10.2478/botlit-2013-0011

VERSITA

BOTANICA LITHUANICA
ISSN 2029-932X

2013, 19(2): 83–90

USE OF LEAF MORPHOMETRIC PARAMETERS FOR IDENTIFICATION OF THE MOST COMMON CULTIVATED INTRASPECIFIC TAXA OF *TILIA PLATYPHYLLOS*

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Abstract

Evarte-Bundere G., Evarts-Bunders P., 2013: Use of leaf morphometric parameters for identification of the most common cultivated intraspecific taxa of *Tilia platyphyllos* [Morfometrinių požymių panaudojimas dažniausiems kultūriniams *Tilia platyphyllos* vidurūšiniams taksonams apibūdinti]. – Bot. Lith., 19(2): 83–90.

To determine variation of the most important morphological parameters of *Tilia platyphyllos* Scop., we studied four most frequently found in Latvia taxa: *T. platyphyllos* subsp. *platyphyllos*, *T. platyphyllos* subsp. *cordifolia* (Besser) C.K.Schneid., *T. platyphyllos* 'Rubra', *T. platyphyllos* 'Obliqua.' Morphometric measurements (length of petioles, width and length of leaf blades, pubescence and margin of leaves) were performed for 10 different specimens of every selected taxon measuring five typical leaves from each specimen. The cultivated intraspecific taxa of *Tilia platyphyllos* differed by the following morphometric parameters – the pubescence of leaves, the margin of leaves and the length of leaf blades. No significant differences were ascertained between taxa in such morphometric parameters as the width of leaf blades and the length of petioles.

Keywords: *Tilia platyphyllos*, intraspecific taxa, leaf morphometry, Latvia.

INTRODUCTION

Tilia platyphyllos Scop. or large-leaved lime is a large deciduous tree native to Central and Southern Europe. In its native range trees may reach the height of 40 m and the trunk diameter of 1.2–1.5 m (Pigott, 2012). It has been widely used as an ornamental tree in parks and other public green areas in Latvia at least for two centuries since 1805 (Mauriņš, 1970). *Tilia platyphyllos* is an extremely variable species and the variability of *T. platyphyllos* occurs both among individual trees within apparently natural populations as well as among large geographical regions that serves as the basis of its division into subspecies (Pigott, 2012). Such morphological variability resulted in the description of various species, subspecies and varieties during the 19th century and the 1st decade of the 20th century, many of which were often systematically unclear and doubtful as well as hard to identify (Simonkai, 1888; Engler, 1909; Schneider, 1912). This uncertainty has determined the reduction of intraspecific taxa and other species similar to *T. platyphyllos* in later works (Browicz, 1968; Pigott, 1997).

The extreme variability of different morphological features is observed also in cultivated material occurring outside the natural distribution area of the species. The Baltic States and Latvia in particular serve as a good example of such diversity of morphological parameters of *T. platyphyllos*. Altogether, 13 different taxa (10 cultivars, 3 subspecies) of *T. platyphyllos* have been grown in different plantations of Latvia from the last decades of the 20th century to the present day. Its most common subspecies are *T. p.* subsp. *platyphyllos*, *T. p.* subsp. *cordifolia* (Bess.) C.K.Schneid., *T. p.* subsp. *grandifolia* (Ehrh. ex Hoffm.) Vollm. (now as a synonym of *T. p.* subsp. *cordifolia*), *T. p.* subsp. *pseudorubra* C.K.Schneid. as well as the following cultivars – 'Aurea', 'Laciniata', 'Laciniata Saldus', 'Laciniata Bauska', 'Rubra', 'Ob-

liqua' (Cinovskis, 1979; Mauriņš & Zvirgzds, 2006; Jurševska & Evarts-Bunders, 2010).

The leaf morphology is central to plant taxonomy and systematics (Bell & Bryan, 2008) and it has mostly been studied using traditional morphometrics (Marcus, 1990; Jensen, 2003; Viscosi & Cardini, 2011). In fact, for some groups of plants, e.g., *Quercus* and *Betula*, leaf characters are considered as "the most important" (Stace, 1989). Lower taxonomic levels – varieties and morphs – can be separated by means of the morphologic and morphometric analysis of leaves (Perović, 2007). In this respect, different intraspecific taxa of *T. platyphyllos* are a good example for the evaluation of leaf morphology and mostly just morphological differences of leaves are commonly used as taxonomically valuable parameters for the identification of those taxa (Krüssmann, 1976; Santamour et al., 1985; Hiller 1991). Several studies present the data on morphology and identification keys of different taxa of the genus *Tilia* L. in Latvia (Cinovskis, 1979; Mauriņš & Zvirgzds, 2006), but the morphometric features of these taxa in Latvia have not yet been studied in detail. The aim of the current study was to determine variations of the most important morphological parameters of *T. platyphyllos* (the width and length of leaf blades, the length of petioles, the pubescence of leaves and types of leaf margins). An additional important task was to compare the acquired morphometric values with the more widely used key books and to clarify whether it is possible or not to use the data of other regions for the identification of the local material.

MATERIALS AND METHODS

Data collection

The inventory of the richest dendrological collections was carried out in the whole territory of Latvia from 2007 to 2012, during which all the planted taxa of the genus *Tilia* were analysed. Altogether, 134 dendrological objects in the whole territory of Latvia (approximately five in each of the former districts) were inspected (Fig. 1). Many of the studied objects are the richest ones concerning the taxa of the genus *Tilia* (National Botanical Garden, Botanical Garden of the University of Latvia, Kalsnava Arboretum, plantations of arboreal plants at Jaunbrēdiķi, Skrīveri Arboretum, Lēdurga Arboretum, Lāčupīte Arboretum and other parks most valuable from dendrological point of view).

The herbarium specimens of the genus *Tilia* collected during the study are deposited at the Herbarium of the Institute of Systematic Biology of Daugavpils University (DAU). The analysed herbarium material was collected mostly in July and August. Some specimens were collected also late in May, when leaves are already fully developed and some others – in early October, before the colouring has taken place. The information about the collected material is summarized in the Appendix 1 and includes the name of the taxa, geographical coordinates (LKS-92 system), locality and habitat, name of the collector and identifier as well as the recording date. Map was produced by using GIS software ESRI ArcGis 10.0.

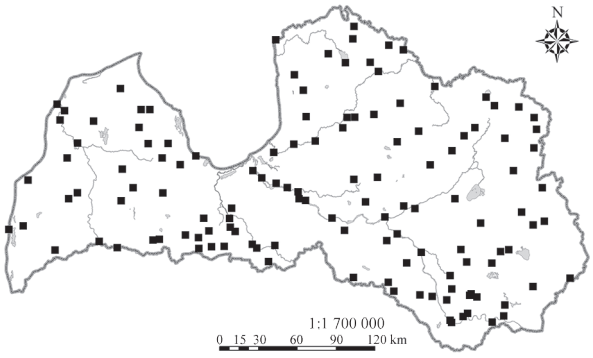

Fig. 1. Map of the inspected dendrological objects in Latvia

Morphometric measurements

Since generative parameters are not presented in all herbaria and usually not observed in many cultivars and other intraspecific taxa at all, in the present study we used only vegetative features. Morphometric measurements were made within this study for four intraspecific taxa of *T. platyphyllos*, which are most frequently planted in Latvia – *T. p.* subsp. *platyphyllos*, *T. p.* subsp. *cordifolia*, *T. p.* 'Rubra' and *T. p.* 'Obliqua'. Within the limits our own material was used for morphometric studies. Morphometric measurements were done for 10 different specimens of every selected taxon of *T. platyphyllos*. Several branches with mature leaves growing in sun-exposed parts of the lower part of the tree crown were collected from each tree and all leaves were detached from twigs and pressed by using the standard methods. Five leaves of the 2nd or 3rd year shoots of each

selected specimen were measured. In order to obtain comparable data, 50 measurements were made for each parameter. The following morphometric parameters were measured in the present investigation – the length and width of leaves as well as the length of petioles. In addition to that, the type of leaf margin was analysed using the scale from 1 to 29 as proposed in the methodology by Gavrilova (1988). The pubescence of leaves was also analysed according to our proposed scale (degrees from 1 to 7):

1 – upper (adaxial) and lower (abaxial) surfaces of leaf blade are naked;

2 – upper and lower surfaces of leaf blade are naked, dense hair bunches are present in axils of the main veins on lower surface;

3 – upper surface of leaf blade is naked, hairs on lower surface are only along the main veins and dense hair bunches are present in axils of the main veins;

4 – upper surface of leaf blade is naked; lower surface is more or less densely pubescent;

5 – upper surface has hairs only along the main veins, hairs on lower surface are only along main veins and dense hair bunches are present in axils of the main veins;

6 – upper surface has hairs only along the main veins; lower surface is more or less densely pubescent;

7 – both surfaces of leaf blade are densely pubescent.

Statistical analysis

Statistical analyses were performed by SPSS software (version 20.0) using descriptive statistic tools (calculated mean, standard error, standard deviation and range) with parametric and non-parametric tests. The length and width of leaves as well as the length of petioles were initially tested for the normality of distribution by using the Kolmogorov-Smirnov test and for homogeneity by using the Levene test. Depending on the results of these tests, the following other tests were selected: the one-way ANOVA test with Sidak post hoc multiple comparison and the Kruskal-Wallis test with the Mann-Whitney post hoc multiple comparison for which a new critical level of significance 0.0085 was designed (by the formula P = 1–0.951/n, where n – number of pairwise comparisons). To compare means in cases with normally distributed data as well as nonhomogeneous data, we used the Brown-Forsythe test. The significance level was selected 5% for all the tests except the Mann-Whitney post hoc multiple comparison.

RESULTS AND DISCUSSION

Descriptive statistics of leaf blade length and width as well as the petiole length of *Tilia platyphyllos* subsp. *platyphyllos*, *T. platyphyllos* subsp. *cordifolia*, *T. platyphyllos* 'Rubra' and *T. platyphyllos* 'Obliqua' were presented in Table 1. Leaf blade length and width as well as petiole length of all the studied lime-tree species were normally distributed ($p < 0.05$). The data on leaf blade width and petiole length were homogenous ($p > 0.05$), but those on leaf blade length – heterogenous ($W_{3, 196} = 5.65$; $p = 0.001$).

The comparison of taxonomic groups showed a significant difference in leaf blade length ($F_{3, 177.25} = 2.872$; $p = 0.038$) (Brown-Forsythe test), the pubescence of leaves (Chi square = 102.84; df = 3; $p < 0.000$) (Kruskal-Wallis test) and the margin of leaves (Chi square = 15.47; df = 3; $p = 0.001$) (Kruskal-Wallis test). There were no significant differences in the leaf blade widths of the analysed taxa of *T. platyphyllos* as well as the lengths of petioles of the studied taxa. Difference in leaf blade length was significant only between *T. platyphyllos* subsp. *cordifolia* and *T. platyphyllos* 'Obliqua', where the mean difference was 0.95 ± 0.36 μm at $p = 0.05$ (Sidak post hoc multiple comparison). It means that the investigation quality can be improved by increasing the number of the investigated specimens that would provide higher or lower p-values or process data with other statistical tests to accept or reject null hypothesis.

Leaf margins of all four studied taxa were defined as spiny-toothed, serrate and biserrate. Leaf margins of *T. platyphyllos* subsp. *cordifolia* and *T. platyphyllos* 'Obliqua' were only serrate, those of *T. platyphyllos* subsp. *platyphyllos* – serrate and biserrate, but most often serrate and those of *T. platyphyllos* 'Rubra' – spiny-toothed, serrate and biserrate, but most often serrate. Significant difference in leaf margins was observed between two pairs of taxa – *T. platyphyllos* subsp. *platyphyllos* and *T. platyphyllos* sub-

sp. *cordifolia* (U = 1000.00; Z = -3.32; p = 0.001) as well as *T. platyphyllos* subsp. *platyphyllos* and *T. platyphyllos* 'Obliqua' (U = 1000.00; Z = - 3.32; p = 0.001).

The pubescence of leaves of *T. platyphyllos* subsp. *cordifolia* was evaluated as 5, that of *T. platyphyllos* 'Obliqua' – as 3 and 5 (most often as 5). The pubescence of leaves of *T. platyphyllos* 'Rubra' was evaluated as 3, 5 and 6 (most often as 5). The pubescence of leaves of *T. platyphyllos* subsp. *platyphyllos* was evaluated as 2 and 3 (most often as 3). Statistically, the pubescence of leaves significantly differed between all the studied taxa of lime-trees ($p < 0.01$), except between *T. platyphyllos* 'Rubra' and *T. platyphyllos* 'Obliqua'.

There is an opportunity to find other morphological parameters of leaves (angles between the main and side veins, proportions between the length and width of leaf blade as well as between leaf blade and leaf petiole) that could be used for the identification of taxa (Jensen et al., 2002).

There are no very significant differences between morphometric parameters of leaves in four analysed taxa; however, the trends are evident. The most easily separable taxon of the studied group is *T. platyphyllos* subsp. *platyphyllos* that is rarely grown in Latvia and is known only from 17 localities. It is characterized by a different type of leaf pubescence as compared to the other taxa. The upper surface of leaf blade is naked; while the lower surface has hairs only along the main veins and there are dense bunches of hairs in axils of the main veins. Although difference in the types of leaf margin serration of the analysed intraspecific taxa of *T. platyphyllos* is statistically significant, taxonomically it is not significant because of being variable in case of various intraspecific taxa. For example, the leaf margin of *T. platyphyllos* subsp. *platyphyllos* is serrate or biserrate. It has been proved that *Tilia platyphyllos* subsp. *cordifolia* is the most common subspecies in Latvia can also be separated from all other taxa by the pubescence of leaves. The upper surface of its leaves has hairs only along the main veins; while the lower surface has hairs only along the main veins and there are dense bunches of hairs in axils of the main veins. Judging by the mean length of leaves, *T. platyphyllos* subsp. *cordifolia* (7.82 cm) can be separated from *T. platyphyllos* 'Obliqua' (8.77 cm).

No significant differences were found in leaf parameters of both concerned intraspecific taxa, however, there is an evident trend that leaves of cultivars have slightly bigger mean morphometric parameters (both length and width) than the concerned intraspecific taxa (cf. Table 1). Since *T. platyphyllos* 'Rubra' and *T. platyphyllos* 'Obliqua' are old cultivars (described in 1770 and 1894, respectively) that are commonly grown in plantations of Latvia, each of them has its own characteristic distinguishing fea-

Table 1. The descriptive statistics of leaf morphological traits of *Tilia platyphyllos*

Traits	Mean	Minimum	Maximum	Standard deviation	Standard error
T. platyphyllos* subsp. *platyphyllos					
Length of leaves	7.92	5.4	11.8	1.35	0.19
Width of leaves	6.9	4.2	10.5	1.29	0.18
Length of petioles	3.47	1.6	5.4	0.83	0.12
T. platyphyllos* subsp. *cordifolia					
Length of leaves	7.82	3.8	13.4	1.66	0.24
Width of leaves	7.09	3.9	12.5	1.51	0.21
Length of petioles	3.54	1.5	7.0	1.05	0.15
***T. platyphyllos* 'Rubra'**					
Length of leaves	8.31	4.5	12.0	1.92	0.27
Width of leaves	7.45	4.2	11.5	1.53	0.22
Length of petioles	3.66	2.2	5.6	0.84	0.12
***T. platyphyllos* 'Obliqua'**					
Length of leaves	8.77	4.5	13.8	2.16	0.31
Width of leaves	7.46	4.2	11.5	1.62	0.23
Length of petioles	3.69	2.2	5.6	0.82	0.12

Number of measurements 50

Table 2. The comparison of morphometric parameters of *Tilia platyphyllos* leaf with the reference 1 (Pigott, 2012) and 2 (Mauriņš & Zvirgzds, 2006) data

Feature	Measurements	1	2
Tilia platyphyllos* subsp. *platyphyllos			
Length of petioles	1.6–5.4	2.3–4.8	3.0
Length of leaf blades	5.4–11.8	5.5–10.9	6.0–10.0
Width of leaf blades	4.2–10.5	5.4–9.9	-
Margin of leaf	Serrate and biserrate, most often serrate	-	Sharply serrate
Pubescence of leaf	3	3	2
Tilia platyphyllos* subsp. *cordifolia			
Length of petioles	1.5–7.0	2.7–5.1	3.0
Length of leaf blades	3.8–13.4	6.1–11.1	6.0–8.0
Width of leaf blades	3.9–12.5	5.8–10.3	-
Margin of leaf	Serrate	-	Sharply serrate
Pubescence of leaf	5	7	7
***Tilia platyphyllos* 'Rubra'**			
Length of petioles	2.2–5.6	-	3.0
Length of leaf blades	4.5–12.0	-	7.0–10.0
Width of leaf blades	4.2–11.5	-	-
Margin of leaf	Spiny-toothed, serrate and biserrate, most often serrate	-	Sharply serrate
Pubescence of leaf	5	-	3
***Tilia platyphyllos* 'Obliqua'**			
Length of petioles	2.2–5.6	-	3.0
Length of leaf blades	4.5–13.8	-	6.0–10.0
Width of leaf blades	4.2–11.5	-	-
Margin of leaf	Serrate	-	Sharply serrate
Pubescence of leaf	5	-	4

ture. For *T. platyphyllos* 'Rubra' it is the pronouncedly orange till carmine colour of shoots, especially in winter, while for *T. platyphyllos* 'Obliqua' it is the markedly asymmetrical leaf base (Santamour et al., 1985).

One of the aims of the study was to compare morphometric parameters of leaves from the Baltic States and especially Latvia, where the studied taxa do not occur in wild, with the data from the published sources of foreign literature. In this way, by comparing the obtained data it is possible to find out if parameters given in key books of other regions can be used in our climatic conditions or not.

There is a pronounced lack of studies on the morphometry of intraspecific taxa of *Tilia platyphyllos* to carry out an easy interpretation of the obtained data. Many dendrological papers by frequently cited authors provide only leaf parameters of the main species, mostly just the length of leaves (6–9(12) cm), while parameters of intraspecific taxa are not at all mentioned (Browicz, 1968; Cinovskis, 1979; Mauriņš & Zvirgzds, 1978; Krüssmann, 1976; Rehder, 1967). For example, there is an inaccurate note in the edition of 'Flora of the Latvian SSR' („Latvijas PSR flora") that the length of leaves of *Tilia platyphyllos* is 5–8 cm, while the width is 6–9 cm, which wrongly indicates that they are wider than longer (Galenieks, 1957). Similar data on the size of leaves and the length of petioles of the genus *Tilia* L. have also been provided by Mauriņš & Zvirgzds (2006), but they are not founded on appropriate morphometric measurements. Perhaps the only one available paper that provides all basic morphometric measurements of intraspecific taxa of *T. platyphyllos* is the book 'Lime-trees and Basswoods: a biological monograph of the genus *Tilia*' (Pigott, 2012). Because of that it was possible to compare our measurements with those published in this book (Table 2). Nevertheless,

the comparison of the data is still burdened with the fact that the number of measurements for different species in this book significantly differs. For example, there are 162 measurements for *T. platyphyllos* subsp. *cordifolia*, but just 39 ones for *T. platyphyllos* subsp. *platyphyllos* (Pigott, 2012). By comparing these data it can be concluded that there are wider measurement limits in our measurements, but, in general, the data provided by Pigott (2012) are useful also for the Baltic conditions.

CONCLUSIONS

Morphometric parameters of leaves of the most often grown intraspecific taxa in plantations of *Tilia platyphyllos* are not very different; however, some of these can be used for the identification of taxa. A more important feature for the identification of intraspecific taxa of *Tilia platyphyllos* is the pubescence of leaves. Another important feature from the analysed ones appropriate for the purposes of identification is the mean length of leaf blades. *T. platyphyllos* 'Obliqua' leaves are larger than *T. platyphyllos* subsp. *cordifolia*.

Despite of fact that papers and key books of foreign authors are not always useful for the identification of taxa due to phenotypical alterations caused by extreme stress of local ecological conditions outside the natural distribution area of species, our study proves that in case of *Tilia platyphyllos* growing in Latvia, the mentioned publications can be used, because morphometric parameters of the taxa obtained in their natural distribution areas are, in general, similar to those obtained during our study from the material grown in Latvia.

ACKNOWLEDGEMENTS

This work was supported by the European Social Fund within the project "Support for the implementation of doctoral studies at Daugavpils University" Agreement No. 2009/0140/1DP/1/1/2/1/2/09/IPIA/VIAA/015. We would like to thank Maksims Zolovs for the assistance in mathematical processing of the data as well as Uvis Suško and Jolanta Bāra for the reviewing the language of the paper.

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MORFOMETRINIŲ POŽYMIŲ PANAUDOJIMAS DAŽNIAUSIEMS KULTŪRINIAMS *TILIA PLATYPHYLLOS* VIDURŪŠINIAMS TAKSONAMS APIBŪDINTI

Gunta Evarte-Bundere, Pēteris Evarts-Bunders

Santrauka

Siekiant nustatyti *Tilia platyphyllos* Scop. svarbiausių morfologinių požymių kintamumą buvo atlikti Latvijoje dažniausiai aptinkamų 4 vidurūšinių taksonų – *T. platyphyllos* subsp. *platyphyllos, T. platyphyllos* subsp. *cordifolia* (Besser) C.K. Schneid., *T. platyphyllos* ‘Rubra’, *T. platyphyllos* ‘Obliqua’ – morfometriniai tyrimai. Buvo vertinti šie parametrai: lapalakščio plotis ir ilgis, lapkočio ilgis, lapų plaukuotumas bei lapalakščio krašto forma. Matavimams buvo parinkta po 5 lapus iš 10 kiekvieno taksono pavyzdžių. Labiausiai taksonai skyrėsi lapų plaukuotumu, lapalakščio krašto forma ir jo ilgiu. Pagal lapkočio ilgį bei lapalakščio plotį reikšmingų skirtumų tarp tirtų taksonų nebuvo nustatyta.

Appendix 1. The studied specimens of *Tilia platyphyllos* deposited at the Herbarium of Daugavpils

Coordinates (LKS-92)		Locality and habitat	Collector and identifier	Date
X	Y			
Tilia platyphyllos* subsp. *platyphyllos				
417343	6359009	Talsi District, Valdemārpils Town, “Priednieki” Dendrological Greenery	G. Evarte -Bundere	05 08 2011
354724	6350945	Ventspils District, Vārve Parish, Lēči Park	G. Evarte -Bundere	04 08 2011
447564	6316498	Tukums District, Tume Parish, Vāgners Arboretum	G. Jurševska	21 07 2008
663013	6195080	Daugavpils City, Ruģeļi housing estate	Det. G. Suhovilo Leg. G. Jurševska	20 09 2004
384968	6257131	Saldus District, Nīgrande Parish, Kalni Village, “Rožkalni” Dendrological Greenery	G. Evarte-Bundere	06 07 2011
663183	6195056	Daugavpils City, Ruģeļi housing estate	Det. G. Suhovilo Leg. G. Jurševska	29 05 2005
521658	6302108	Salaspils District, Salaspils, National Botanical Garden	Det. G. Evarte-Bundere Leg. P. Evarts-Bunders	02 08 2010
544733	6353566	Krimulda District, Lēdurga Parish, Lēdurga Arboretum	Det. G. Evarte-Bundere Leg. P. Evarts-Bunders	03 08 2010
617459	6363922	Smiltene District, Silva Village, Silva Arboretum	Det. G. Evarte-Bundere Leg. P. Evarts-Bunders	04 08 2010
521658	6302108	Salaspils District, Salaspils, National Botanical Garden	Det. G. Evarte-Bundere Leg. P. Evarts-Bunders	02 08 2010

Appendix 1 continued

Coordinates (LKS-92)		Locality and habitat	Collector and identifier	Date
X	Y			
Tilia platyphyllos* subsp. *cordifolia				
632686	6215767	Ilūkste District, Bebrene Parish, Bebrene Park	G. Jurševska	04 10 2008
447564	6316498	Tukums District, Tume Parish, Vāgners Arboretum	Det. G. Jurševska Leg. P. Evarts-Bunders	21 07 2008
503263	6254873	Bauska District, Mežotne Parish, Mežotne Park	G. Jurševska	20 07 2008
469738	6265273	Jelgava District, Zaļenieki Parish, Zaļenieki Estate Park	G. Jurševska	03 08 2006
617459	6363922	Smiltene District, Silva Village, Silva Arboretum	Det. G. Jurševska Leg. P. Evarts-Bunders	04 08 2010
580938	6413785	Rūjiena District, Jeri Parish, Endzele Village	G. Evarte-Bundere	03 08 2010
683786	6368730	Alūksne District, Alūksne, Alūksne park	Det. G. Evarte-Bundere Leg. P. Evarts-Bunders	04 08 2010
521658	6302108	Salaspils District, Salaspils, National Botanical Garden	Det. G. Evarte-Bundere Leg. P. Evarts-Bunders	02 08 2010
54473	6353566	Krimulda District, Lēdurga Parish, Lēdurga Arboretum	Det. G. Evarte-Bundere Leg. P. Evarts-Bunders	03 08 2010
539364	6290175	Ķegums District, Ķegums Parish, Tome Recreation Centre	Det. G. Evarte-Bundere Leg. P. Evarts-Bunders	01 08 2010
***Tilia platyphyllos* 'Rubra'**				
580938	6413785	Rūjiena District, Jeri Parish, Endzele Village	G. Evarte-Bundere	03 08 2010
352340	6363262	Ventspils City, the Children's Town	G. Evarte-Bundere	05 08 2011
728839	6272723	Ludza Town, central park	G. Evarte-Bundere	30 08 2011
666797	6338784	Gulbene, estate park	G. Evarte-Bundere	09 07 2011
582418	6353150	Priekuļi District, Priekuļi Agricultural Vocational School	G. Evarte-Bundere	10 07 2011
51574	6241576	Bauska District, Gailīši Parish, Uzvara Village	G. Jurševska	20 07 2008
632686	6215767	Ilūkste District, Bebrene Parish, Bebrene Park	G. Jurševska	04 10 2008
620211	6284536	Madona District, Kalsnava Arboretum	G. Jurševska	27 07 2008
447564	6316498	Tukums District, Tume Parish, Vāgners Arboretum	det. G. Jurševska leg. P. Evarts-Bunders	21 07 2008
564758	6275160	Skrīveri District, Skrīveri Arboretum	A. Ozoliņa	22 09 2007
***Tilia platyphyllos* 'Obliqua'**				
431463	6258764	Auce District, Vecauce Park	G. Evarte-Bundere	06 07 2011
590656	6287682	Koknese District, Bebri Parish, Vecbebri Park	G. Evarte-Bundere	03 07 2011
607141	6257821	Sala District, Sala Parish, greenery in the centre of Sala Village	G. Evarte-Bundere	03 07 2011
657504	6195185	Daugavpils City, surroundings of Sporta Street	leg. K. Brutāne det. G. Evarte-Bundere	16 09 2011
698261	6207952	Krāslava District, Kombuļi Parish, the centre of Kombuļi Village	G. Evarte-Bundere	16 08 2011
655989	6230771	Vārkava District, Upmala Parish, Vecvārkava Park	G. Evarte-Bundere	16 08 2011
701422	6250667	Rēzekne District, Lūznava Parish, Lūznava Park	G. Evarte-Bundere	14 08 2011
519776	6325969	Ādaži District, greenery in the centre of Ādaži Town	leg. A. Bojāre det. G. Evarte-Bundere	20 08 2011
434133	6294628	Jaunpils District, Jaunpils Parish, Strutele Village	G. Evarte-Bundere	03 08 2011
55180	6334698	Sigulda District, Sigulda Town, the square and park at the railway station	G. Evarte-Bundere	10 07 2011