly preserved sporomorphs. One sample did not include any sporomorphs at all. Along with sporomorphs, silt particles, charred particles and very small, amorphous dark brown particles (probably organic), were present on the slides.

From 5 to 59 AP (trees and shrubs) and from 56 to 206 NAP (non-arboreal) pollen grains were counted for each sample. For interpretative purpose 10 samples were analysed, and 69 taxa were determined overall.

The results of pollen analysis are plotted as a raw data pollen diagram, which includes all determined taxa, and as a diagram summarizing taxa by group.

For the quantification of sporomorphs, drawing the diagrams and implementing numerical analysis, the POLPAL computer programs were used (Walanus & Nalepka 1999, 2004, Nalepka & Walanus 2003).

LABORATORY TREATMENT OF MATERIAL FOR MACROFOSSIL ANALYSIS

Samples for macrofossil analysis were collected in 2001 with volumes between 0.5–3.0 dm^3. Firstly using flotation by clear water, the charred fragments were separated and collected. The remaining material was boiled in 10% of KOH and sieved using 0.02, 0.05 and 0.20 mm sieves. Fruits and seeds were determined using a binocular microscope at × 25 magnification. Charred wood was determined using three break directions and reflected light at × 500 magnification. All macro- and microfossils were determined using the reference collections at the Palaeobotany Department of the W. Szafer Institute of Botany Polish Academy of Sciences.

Material for radiocarbon dating (AMS), collected in 2003, was treated with distilled water, sieved through a 0.20 cm diameter mesh, and separated using a binocular microscope.

RESULTS OF MICRO- AND MACROREMAINS ANALYSE

RESULTS OBTAINED FROM MATERIAL COLLECTED IN 2001

No plant microfossils – pollen grains, spores, or diatoms (Prof. K. Wołowski, pers. comm.) – were present in the material collected in 2001. Silt, charred particles and amorphous

Table 2. Plant macroremains (det. by Z. Tomczyńska 2001, unpubl.)

Trees	Shrubs	Herbs, cultivated	Herbs, wild plants
Abies alba	Rosaceae undetermined	*Panicum miliaceum*	*Agrostemma githago*
Alnus sp.	*Sambucus nigra*	*Triticum* sp.	*Carex* sp.
Betula sp.		Cerealia	*Chelidonium majus*
Betula verrucosa		*Pisum* sp.	*Chenopodium* t. *album*
Carpinus betulus			*Chenopodium hybridum*
Fagus sylvatica			*Galium spurium*
Fraxinus excelsior			Poaceae
Picea/Larix			*Scrophularia nodosa*
Pinus sylvestris			Apiaceae
Populus sp.			*Urtica dioica*
Quercus sp.			
Tilia sp.			
coniferous undetermined			

organic remains covered the slides, examined by microscope.

In all samples, however, there were charred and uncharred plant macroremains, means fruits, seeds, wood (Tab. 2). The species that were present are often interpreted as garden and field weeds or ruderal plants. Among them were present charred remains of the cultivated plants: wheat (*Triticum* sp.), millet (*Panicum miliaceum*), and, maybe, pea (*Pisum* sp). Among wild herbaceous plants swallowwort (*Chelidonium majus*) was identified. Small particles of charred and uncharred wood were determined. The most common tree fragments belonged to oak (*Quercus* sp.), beech (*Fagus sylvatica*), and fir (*Abies alba*) and likewise fragments of elder (*Sambucus*) were frequent. One fragment of wood was determined as possibly a Rosaceae shrub. The common elder (*Sambucus nigra*), was also recognized on the basis of a preserved seed.

RESULTS OBTAINED FROM MATERIAL COLLECTED IN 2003

Samples collected in 2003 from the Wawel Royal Gardens contained very low numbers of pollen and spores belonging to trees, shrubs and herbs. Most of that sporomorphs were badly preserved, nevertheless the pollen diagram containing all of them was constructed (Fig. 4). Among counted pollen grains and spores, indeterminable sporomorphs show very high numbers and dominate in a few samples (Fig. 5). They were badly damaged and mostly categorized as 'Corroded' and 'Degraded' (Fig. 4).

RADIOCARBON DATING

Two AMS radiocarbon determinations are available from the Royal Gardens (Tab. 3), dated by the Poznań Radiocarbon Laboratory. After the pollen analysis was completed, appropriate samples were selected for charcoal extraction, and this material was washed from a few cm^3 of sediment. Dates are presented as conventional ^{14}C dates BP and in brackets the 68% (1 sigma) and 95% (2 sigma) ranges of calibrated age are denoted. The OxCal 3.0 program was used in the calibration.

DESCRIPTION OF LOCAL FLORA ASSEMBLAGE ZONES

Initially, an attempt was made to draw and interpret the percentage pollen diagram (Fig. 6) in a standard way (Makohonienko

Table 3. Radiocarbon dates obtained from profiles at the upper terrace of the renaissance Royal Gardens site. The 68% and 95% ranges of the calibrated age are shown

Depth [cm]	Material	No	^{14}C BP	Cal AD 68.2%	Cal AD 95.4%
15.0–19.0	One piece of *Quercus* charcoal	Poz-4551	1400 ± 30	619AD – 632AD (14.9%) 637AD – 663AD (53.3%)	600AD – 685AD
30.0	Several pieces of charcoal too small to be determined	Poz-4553	1260 ± 30	685AD –780 AD	670AD – 870AD

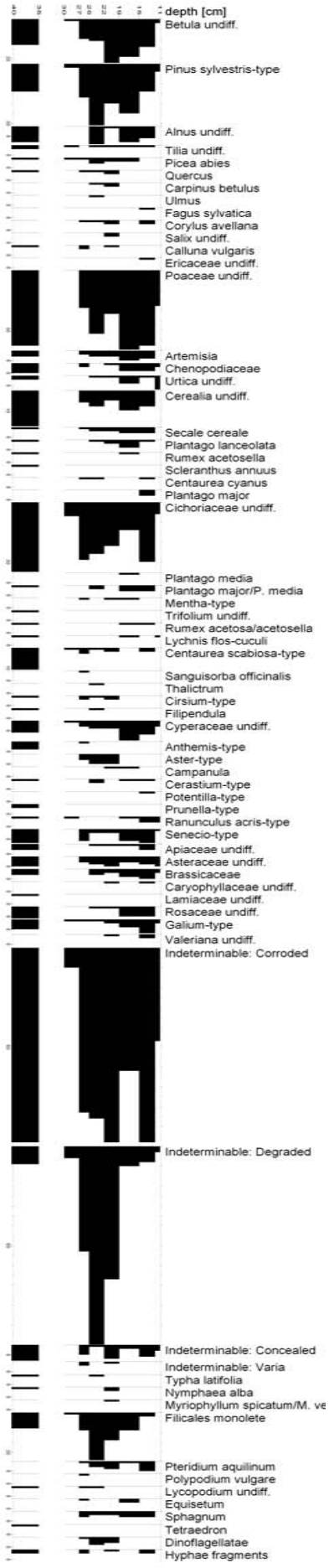

Fig. 4. Raw data pollen diagram from the upper terrace of the renaissance Royal Gardens, Wawel Hill

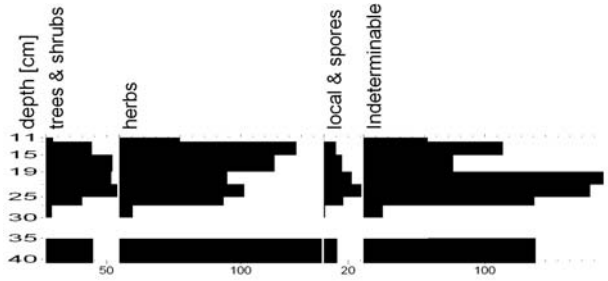

Fig. 5. Pollen grains (raw data) summarized as groups

& Nalepka 2007) divided into four local pollen assemblage zones (LPAZ) following Birks (1979, 1986) and Janczyk-Kopikowa (1987), on the basis of the visual analysis of individual pollen curves supported by numerical analysis ConSLink and PCA (Tab. 4).

Table 4. The upper terrace of the renaissance Royal Gardens. Local pollen assemblage zones (LPAZ) based on percentages of sporomorphs, published by M. Makohonienko & D. Nalepka in 2007 (Fig. 6)

LPAZ	Name of LPAZ	Depth [cm]
W_{-1}	Poaceae–Cerealia	35–40
W_{-2}	*Tilia–Picea*–Cichorioidae	27–30
W_{-3}	*Betula–Pinus*–Poaceae–Filicales	12–25
W_{-4}	Poaceae–*Urtica–Ranunculus acris*–Asteraceae	11

However, because very low numbers of sporomorphs were present in the samples, this article presents the results and makes interpretations on the basis of the raw data (Fig. 4). *A priori* knowledge of the renaissance Royal Gardens is an additional argument to interpret the raw data in this case. The sediments deposited in the garden are known to have been transported there in bulk (Gwizdałówna 1995 after Chmiel 1933). The sediment did not accumulate as it would have done in, for example, a natural basin.

DISCUSSION

POLLEN ANALYSIS OF MATERIAL FROM THE ROYAL GARDENS

Sediment from the Royal Gardens appears to be too aerated to preserve sporomorphs well (Makohonienko & Nalepka 2007). Nevertheless, sporomorphs are present in the soil, but they are very badly preserved – most of them are so decomposed that they are impossible to

determine. It is likely that the sediments have also been reworked by leaching processes and the activity of microfauna and bacteria living in the soils (Aaby 1993, Nalepka 1999). This means that dating the sediment is affected and likely to be inaccurate.

First, as the material contained some pollen grains and spores, the results were treated using a standard approach, calculating the percentages of determined taxa, dividing the percentage pollen diagram into local pollen assemblage zones (LPAZ, Tab. 4, Fig. 6), and interpreting them (Makohonienko & Nalepka 2007). However, the low number of pollen grains and spores, and additionally many sporomorphs undetermined among them, limit the possibility of using a standard approach and favour consideration of the raw data instead.

It is notable that some of the taxa identified in the macrofossil analysis were not determined during pollen analysis. This includes trees (*Abies alba*, *Fraxinus excelsior*, *Populus* sp.), shrubs (*Sambucus nigra*), and herbs (*Chelidonium majus*, *Pisum* sp., *Scrophularia nodosa*). Nevertheless this difference does not change the interpretation of the plant composition presented because the identification of same taxonomic units of various ranks can be compared (Tab. 5).

The identified sporomorphs and plant macroremains (Fig. 4, Tab. 2) represent communities developed mostly on open, unforested sites. The calculations, both including and excluding indeterminate taxa, clearly showed the dominance of herbaceous taxa in the analysed pollen spectra. Among the plant communities represented are: meadows (e.g. *Lychnis flos-cuculi*, *Sanguisorba officinalis*, *Centaurea scabiosa* t.), ruderals (*Artemisia*, Chenopodiaceae), and cultivated fields (Cerealia undiff., *Secale cereale*, *Panicum miliaceum*, *Agrostemma githago*). A few sporomorphs

Table 5. Taxa determined both in pollen and macroremains analyses from the site at the renaissance Royal Gardens on the Wawel Hill

Pollen	Macroremains
Betula	*Betula verrucosa*
Cyperaceae	*Carex* sp.
Chenopodiaceae	*Chenopodium* t. *album*, *Chenopodium hybridum*
Galium t.	*Galium spurium*
Cerealia undiff.	*Triticum* sp., *Panicum miliaceum*
Caryophyllaceae	*Agrostemma githago*

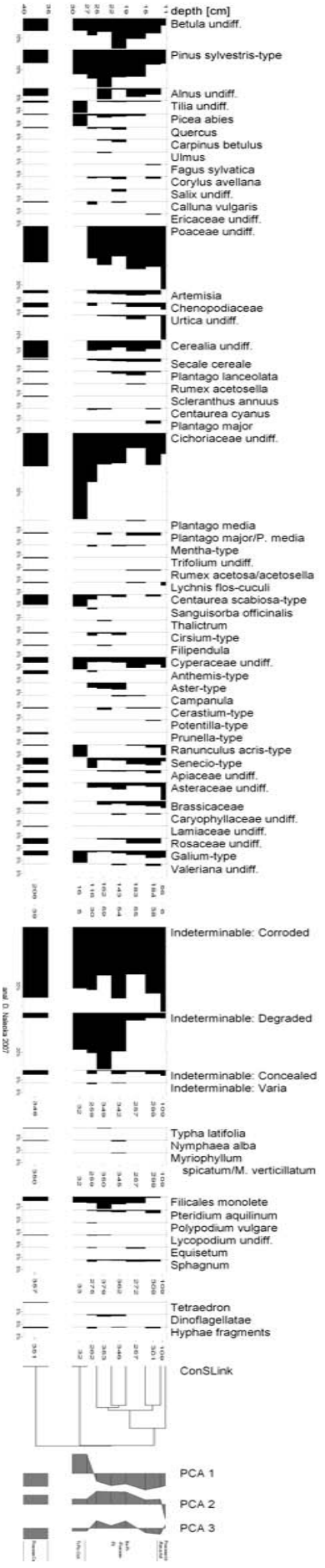

Fig. 6. Percentage pollen diagram from the upper terrace of the renaissance Royal Gardens (as interpreted in Makohonienko & Nalepka 2007)

indicate communities developed on wet soils and in eutrophic water (*Typha latifolia*, *Nymphaea alba*). Several taxa indicate herbaceous, cosmopolitan plant communities. Only a few of those communities might have been present in the close Wawel castle vicinity, e.g. ruderal communities. Most of the recognized communities would have developed further from the confines of the castle, e.g. crop fields, meadows, groves, coppices, open forests or group of trees and reed-swamp and aquatic plants. Therefore, it is reasonable to conclude that the soils present in the renaissance Royal Gardens come from outside the Wawel Hill area, but not actually from it. The cornfields would have been located in the vicinity, but only came to be included in the garden soils through transportation of soil to the Wawel Hill. Alternatively, it is possible that the pollen came into the soils through the disposal of cereals or crop plants delivered to the royal kitchens of the Wawel Hill, possibly from sweepings. It is also possible that straw may have been used in the garden for any purposes. Ruderal plants pollen could derive from many sources. They could come together with soils or they come from plants growing within the renaissance Royal Gardens, for example, along paths.

The analysed samples contained relatively high numbers of Cichorioidae pollen grains, which are common in sediments excavated from archaeological sites (Makohonienko et al. 1998a, b). It is possible that these pollen grains persist due to their strong exines, which appear to be more resistant to decomposition in the sediment than exine of many other plants. Their abundance therefore does not reflect that Cichorioidae plants played a larger role than others plants (Makohonienko et al. 1998a, b).

ORIGIN/LOCALIZATION OF THE ANALYSED GARDEN SEDIMENTS

The pollen analysis shows that the garden sediments derive from an area, in which in close contact were fresh meadows (*Lychnis flos-cuculi*), oxbow-lakes or ponds with slow coming water (*Nymphaea*, *Phragmites*), riverine forests (willows, alders, *Filipendula*), and mixed forests (pine, birch, oak, lime, hazel) as well as cornfields (*Secale cereale*) with weeds (*Scleranthus annuus*). Such situation could have existed in the area of the former Czarna Wieś village, indicated by the archives of The Royal Wawel Castle as the source area for

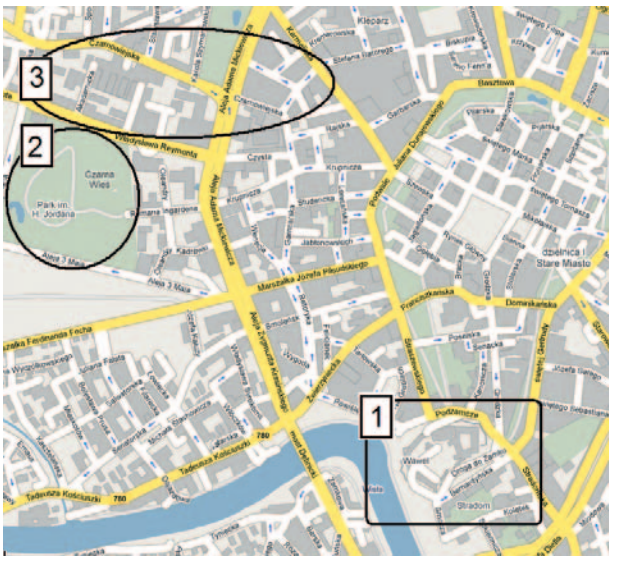

Fig. 7. Krakow centre and the location of the Wawel Hill **(1)**, Jordan Park (Park im. H. Jordana) **(2)**, and Czarnowiejska street **(3)** in the 21st century

garden soil. Nowadays it is the area near Park im. H. Jordana (Jordan Park), although on the east of this park Czarnowiejska street has existed, a street and the park extended almost in the centre of Kraków (Fig. 7).

The state of preservation of some pollen grains and spores indicates that the sediments cannot come from dry sites. It seems that soils in the renaissance Royal Gardens were gardened for a short period only, and they were dug not too often, as sporomorphs still persisted in them. But the high number of degraded and corroded sporomorphs suggests that this material was aerated to some degree.

THE AGE OF THE EXAMINED MATERIAL

The species composition of the identifiable sporomorphs is consistent with the most recent period of the Holocene, the Subatlantic period (Ralska-Jasiewiczowa et al. (eds) 2004).

Both radiocarbon determinations, 1400±30 ^{14}C BP and 1260±30 ^{14}C BP, obtained from the charred wood particles from the bottom layers, are very similar to each other (Tab. 3) and the calibrated values strongly overlap. This indicates that the age of the dated charcoal taking from the renaissance Royal Gardens soils, seems to date to the 7th–8th centuries AD. However, those soils were placed on top of the medieval defence walls, after they were levelled, and dated by archaeologists excavating the site to the 12th century AD. Thus soils probably were dug up in the flowerbeds before the plants were sown and cultivated. Digging

soils would cause displacing older charcoal woods to examined soils. But the dating result excluded the suspicion that flowerbeds were fulfilled by much younger soils.

SUGGESTIONS ON BONA SFORZA HERBS GARDENED IN THE RENAISSANCE ROYAL GARDENS BASED ON MICRO- AND MACROREMAINS ANALYSES

During the palynological analysis, careful attention was paid to the possible presence of Lamiaceae and Rubiaceae (*Galium* type) pollen grains. These families contain herbs such as basil (*Ocimum basilicum*), marjoram (*Origanum majorana*), rosemary (*Rosmarinus officinalis*), woodruff (*Asperula*) and were, according to the castle's archives, cultivated (gardened) in the renaissance Royal Gardens. Unfortunately, only a few pollen grains belonging to these families were determined as belonging to them. This means that pollen analysis neither confirms nor refutes the statement that these herbs were cultivated in the excavated areas and could be the mysterious Bona Sforza herbs cultivated by her.

None of the variety of herbs, shrubs and trees found as macroremains in samples in 2001 (Tab. 2) are known garden plants in the past. However, all the other, determined plant taxa from the renaissance Royal Gardens are the same as those found in the Wawel Hill medieval layers (Wasylikowa 1978a, b, 1991).

In addition, traces of wooden constructions surrounding the flowerbeds were not found. Although charcoal belonging to several species of trees (Tab. 5), was found in the samples, dating evidence suggests these fragments are older than the gardens (see Tab. 3) and may not originate from wooden box.

CONCLUSION

In the material coming from both years when palaeobotanical sampling was conducted, 2001 and 2003, there was no concrete evidence to indicate which plants were cultivated in the upper terrace of the renaissance Royal Gardens during the 16th century. There were also no traces of wooden boxes that could have been used as soil containers for the garden plants, as suggested in the Wawel castle archives (Gwizdałówna 1995).

Phot. 4. View of the restored renaissance Royal Garden in the Wawel Hill (after Smólski et al. 2005) in 2006 (phot. D. Nalepka)

In 2005 on the upper terrace, the renaissance Royal Gardens were restored on the basis of the archaeological discoveries and according to 16th (Italian) rules (K. Żółciak, pers. comm.). Historical references to the existence of 'boxes' in the renaissance Royal Gardens led to the presentation of boxed flowerbeds, popular in those times, and in which plant collections were exhibited. To recreate the original ambience of the gardens, a variety of species were planted within the box frames, including lavender (*Lavendula*), catmint (*Nepeta*), rue (*Ruta*), rosemary (*Rosmarinus*), asperula (*Asperula*) and French rose (*Rosa*). The restoration also presented other features, characteristic of 15th and 16th centuries gardens, including ornamental beds laid out in simple patterns and a flower meadow with a trellis. These restorations are also based on 15th and 16th century iconography of garden architecture (Phot. 4, http.www.wawel.krakow.pl/en.).

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