HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

MEASUREMENTS ON THE GREATEST TREES OF HUNGARY

Ph.D. thesis

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INTRODUCTION AND OBJECTIVES

Old trees with large girth are important habitats in various ecosystems, and function as cultural legacies as well.

Old and great trees contain several types of microhabitats, eg., hollows, wood mould, decaying wood in the crown, flaking bark which support specialised species including fungi, lichens, birds, small mammals etc. This is why the old and great trees are keystone structures in natural, agricultural and urban ecosystems. Their great size and age provide ecological niches of value to specialised flora and fauna that cannot be provided by younger, smaller trees and function as cultural–emotional legacies as well.

We believe that the greatest trees in Hungary represent extraordinary nature values and qualities in forests, cultural landscapes, as well as cultural heritage and landscape features. This is why we aimed to measure their general data (girth, perimeter, height etc.) and main, the rate of different species among the greatest Hungarian trees, their health status, and accessibility.

Old and large trees are such irreplaceable and therefore invaluable elements of the country's natural heritage, so the active protection is an essential task. Overuse and misuse do not help their survival. Their deliberate destruction and reduced resistance to pathogens increase their destruction.

Some trees deserve protection because of their high age and size. There are also adventive tree species in Hungary, the largest specimens of which deserve special attention because of their rarity. Nowadays others are rare in some places because of the economic transformation. In addition, there are those whose particularly beautiful growth, shape, or even unreal growth make them a rarity of nature. Some have memories of the history of the nation, others are associated with folklore and stories.

Nowadays, more and more tenders are involved in village renewal and rural heritage programmes, in which the preservation of trees plays an important role.

The importance of preserving their genome and collecting their propaggulums is indisputable. The importance of preserving their genome and collecting their propaggulums is indisputable. Not least, methusalams are an integral part of nature (not only of narrow cultural landscape), and because they are invaluable dendrological, botanical values, landscape elements, we have a duty to preserve them both now and in the future.

Working with the largest trees in our country is not an easy task. In Hungary, there is very few information about large trees compared to the number of books, magazines and websites. Works that are detailed do not cover many individual, but any collection work that is extensive does not provide details about the trees.

My original aim was to observe the greatest trees (and shrubs that grow info trees) of Hungary, collect their datas, presentation their visual materials. My aim is also to group the trees according to their habitat, health status and accessibility, as well as to show their infestation with *Agrobacterium*, Polypores and ivy. The aim of my work is also to organize the extent of the damage to the surveyed species and to determine which species and frequency the pests tested occur. I review the overall conservation status of the individuals, their role in society and the current and future opportunities for dead or no longer listed animals.

MATERIALS AND METHODS

We measured altogether 2000 great trees throughout the total area of Hungary, ie., in 19 counties, 531 settlements (Figure 1). Most trees were measured in Veszprém County (316 pieces) and Somogy County (296 pieces). The Great Hungarian Plain served with the smallest number of samples, because extensive woodlands are lacking here. „Greate” means great girth.

My measurement lasted from 2008 to February 2018. As trees and pests can be found regardless of season, there were no environmental barriers to sampling (rain, temperature, etc.). I randomly surveyed the trees with a single sampling. The large number of trees did not allow for a repeat of the tests.

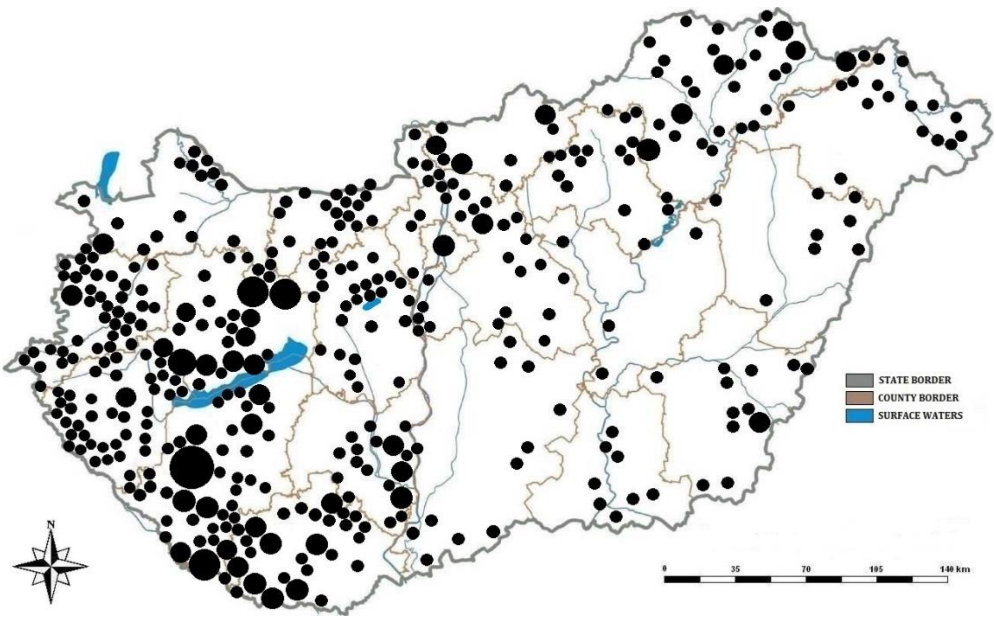

Figure 1: The situation of the observed settlements on the map of Hungary. A small dot indicates one settlement, a medium dot two or three settlements, while large dots refer to at least five settlements situated close to each other.

The range of studied species is based on the database of Pósfai: it ranges from forestry-important tree species to ornamental and fruit trees (of course whit large sizes and old age). The minimum girth of each tree specimen to be listed in the database depends on the species.

Pósfai was looking for their smallest girth (perimeter) measured between 0 and 130 cm height (because of branches near the ground or breast height). In his opinion, this is the basis for a comparison. In my view, this is the opposite, so my surveys covered measurements of the girth at breast height, the smallest trunk diameter, the crown diameter and the height.

It is important that not all of the 2 000 surveyed trees can be found in the internet database, because I have also found quite a few trees myself, which meet Pósfai's survey criteria, but have not yet been added to the database. Nevertheless, it was included in the research, because both the survey method and the minimum girth are the same.

As a new aspect, the health status and the accessibility were presented on a 5-points scale (health status: 1 – dead, 2 – bad condition, 3 – fair condition, 4 – good condition, 5 – excellent condition; ill. accessibility: 1 – very difficult, 2 – poor, 3 – medium, 4 – good, 5 – excellent).

I also examined the rate of disappearance of individual trees between the registration in the Pósfai database and the survey (update, new data).

We measured the health status of 7 trees with a Fakopp Arborsonic 3D Acoustic Tomograph in 2012, at different layers and heights.

Another new aspect: the rates of polypores, *Agrobacterium* and ivy damage are also described on a 5-point scale (1 – not infected, 2 – sparsely infected, 3 – slightly infected, 4 – moderately infected, 5 – acutely infected).

Another new aspect also that I group the trees in an unprecedented way: 1. field, orchard, arable, vineyard, cellar; 2. flood area, waterfront, fish pond; 3. inland area; 4. wood pasture; 5. public park, botanical garden, arboretum; 6. castle; 7. church, cemetery, holy place; 8. castle, castle park; 9. other wooded areas.

SUMMARY OF THE RESULTS

I measured altogether 2,000 trees in the area of 531 Hungarian settlements, belonging to 48 genera and 72 different species. I have made more than 45,000 km of roads. The most frequent among the greatest tree species is beech (*Fagus sylvatica*; 400 specimens) and the oak genus (*Quercus* spp.; 427 specimens). Typically, the total number of 38 genera in the „Other" group (389 pieces) is less than the number of the above two groups. The poplar genus also occurred in a fair number of floods and waterfronts (226 pieces, mostly black poplars). In the lime and maple genera, the common species of Hungary are equal distributed. I measured 29 native and 43 non-native species. 1550 specimens belong to native species, while 450 are adventive (Table 1).

Table 1: List of the observed species and their main data. N = native, A = adventive [those taxa whose native nature is still under dispute in Hungary (Abies alba, Castanea sativa, Juglans regia, Quercus frainetto) and those that are native only in a limited percentage of the country, but occur in a much greater area (Pinus sylvestris, Sorbus domestica, Taxus baccata and Tilia tomentosa) are also here (based on Bartha 2000)]; Min. girth = minimum girth, Agrob. = Agrobacterium infection, S = single tree, F = surrounded by other trees in a park or forest, Comb. = combined infection/damage.

Species	**N/A**	**Min. girth (cm)**	**Number of measured trees S/F**		**Polypore**		***Agrob.***		**Ivy**		**Comb.**	
					S	**F**	**S**	**F**	**S**	**F**	**S**	**F**
Abies alba	A	300	1	4		1				3		
Abies cephalonica	A	300		1						1		
Abies numidica	A	300		1						1		
Acer campestre	N	300	7	34				1	1	16	1	
Acer negundo	A	300	2	7				1	1	2		
Acer platanoides	N	300	2	18						7		1
Acer pseudoplatanus	N	300	2	15							2	3
Acer saccharinum	A	300	5	22		2		1	1	1		
Aesculus flava	A	400		1								
Aesculus hippocastanum	A	400	1	13						2		1
Ailanthus altissima	A	300	4	4						1		
Alnus glutinosa	N	300		17				2		4		1
Betula pendula	N	200		7				2				
Calocedrus decurrens	A	300		7						2		
Carpinus betulus	N	300	2	74		6		2		9		3
Castanea sativa	A	500	17	36				3	4	3		
Catalpa	A	200	1	3						2		

bignonioides												
Cedrus deodora	A	500		1								
Cedrus libani	A	400		1								
Celtis occidentalis	A	300	7	24		1				7		
Corylus colurna	A	300	4	4				1				
Crataegus monogyna	N	100	1	1								
Fagus sylvatica	N	400	3	397		66		8		26		4
Fraxinus angustifolia ssp. *pannonica*	N	400	1	12						4		1
Fraxinus excelsior	N	400	6	31		1	1			7		1
Ginkgo biloba	A	400	2	8				1	1	5		
Gleditsia triacanthos	A	300		2								
Gymnoclaudus dioicus	A	300		1						1		
Hedera helix	N	50	2	1								
Juglans nigra	A	300	1	6				1				
Juglans regia	A	300	1									
Larix decidua	A	300		5						1		
Liriodendron tulipifera	A	400	1	6						2		
Maclura pomifera	A	300		2				1		1		
Magnolia acuminata	A	200		3						3		
Morus alba	A	400	9	3					1			
Paulownia tomentosa	A	300	1	3					1	1		
Picea abies	A	300	2	20					1	1		
Pinus nigra	A	300	3	12						6		
Pinus sylvestris	A	300	1	5						2		
Pinus strobus	A	300		1								
Platanus x *acerifolia*	A	600	11	47			3	4		10	1	1
Populus alba	N	600	4	11				3		2		
Populus x *canescens*	N	600	3	9						5		
Populus nigra	N	600	25	174	1	1	8	91	4	5		13
Prunus avium	N	300	4	10				2	2	1		
Pseudotsuga menziesii	A	300	1	4		1						
Pterocaria stenoptera	A	600		1								
Pyrus pyraster	N	300	6	16						2		
Quercus cerris	N	500	6	23		1		4		1		1
Quercus frainetto	A	400		1						1		
Quercus petraea	N	500	2	9		1				4		
Quercus pubescens	N	400	3	1								

Quercus robur	N	500	95	284	1	12	3	22	12	67	2	13
Quercus rubra	A	400		3		1				1		
Robinia pseudoacacia	A	300	5	14								
Salix alba	N	600	8	70		2	1	6		2		
Salix caprea	N	200		1								
Sambucus nigra	N	100	1	1								
Sequoiadendron giganteum	A	500	2	12				1		3		1
Sophora japonica	A	400	7	14					2	10		
Sorbus domestica	A	200	4	1					1			
Sorbus torminalis	N	200		7						1		1
Taxodium distichum	A	300	1	23						9		
Taxus baccata	A	200	4	9						2		
Thuja plicata	A	300		3								
Tilia cordata	N	400	19	40		1		5	1	9		
Tilia platyphyllos	N	400	10	45		1		6		7	2	
Tilia tomentosa	A	400	8	6		1				4		
Ulmus glabra	N	400		2						1		
Ulmus laevis	N	400	1	25				2		6		
Ulmus minor	N	400	1	1						1		
TOTAL	-	-	**320**	**1680**	**2**	**99**	**16**	**170**	**33**	**275**	**8**	**45**

Polypore infection could be detected in 65 out of the observed 531 settlements, 123 per 2000 trees. Based on my results, mostly beech suffered from Polypores: 66 of 400 beech trees were infected. A total of 101 trees were infected by Polypores: 99 trees were surrounded by other trees and 2 trees were single.

217 trees were infected by *Agrobacterium* species, it means 21 places out of the observed 531 settlements. Not surprisingly, mostly poplars suffered from these bacteria: 99 of 199 black poplars (*Populus nigra*) suffered from these bacteria. A total of 186 trees were infected by *Agrobacterium*: 170 trees were surrounded by other trees and 16 trees were single.

Ivy was found on 353 trees, it means 157 places out of the observed 531 settlements. Mostly i found ivy on pedunculate oak (*Quercus robur*): 79 of 379. A total of 308 trees were damaged by ivy: 275 trees were surrounded by other trees and 33 trees were single.

More than half (52,35%) of the measured great trees are in good or excellent condition (598+449=1047 specimens). However, 6.05% of the measured great trees (ie., 121 specimens) have died since their first listing in the nation-wide database, or they no longer reach the size necessary to be listed. One of the reasons is that the measured tree dried up, but in some form it can still be found in the registered place (either in its entirety [26 pieces], or only part of it [40 pieces]). Another reason is the well-known felling of trees (29 pieces), which can certainly be traced back to other known forms of destruction (e.g. felled because it is dried up), but for the sake of simplicity it is treated as a separate category, since in an ecosystem there is a different role of a tree left behing on leg and a felled tree. Next reason is the fall of trees (20 pieces). Last reason that may be overcome is if the tree for some reason does not reach the listed size (e.g. barking, reduction in size due to fracture wounds [6 pieces]).

Only 1% of the measured trees (ie., 20 specimens) belonged to the 1 = very difficult accessibility category. 7.55% of the measured trees (ie., 151 specimens) are poorly accessible. The medium (3) category counts 633 trees, ie., 31.65%. Good accessibility is a feature of 475 great trees, ie., 23.75%. Finally, 36.05% of the great trees (721 specimens) stand in a well-kept park that is easy to access by car and the visitors can walk everywhere, and those that stand only a couple of meters far from the paved road.

The results of grouping by location are shown in Table 2.

Table 2: The groups by location, their number and description

Group	number (pieces)	Description
field, orchard, arable, vineyard, cellar	198	The most relevant group in terms of agrobiodiversity. They didn't stay up by chance, they stayed human. On the border of arable-forest-lawn, in the middle of arable land as a solitary, in an orchard or between cellars.
flood area, waterfront, fish pond	347	All trees found in habitats that are in some form related to water. For example, the forest of Gemenc or the floodlains next to the rivers. This group includes licensed trees with embankments (e.g. Szigetköz).
inland area	160	All trees located inland which are not located in a public park or public garden. Roadside tree lines and solitary inland trees are also included: for example, the sweet chestnut trees of Iharosberény.
wood pasture	162	All trees belonging to wood pasture. For example, the oaks of Csokonyavisonta or the oak wood pasture of Túristvándi.
public park, botanical garden, arboretum	131	All parks and gardens that can be visited free or with entrance. For example, the park Szeleste, Alcsútdoboz or Gödöllő.
castle	10	Small group, but still to be separated from the castle/castle park group. The defence strategy is also different (because there are other tenders for the repair of

		a castle and its surroundings, and differently for a castle). Furthermore, the castles can be visited without permission, while most of the castle parks are not, so the maintenance of the trees next to the castles is even more important.
church, cemetery, holy place	46	In Hungary, this group does not make a difference, but in many places abroad the trees are (also) typed accordingly. It is an important group, it also lends the trees a spiritual side in addition to the statistics, which, although scientifically (according to many) cannot be understood, is definitely present around the trees.
castle, castle park	322	All castles and castle parks that can be visited free and only with permission. It is important to note that not all castles now have parks, and not all former castle parks now have castles.
other wooded areas	624	The largest group, because of course most large trees still live in wooded areas (e.g. beeches, hornbeams, oaks).

When measuring decay status, I found that in 2-2 of the 7 trees cases there was slight and medidum and 3 cases of strong damage.

A new result is the updating of the registered data compared to the Pósfai database in 2008-2018 and the increase in the number of registered trees ("fixing new" trees in the database). Based on these, 13 trees were added to the database and 37 status updates (usually destruction) were made.

CONCLUSIONS AND RECOMMENDATIONS

During my travels I have travelled all the counties, I have been to many places I have never seen before. So I can draw some conclusions about our largest trees. The first is that they are not as easy to find as you might think: while some trees are located inland, in parks, in the care of them, surrounded by them, others are often hidden away, in the wild bushes of a ruined mansion, on the edge of remote fields, in the middle of a forest, among rows of cellars. Looking at the state of health, it can be said that the largest representatives of certain species are usually in poor condition (e.g. poplar). Any species with more pests has an even more negative status (e.g. beech). Therefore, the documentation of these trees is crucial: in the last one or two decade we have lost giants such as the chestnut of Szentgyörgyvár, the oak of Zsennye, the elm of Rák-tanya or the beech of Balatonhenye. An important factor is the immunity status of the species. Looking at our current list, we can find that legally protected and unprotected species alternately follow each other. It's sad that giants (e.g. lime of Ötvöskónyi) aren't protected. However, despite the fact that, for example, the chestnuts of Velem, the poplars and willows of Gemenc, although they are in a protected natural area, do not receive any special attention or treatment.

The number of trees in the online Pósfai database is constantly increasing (from 700 in 2008 to 3500 in 2020), and this reflects the popularity of large trees, emerging citizen science activities, although advances in digital technology contribute to this (smartphone, GPS, mobile internet for the immediate fixing and notification of trees). I must also mention the European Tree of the Year competition.

Based on my results, I can conclude that one third of the observed trees (648 out of 2000) suffer from Polypores, *Agrobacterium* or ivy. Polypores were detected on altogether 16 species. I found the *Agrobacterium* on altogether 23 species. Ivy was found on 56 different species.

The measured diseases and damage-causing organisms usually attack those trees that are surrounded by other trees, ensuring a good chance for pest reproduction. Almost no solitary trees were damaged amongst the ornamental non-native species, since their old specimens usually appear in parks and arboretums, surrounded by other trees. However, it is obvious, even in case of the oaks, maples and wild pear (i.e. those species that usually stand as solitary), that the presented damage mostly appears in denser stands.

We measured 29 native and 43 non-native tree species. A total of 1550 out of 2000 measured specimens are native. All the three damage types were mostly documented on native trees, but the thorough rate of damaged trees is about the same in case of native and adventive species. A total of 33.5% of the native specimens (519 out of 1550) and 28.7% of the adventives (129 trees out of 450) are damaged by any (or more than one) of the mentioned infections or ivy.

More than half of the trees are easily accessible, while only about 9% is very difficult to reach. 1745 out of the measured 2000 trees can be freely visited (ie., without any special permission or entrance fee). Access is really hard only in case of 171 great trees. This might be considered as beneficial for the tree as well, in order to protect it from disturbances emerging from mass visiting (eg., climbing onto the big branches).

It can be concluded that most of the old trees are not protected territorially in Hungary. The lack of protection can be explained primarily by economic reasons, since their management and pest control is not economically viable for owners, foresters or park gardeners. Other reasons may be lack of knowledge or responsibility. Only a very small part of the largest Hungarian trees is covered by hungarian nature conservation, and we can even say that some of the protected trees are also close to destruction. The main causes of this negative phenomenon are a lack of care or treatment, the presented pests and diseases, or environmental factors such as storm, wind or frost damage.

While the age of trees is not usually a prerequisite for being emotionally important to the local community, many of the documented trees are indeed among the oldest in the country. I have therefore come to the conclusion that trees rooted in the past also have a cultural-emotional aspect (e.g. cemeteries, temples, legends) that must be preserved and cultivated.

However, all these efforts (legal protection, documentation, awareness-raising) are worthless without the help of local authorities, NGOs and residents, since the protection of large and old trees is not yet at the level of national awareness of their importance. It must therefore be the first step towards bringing the locals together to live with these plants.

NEW SCIENTIFIC RESULTS

1. I have measured and documented the main parameters and health status, accessibility and conservation conditions of the greatest trees from 29 native and 43 adventive species (2000 species in 531 municipalities).
2. Three-quarters of the measured greatest Hungarian trees are in at least acceptable health, but they are dying rapidly: 121 of the 2,000 surveyed trees have since died in the average six years since registration in Pósfai database and my research.
3. I found Polypore infection on the 12,2% (65 cases), *Agrobacterium* infection on the 22,8% (121 cases) and damage by ivy on the 29,6% (157 cases) of the measured 531 municipalities.
4. The geatest trees of Hungary in the park or forest are primarily damaged by pests or pathogens, while the most of solitary trees are healthy. The most infected regions are the western and southwestern counties, while the North Hungarian Mountains and the Great Hungarian Plain are much less affected.
5. I group the 2000 measured trees into 9 geoups: 1. field, orchard, arable, vineyard, cellar; 2. flood area, waterfront, fish pond; 3. inland area; 4. wood pasture; 5. public park, botanical garden, arboretum; 6. castle; 7. church, cemetery, holy place; 8. castle, castle park; 9. other wooded areas. These groups are essential to raise awareness and start defending.

LIST OF PUBLICATIONS IN THE TOPIC OF THE DISSERTATION

Full article in international journal with impact factor

M. Takács, Á. Szénási, Á. Malatinszky (2020): Polypores, *Agrobacterium* and ivy damage on Hungarian ancient trees. Nature Conservation 40: 1-38. doi: 10.3897/natureconservation.40.51633

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Takács M., Malatinszky Á. (2009): Az európai hárs-kultusz áttekintése és a dunántúl legnagyobb hársfái. Tájökológiai Lapok 7(2): 457-464.

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Abstracts in Hungarian language in conference book-of-abstracts

Takács M. (2011): Magyarország legnagyobb szelídgesztenyéinek dendrometriai, történeti és néprajzi áttekintése. In: SZIE Környezetvédelmi (Zöld) Szakkollégium – I. SzaKKKör Konferencia előadásainak összefoglalói. 2011.11.14. Gödöllő, p. 40. (ISBN: 978-963-269-281-4)

Takács M., Malatinszky Á., Mravcsik Z. (2012): A hársak és a szelídgesztenyék európai, valamint hazai tájtörténeti, néprajzi szerepének áttekintése. In: SZIE Környezetvédelmi (Zöld) Szakkollégium – II. SzaKKKör Konferencia előadásainak összefoglalói. 2012.05.07. Gödöllő, p. 40. (ISBN: 978-963-269-288-3)

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Takács M. (2013): A szelídgesztenyét veszélyeztető tényezők és a hazai termesztés rövid áttekintése, a legnagyobb élő egyedek bemutatása. In: XIX. Növénynemesítési Tudományos Nap, Összefoglalók. 2013. március 7. Pannon Egyetem, Georgikon Kar, Keszthely. p. 142. (ISBN: 978-963-9639-50-8)

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Szántó L, **Takács M**. (2020): Ötvöskónyi nevezetes fái (könyvfejezet). In: Ötvöskónyi – Nyolc évszázad krónikája. Ötvöskónyi Község Önkormányzata. pp. 351-356.