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MM: study idea, developed the idea of the manuscript, wrote and edited the manuscript; SM, NK: prepared data, wrote and edited the manuscript, prepared graphics

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#### **ORIGINAL RESEARCH PAPER**

# Historical gardens and their potential use for proecological development of urban green space, as illustrated by Felin Manor Park in Lublin, Poland

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## Abstract

Historical urban parks are particularly valuable in terms of their ecology, as they offer habitats to many valuable flora and fauna. A study was conducted in Felin Manor Park, Lublin, southeastern Poland, dating back to the end of the nineteenth and the first half of twentieth century. The aim of the study was to assess the suitability of this type of urban park for the proecological design of urban green areas that will comply with the legal requirements for historic gardens. The investigation demonstrate that long-living native tree species (e.g., Tilia cordata, Quercus robur, and Fraxinus excelsior) are the best preserved plants in this park. The dendroflora of the park is, however, characterized by a great variety of species flowering between early spring and fall. These reward species ensure continuity of the food base for insects throughout the vegetation season. A floristic inventory facilitated development of a concept for the restoration of the park combining cultural (historical, educational) and ecological functions. Tilia cordata was used for line planting arrangements along the park boundary. It is a component of the alley design along the driveway and is one of the most valuable nectar reward species. The survey allowed the definition of future design guidelines, i.e., the preservation of the historical park structures (formed by long-living native species) and complementation of the park dendroflora with species that are attractive for bees and other insect pollinators. To supplement their food base, it is recommended that a "bee garden" with herbaceous reward plants should be created.

#### **Keywords**

restoration; historical garden; dendroflora; ecology; pollinators

## Introduction

The civilization progress in urbanized areas is closely related to technological development, which improves the comfort of city residents. However, this progress is associated with many threats to the natural environment, e.g., a decline in the areas with ecological functions and degradation of urban nature systems, all of which exert a negative effect on the quality of life for residents and the natural potential of urban areas [1,2]. As highlighted by Majdecki [3], only green enclaves creating a system of interconnected natural features can have a positive impact on the beneficial function for the urban agglomeration. Special ecological value is ascribed to public parks, private gardens, or allotments, all of which provide a refuge for many valuable flora and faunal species [4,5]. Historical parks are particularly precious, as they are a combination of intertwining and mutually interacting components from different epochs and periods of history. These features are very often highly diversified in terms of their surface area, structure, degree of preservation of the historical substance (including historical dendroflora), and their management needs. The vegetation, which is subject to continuous changes and numerous transformations introduced by successive generations of users, is often a nonhomogeneous form in terms of composition and style [1,5,6]. These areas are usually characterized by a high species diversity and hence they can serve as substitutes for natural forest areas and mid-field afforestations, thus creating nesting sites [5] and food habitats for many wild animals, including pollinating insects [7]. It should also be emphasized that, besides their ecological function, these areas are strongly associated with cultural function (historical, social, scientific, or educational aspects) [8]. Manor parks are examples of historical parks. The first examples of this style were created at suburban villas built in Europe since ancient times [9,10].

At present, a set of basic conservation principles is specified by the provisions of the act on the protection and guardianship of monuments [11] and the national nature conservation act [12]. However, there is no universal method for conservation procedures. The conservation guidelines are determined individually by the provincial monument conservator. This is related to the fact that each garden art monument requires an individual approach, and the specificity of such activities depends primarily on the importance of the subject, its owner/manager, and the current and planned future function(s). As shown by Majdecki [3], the criterion for selection of species for historic parks is mainly related to the origin of the favored species at that time. Currently, restoration activities in a historical park mainly consist of highlighting the preserved structures, supplementing the missing elements and protecting the existing historic elements [13]. It should be emphasized that proecological activities are not regarded as restoration activities but can constitute the added current value.

Lublin is an example of a city with several historical parks, e.g., Saski Garden, Ludowy Park, Bronowicki Park, and Węglin, Sławin, and Felin manor parks [14]. The last-mentioned is an independent grange farm originating from the last quarter of the nineteenth century and was developed into its current form in the mid-twentieth century [15,16]. The aim of this present study was to indicate the suitability of this historical manor park in proecological design of urban green areas with simultaneous maintenance of cultural values, historical and educational assets [according to the European Union's policy: Green Infrastructure (GI) – Enhancing Europe's Natural Capital, 2013]. An inventory and characterization of the park dendroflora was carried out and guidelines for management supporting the reward base for insect pollinators are proposed.

## Material and methods

## Study area

Lublin, the capital of Lubelskie Province, is located in the southeastern part of Poland  $(51^{\circ}22' \text{ N} \text{ and } 22^{\circ}63' \text{ E}; 213-214 \text{ m} \text{ a.s.l.})$ . It covers an area of 147 km<sup>2</sup> and presently has 370,270 inhabitants. The climate in the city is moderate with a mean annual temperature of 8.1°C; July is the warmest month (18.7°C), and January the coldest (-3.0°C). The growing season lasts on average 212-216 days. The annual precipitation is 553 mm with the highest monthly noted in July (77 mm) and the lowest values recorded in January (30 mm) [17,18].

The study was conducted in Felin Manor Park in Doświadczalna Street, Lublin, located in the Felin District covering an area of 2.7 ha (7.4 acres), of which 2.2 ha (6.0 acres) are occupied by the historical park.

## Data collection

Historical analysis was based on materials stored at the Provincial Monument Conservation Office in Lublin and the State Archives in Lublin. These included the plan of Felin property from 1927 prepared on the basis of a plan from 1920 [19], the plan of the historic garden in Felin from 1981, prepared from the records of gardens and historic parks of Lubelskie Province [20], and the contemporary detailed dendrological inventory from 2016 [21]. Comparison of historical data allowed identification of the historical arrangement of plantings and assessment of the state of conservation of the park trees and the shrubs.

The field study was carried out in 2016. The trees and shrubs were inventoried on a topographic map at a scale of 1:500 provided by the State Geodetic and Cartographic Resources in Lublin. Trunk diameters (measured at 1.3 m from the ground), crown diameter, and tree heights were measured and the health status of the trees was assessed. Measurements of the trunk diameter and the tree canopy range were performed using a calliper and a measuring tape, whereas the tree heights were estimated with using a level staff (length 3 m). The shrubs were described in terms of their height and ground cover expressed in m<sup>2</sup>.

Based upon the tree age table produced by Longin Majdecki [3,22], the ages of the trees and shrubs were estimated and the park tree stand was then classified into four age groups: Group I (>100 years old and more), Group II (70–100 years), Group III (30–70 years), and Group IV (<30 years). The tree and shrub species were characterized in terms of the duration of their phenological flowering phase and health status. The latter was assessed by the degree of dead wood present in the crown. Additionally, outer and inner losses were indicated and specimens to be felled were selected. Flower color distribution during the growing season was also determined.

#### Historical outline

The first records of the research area originate from the mid-fourteenth century which demonstrate that it was part of the Tatary royal estate (at present, a district of Lublin). Between the mid-fifteenth century and the partitions of Poland (1795), these properties were owned by Lublin voivods [23,24]. Subsequently, they became the so-called "national good", which Tsarina Catherine II handed over to Count Adam Ożarowski for his participation in the Targowica Confederation. In 1839, the administration of Tatary was taken over by Emanuel Graff, who established an approximately 160 ha grange farm under the name of Felin between 1850–1856. In this area, he built a onestorey, shingle-covered manor house for the administrator and farm buildings such as stables, cowsheds, piggeries, barns, and granaries [25,26]. During World War II, the Felin Grange was confiscated by the German occupation authorities. At that time, the orchard surrounding the manor was cut down and replaced by a newly established ornamental garden. Additionally, an access road to the Zamość main road was laid out and the roadsides were planted with trees. After the war, the Felin estate (with an area of 147 ha) became the property of the State Treasury and it was handed down to Maria Curie-Skłodowska University in Lublin. In 1955, the experimental Felin farm became part of the Higher School of Agriculture (at present, the University of Life Sciences in Lublin) [15,16] and was included within the administrative borders of Lublin in 1947 [15] or 1959 [16].

## Results

## Historical analysis of Felin Manor Park

The plan of Felin property from 1927 was prepared based on that from 1920 [19], and indicates that the central part of the property was occupied by an L-shaped manor with a driveway terminating with an oval lawn. The area closely surrounding the manor was occupied by an orchard and a vegetable garden. The analysis of archival materials also revealed that a lime-tree alley composed of *Tilia cordata* Mill. separating the planting from neighboring fields (not shown on the plan from 1927), was the main spatial element of the park [19]. The analysis of the plan of the historic garden in Felin from 1981 [20] showed new administrative, residential, and commercial buildings in the northern part of the park, the construction of which was associated with removal of a part of the historical tree stand, including a fragment of the lime-tree lane (Fig. 1). The plan also showed an ornamental garden and a small vegetable garden. The small



Fig. 1 The Felin Manor Park – inventory map from 1981 imposed on a contemporary situational map [20].

ornamental garden replaced the former orchard surrounding the manor [15,16]. The plan and archival photographic documentation also indicated the park tree stand and the access road between the manor and the Lublin–Zamość road with *Betula pendula* Roth. planted on the roadsides, with a species composition similar to that in the ornamental garden at the entrance gate [19,20].

The inventory carried out in 2016 demonstrated that new plantings and small architectural features had been introduced in the park (Fig. 2). The historical oval shape of the driveway had been changed into a round shape, and a new surface which did not resemble the original layout had been established (pavement slabs and hexagonal paving stones). There were no remnants of the original orchards or the vegetable garden, which



Fig. 2 Spatial layout of the Felin Park in 2016 [21].

had been replaced by an experimental apiary. Similarly, there was no birch alley that used to lead to the southern side of the park (at present, Doświadczalna Street).

The study demonstrated a casual character of the current arrangement of the trees. On this background, there were distinct *T. cordata* line plantings along the park fence (along the eastern, southern, and western borders with fragmentarily preserved plants along the northern border) and an alley of *Acer negundo* L., *A. platanoides* L., *Populus nigra* L., and *T. cordata* trees growing at irregular intervals along the driveway [21].

## Dendrological inventory of the park

During the park dendrological inventory carried out in 1981, about 260 historic trees were discovered. These were mainly species such as: *T. cordata, Robinia pseudoacacia* L., *A. negundo, A. platanoides, Picea abies* L., and *Juglans regia* L. Less numerous species were also recorded, including: *Acer saccharinum* L., *Aesculus hippocastanum* L., *F. excelsior, Q. robur*, and *Thuja occidentalis* L. (Fig. 3).

The present park tree stand comprised 32 tree taxa (412 trees). *Tilia cordata* represented the greatest percentage (27.7% – 88 trees), whereas a lower share was found for *A. platanoides* (11.5% – 41 trees), *R. pseudoacacia* (11% – 39 trees), *P. abies* (9.8% – 35 trees), and *F. excelsior* (7.9% – 28 trees) (Fig. 4). In total, 20 species of shrubs were recorded in the park (62 shrubs). The highest abundance was found for *Padus avium* Mill. (12.9% – eight shrubs) and *Caragana arborescens* Lam. (9.7% – six shrubs).

Analyzing the changes in the species structure and participation of individual species in the park stand, an increase in the share of native species (*A. platanoides*, *P. abies*, *F. excelsior*, *Carpinus betulus* L.) could be noticed with a simultaneous decrease in the number of species of alien origin (*A. negundo*, *J. regia*). The exception here was *R. pseudoacacia*, which share had slightly increased. The park dendroflora had also been enriched by the introduction of numerous new species (not recorded in the inventories from 1981).

The tree stand in the park was classified into four age groups. Group I included 23% of the park tree stand. *Tilia cordata* was the core element of the group (92%). The share of the other species, i.e., *Quercus rubra* L. and *F. excelsior*, accounted for 4%. These species were primarily planted in linear arrangements or as solitary trees near the manor in the late nineteenth century and constituted the compositional base of the park.



Fig. 3 Percentage share of trees in Felin Manor Park in 1981.



Fig. 4 Percentage share of tree species in Felin Manor Park (in 2016).

Group II represented 16% of the tree stand. The core species were introduced during the establishment of the ornamental garden. The largest share was represented by *R. pseudoacacia* – 20%. The share of the other species was as follows: *F. excelsior* and *Populus* ×*canadensis* Moench – 12% each, *A. negundo* and *A. saccharinum* L. – 7% each, *A. platanoides, Fraxinus pennsylvanica* Marshall, *P. abies, Q. robur* 'Fastigiata', and *T. cordata* – 5% each, and *A. hippocastanum, B. pendula, C. betulus, Larix decidua* Mill., and *Q. rubra* – 2% of the tree stand.

Group III was the largest, as it represented 32% of the park tree stand. It comprised self-sown plants or spontaneous plantings that appeared in the park after World War II. They are mostly represented by *A. platanoides* – 25%, *R. pseudoacacia* – 15%, *F. excelsior* and *T. cordata* – 10% each, *P. ×canadensis* – 6%, and *A. negundo* – 5%. The other species accounted for 3% to 1%: *Acer pseudoplatanus* L., *A. hippocastanum*, *B. pendula*, *C. betulus*, *J. regia*, *L. decidua*, *P. abies*, *Picea pungens* Engelm. 'Glauca', *Pseudotsuga menziesii* (Mirb.) Franco 'Glauca', *Q. rubra*, *Salix fragilis* L., *Salix sepulcralis* Simonk. 'Chrysocoma', and *T. occidentalis*.

Group IV represented 29% of the park tree stand and comprised self-sown plants and specimens introduced in recent years. They were dominated by *P. abies* – 38%, *A. platanoides* – 17%, *T. cordata* – 11%, as well as *P. pungens* and *P. ×canadensis* – 6% each. Species accounting for 4% to 2% included *Fagus sylvatica* L., *F. excelsior, L. decidua, P. nigra* 'Italica', *Prunus cerasifera* Ehrh., *R. pseudoacacia*, and *Sorbus aucuparia* L. Em. Hedl. (Fig. 5).





The park dendroflora was dominated by species flowering in the spring – 67.8% (332 plants). Plants blooming in summer accounted for 31.8% (156 plants) and those flowering in fall represented only 0.4% (two plants). No species flowering in winter were inventoried in the area inspected. In the spring and summer months, yellow-flowered species (195 specimens – 42%) and white-flowered plants (126 specimens – 27.2%) prevailed. The lowest abundance was found for plants with claret (one plant – 0.2%) and violet (two plants – 0.4%) flowers. In fall, there were only white-flowered species – two plants. The white-, pink- and violet-flowered plants were entomophilous species (96.8–100%), as well as the yellow-flowered taxa (86.1%). The plants with green, orange, and claret



**Tab. 1**Reward value of some plants inventoried in Felin Manor Park, Poland(based on literature data).

Species	Nectar reward	Pollen reward
Acer platanoides	+++	++
Acer pseudoplatanus	++	++
Aesculus hippocastanum	++	++
Betula pendula	+	+++
Carpinus betulus	+	+
Cotoneaster divaricatus	+	+
Fraxinus excelsior	+	+++
Prunus cerasifera	++	+
Malus alba	++	++
Prunus domestica	+	+
Robinia pseudoacacia	++	+
Rhus typhina	+++	++
Salix fragilis	++	+
Sorbus aucuparia	++	+++
Tilia cordata	+++	+

Legend: +++ - very high; ++ - high; + - low.

flowers were anemophilous species [27–31], e.g., representatives of the genera *Fraxinus*, *Picea*, *Populus*, and *Rhus* (Fig. 6).

The dendroflora of Felin Manor Park was dominated by nectariferous and polleniferous plants. The most valuable nectariferous species were represented by the genera Acer, Rhus, and Tilia, whereas Betula, Fraxinus, and Sorbus were the most important polleniferous taxa [27,32] (Tab. 1). Healthy trees and shrubs accounted for 67% (276 trees), whereas the others were regarded as unhealthy and required appropriate management. Treatments for improvement of the habit and fitness were applied to 61 specimens (15%). Sanitation cutting (removal of deadwood) was recommended for 51 specimens, corrective cutting (to restore tree statics) for two trees, trimming for one plant, removal of one of two main stems for five plants, and removal of root suckers and replanting - one plant. Corrective cutting was recommended in order to restore the tree statics in several cases. Plants that qualified for removal (18% - 75 specimens) included specimens that were mainly dead or damaged and not likely to survive as well as secondary plantings incompatible with

the composition arrangement of the park, or those that were a threat to human safety or to property.

## Discussion

Historical parks are historical features, which in a broader sense are closely associated with the protection of the natural environment. Proper conservation measures for this type of features can increase the value of urban areas [3]. The analysis of the transformation of the structure of the tree stand in Felin Manor Park demonstrate that *T. cordata* (forming the historical line planting) is the most durable species, similar to *Q. robur* and *F. excelsior*, which are the remnants of the historical compositional base of the park. Similarly, investigations conducted by Kseniak in many parks from the Lublin region [16] and in the most important residential gardens in Poland, e.g., Wilanów and Białystok parks [33], indicate that long-lived native species are the dominant elements. This suggests that native species rather than short-lived alien plants should be planted to preserve the park structure.

The age analysis of the tree stand indicates that *T. cordata* is the main component of the park tree stand. However, the percentage share of this species will gradually

decline, since it represents the oldest age group (>100 years). *Acer pseudoplatanus* and *P. abies* (the most abundant in the youngest age group and introduced into the park via artificial planting) are the major species suitable for natural tree stand renewal. Since no restoration measures are presently undertaken, e.g., planting historical species (*T. cordata*) and selective thinning of self-seedlings, significant changes in the species structure of the tree stand with the dominance of *A. platanoides* are predicted.

Similar to mid-field afforestations in the agricultural landscape, park vegetation is a highly valuable element in the urban landscape. The functions of park vegetation include improvement of biodiversity, temporal and spatial dynamics of the urban flora, and creation of a food base as well as nesting and breeding sites for pollinators and replacement habitats for a large group of Apoidea [34-38]. As reported by Lipiński [32], Antoń et al. [39], and Denisow et al. [40], melliferous species growing abundantly close to apiaries are most important for bees. Such vegetation should ensure continuous flowering from early spring to the fall. The present study indicates that the Felin Park grounds constitute a "supply area" for the adjacent apiaries. Therefore, the park creates favorable conditions for wild bees and other pollinating insects (nesting sites, available food resources), which may beneficially influence the species diversity and pollinator abundance. In order to support pollinators, the continuity and supplementation of resources in the food web of various pollinator groups are essential [27,32]. The study has demonstrated that reward species are an important component of the Felin Manor Park. As reported by Kołtowski [27] and Lipński [32], the most valuable park species that provide nectar reward include: A. platanoides, P. avium, P. cerasifera, and S. fragilis (reward in April); A. pseudoplatanus, A. hippocastanum, Cotoneaster divaricatus Rehder & E. H. Wilson, Lonicera tatarica L., Prunus domestica L., and S. aucuparia (reward in May); R. pseudoacacia and Rhus typhina L. (reward in June), and T. cordata (reward in July), which is important due to the simultaneous nectar and pollen reward [41]. Many researchers underline the importance of pollen resources which are crucial for the proper growth and development of pollinators [42–45]. The most valuable species offering pollen reward in Felin Manor Park are Picea gymnosperms as well as Acer, Betula, Fraxinus, Populus, Quercus, and Sorbus angiosperms [27,32]. Our investigations have revealed that the color of the flowers of the dendroflora is not only an aesthetic visual attractant but also offers nectar and pollen rewards [46].

In recent years, there has been an increase in the importance of ecology in conservation work carried out in historical parks and gardens, especially in terms of biodiversity and habitat protection [47,48]. Such activities have been undertaken in Łazienkowski and Wilanowski parks (central Poland), where houses for insects have been installed [49-52]. Melliferous plants were introduced by Milecka et al. [53] in the manor complex in Chociw (central Poland). The introduction of melliferous plants yields a strong visual effect, and appropriate species can be a reward base for insect pollinators [54-59], as recommended by the national pollinator strategy [60]. To supplement the pollinators food base of protected areas such the Felin Park, it is recommended that a "bee garden" with herbaceous reward plants (e.g., Brassica napus L. var. napus, Borago officinalis L., Dracocephalum moldavica L., Fagopyrum esculentum Moench, Onobrychis viciifolia Scop., or Phacelia tanacetifolia Benth.) should be created in the surroundings, as its implementation within the borders of the park may be contrary to legal regulations regarding the protection of monuments. The above-mentioned species were chosen not only because of their melliferous character, but also to increase the aesthetic values of the "bee garden", which also has educational functions in addition to being an attractive visual element of urban greenery.

## Conclusions

Investigations of the dendroflora in Felin Manor Park have shown that native species of trees are the most long-standing specimens of the park flora. *Tilia cordata* is the major and concurrently the oldest component of the tree stand. This species grows in linear arrangements along the park fence; it is also a component of the alley design along the driveway and it is one of the most valuable nectar reward species. These results have allowed definition of design guidelines, i.e., the preservation of the historical

park structures (formed by long-living native species) and complementation of the park dendroflora with species that are attractive for bees and other insect pollinators. Historic parks are objects which come from different periods of time, have differences in style and differ in the state of the historic substance preservation. Above all, they are subjects of different legal requirements. In the case of the Polish historic gardens, the specific legal conditions are determined individually for each garden in the form of conservation guidelines, developed by the Provincial Heritage Monuments Protection Office. Proecological activities involving the improvement of the pollinator feed-base are easy to introduce especially in landscape (irregular style) parks such as Felin. Due to its "naturalistic" character, it is possible to introduce a greater number of melliferous plants in every layer of the park, in comparison to regular gardens, where a possible set of species has usually limited the historically accrued species and is subject to stricter conservation requirements.

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# Historyczne założenia ogrodowe i możliwości ich wykorzystania w pro-ekologicznym kształtowaniu zieleni miast (na przykładzie parku dworskiego Felin w Lublinie, Polska)

#### Streszczenie

Parki historyczne w miastach są szczególnie wartościowe pod względem ekologicznym, gdyż stanowią miejsca życia wielu cennych okazów flory i fauny. Badaniami objęto Park dworski Felin, pochodzący z końca XIX i 1 poł. XX w., położony w Lublinie, Polska południowo-wschodnia. Celem badań było wskazanie przydatności tego typu obiektów w proekologicznym kształtowaniu terenów zieleni miasta, które byłoby zgodne z wymogami prawnymi dotyczących zabytkowych założeń ogrodowych. Przeprowadzone badania wykazały, że najtrwalszym gatunkiem w parku są gatunki rodzime (*Tilia cordata L., Quercus robur L. i Fraxinus excelsior L.*). Dendroflorę parku cechuje duża różnorodność gatunków, kwitnących od wczesnej wiosny do jesieni. Gatunki te są roślinami pożytkowymi i zapewniają ciągłość bazy pokarmowej dla owadów przez cały okres wegetacyjny.

Inwentaryzacja florystyczna umożliwiła opracowanie koncepcji rewaloryzacji parku, w której połączono funkcje kulturowe (historyczne, edukacyjne) i ekologiczne. *Tilia cordata* buduje nasadzenia szpalerowe wzdłuż ogrodzenia parku, jest gatunkiem składowym układu alejowego wzdłuż podjazdu. Wyniki własne pozwoliły na określenie wytycznych projektowych tj.: zachowanie historycznych struktur parku (utworzonych przez gatunki rodzime, długowieczne) oraz uzupełnienie parkowej dendroflory o gatunki atrakcyjne dla różnych grup owadów zapylających. W celu poszerzenia funkcji ekologicznej nasadzeń kompleksu parkowego proponuje się stworzenie na terenach przyległych "ogrodu pszczelego" z pożytkowymi roślinami zielnymi.