



# **Shared strategies for survival: a comparative analysis of leaf dry-matter content within Taxodiaceae species under urban conditions**

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# 01. INTRODUCTION



# The background: Urban Stressors

Urban heat islands raise air and surface temperatures

Temperature

Soil sealing reduces water infiltration and compacted soils restrict root growth

Soil conditions

Irregular precipitation and atmospheric drought cause water stress

Water access

Air pollution damages leaves and disrupts physiological processes

Air pollution



# The background: Urban Stressors

## These conditions cause:

- stress to tree water balance;
- leading to reduced growth;
- weaken vitality and increased vulnerability to disease, damage and decline.





# LDMC: what and why?

**Functional traits allow comparison of species performance and respond predictably to stress.**

- LDMC = dry mass / fresh mass;
- Higher LDMC = dense tissues, conservative water use;
- Indicates tolerance to drought and slower turnover;
- Useful for rapid screening of urban tree resilience.



# Target species and research aim

- *Metasequoia glyptostroboides* Hu & W.C.Cheng. (dawn redwood);
- *Taxodium distichum* (L.) Rich. (bald cypress);
- *Sequoiadendron giganteum* (Lindl.) J. Buchh. (giant sequoia).

The goal of this research is to assess LDMC as an indicator of drought tolerance across these three species under urban conditions.





## 02. MATERIALS AND METHODS



## Study sites

- 21 individuals from 14 sites across Sofia's green infrastructure
- Sites were chosen based on variability in maintenance, irrigation, soil sealing
- Including public parks, streets, pedestrian squares, business and scientific complexes and botanical gardens



*M. glyptostroboides*

*T. distichum*

*S. giganteum*



## Collected data:

- Height and DBH were measured for all trees;
- Phytosanitary condition was assessed using a five-grade scale (Pencheva, 2015);
- Recording of site variables: irrigation, maintenance intensity, planting type;
- Leaf sampling for LDMC calculation.



## LDMC Protocol:

- Leaf samples taken from sun-exposed mid-crown branches
- Fresh mass measured immediately using precision scale
- Oven-dried at 80°C until constant mass achieved
- LDMC calculation as a ratio between dry/fresh mass





Photo credit: *Dr. Ali Samer Muhsan*

# 03. RESULTS AND DISCUSSION



# Specimen Characteristics

№	Species	Specimen characteristics			Site	GI <sup>1</sup> element	Other site specifics		
		Height (m)	DBH (cm)	Phytosanitary condition			Irrigation	Maintenance level	Planting type
1	<i>Metasequoia glyptostroboides</i>	17	45	0	BAS Botanical Garden	Urban garden / park	Yes	Intensive	Group
2	<i>Metasequoia glyptostroboides</i>	15,60	65	1	BAS Scientific Laboratory Complex	Pedestrian square	No	Semi-intensive	Solitaire
3	<i>Metasequoia glyptostroboides</i>	15	52	1	Business Park Sofia	Pedestrian square	No	Intensive	Solitaire
4	<i>Metasequoia glyptostroboides</i>	14	38	2	“Frederich Joliot Curie” str.	Street plantings	No	Extensive	Solitaire
5	<i>Metasequoia glyptostroboides</i>	18,20	71	0	Park “Pancharevo Lake”	Urban garden / park	No	Semi-intensive	Group
6	<i>Metasequoia glyptostroboides</i>	21	67	0	Sofia University Botanical Garden	Urban garden / park	Yes	Intensive	Group
7	<i>Metasequoia glyptostroboides</i>	9	33	0	South Park	Urban garden / park	No	Extensive	Group
8	<i>Sequoiadendron giganteum</i>	17,40	108	0	BAS Botanical Garden	Urban garden / park	No	Intensive	Solitaire
9	<i>Sequoiadendron giganteum</i>	16,20	93	1	BAS Scientific Laboratory Complex	Pedestrian square	No	Semi-intensive	Group
10	<i>Sequoiadendron giganteum</i>	17,10	81,50	1	“Bulgaria” boulevard	Street plantings	No	Extensive	Group
11	<i>Sequoiadendron giganteum</i>	8,20	64	2	Knyazhevskia Garden	Pedestrian square	No	Intensive	Solitaire
12	<i>Sequoiadendron giganteum</i>	18,30	106	0	Sofia Zoo	Urban garden / park	No	Intensive	Group
13	<i>Sequoiadendron giganteum</i>	13,60	45,50	1	South Park	Urban garden / park	No	Extensive	Group
14	<i>Sequoiadendron giganteum</i>	16	57	1	The University of Forestry Arboretum	Urban garden / park	No	Semi-intensive	Group
15	<i>Taxodium distichum</i>	16	41	2	Borissova Garden	Urban garden / park	No	Semi-intensive	Solitaire
16	<i>Taxodium distichum</i>	12,40	38	1	Business Park Sofia	Street plantings	Yes	Intensive	Solitaire
17	<i>Taxodium distichum</i>	14,70	44	1	Doctors’ Garden	Pedestrian square	No	Semi-intensive	Solitaire
18	<i>Taxodium distichum</i>	13,80	52	0	Garden “Algeer”	Pedestrian square	No	Semi-intensive	Solitaire
19	<i>Taxodium distichum</i>	7	16	0	Sofia Tech Park	Urban garden / park	Yes	Intensive	Solitaire
20	<i>Taxodium distichum</i>	12,60	36	1	Sofia Zoo	Urban garden / park	No	Intensive	Group
21	<i>Taxodium distichum</i>	13,60	39	1	South Park	Urban garden / park	No	Extensive	Group

Table 1.: Characteristics of sampled specimens and their specific site conditions in Sofia’s green infrastructure



# Specimen Characteristics

- Specimens varied widely in height (7-22 m), DBH and maturity;
- Better overall condition was recorded in intensively maintained parks;
- Street plantings showed higher stress response.

**Site factors such as irrigation, soil sealing, and maintenance intensity strongly influenced overall tree performance.**



# LDMC Results

The statistical analysis showed no significant differences between the species' LDMC:  $\chi^2 = 2.375$ ,  $df = 2$ ,  $p = 0.305$ .

Despite the lack of significance, a numerical trend was observed in median LDMC.:

***T. distichum* > *S. giganteum* > *M. glyptostroboides***

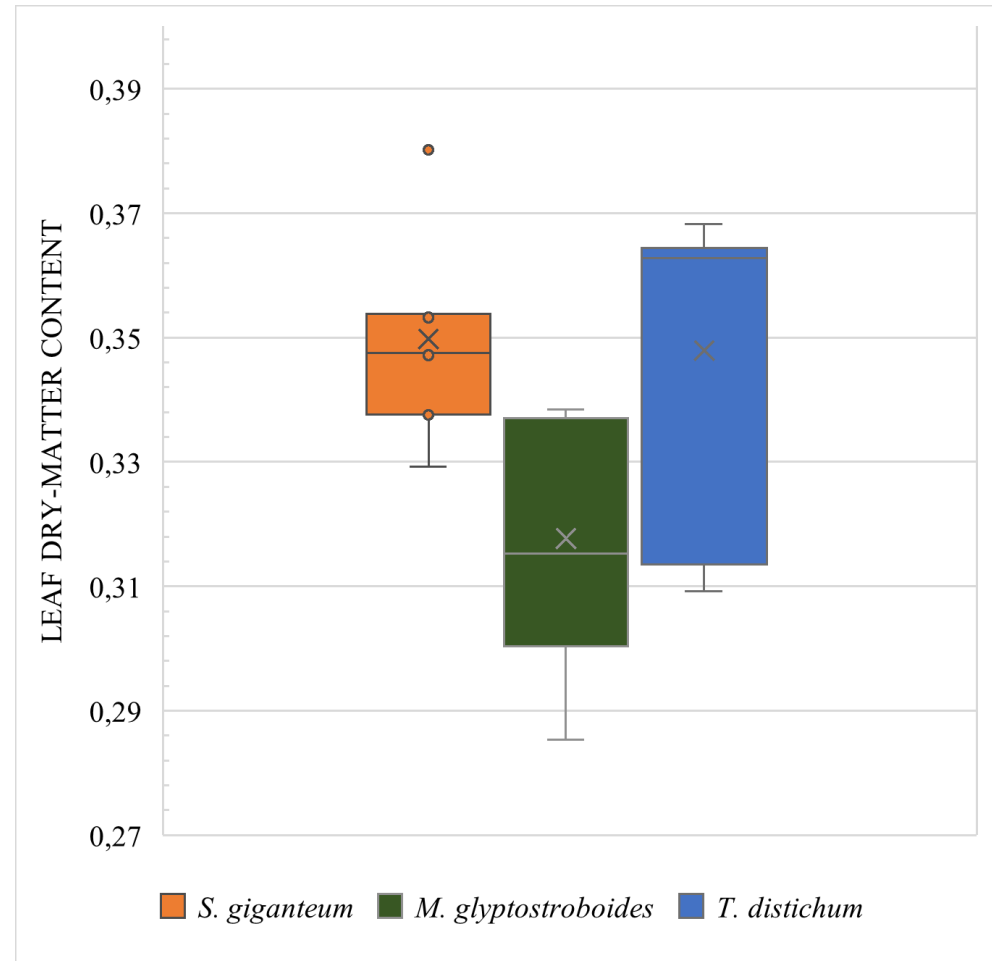


Figure 1.: Distribution of leaf dry-matter content (LDMC) for *S. giganteum*, *M. glyptostroboides*, and *T. distichum*



# Functional Interpretation

- Similar LDMC suggests shared drought-conserving strategies;
- Environmental filtering in urban settings is likely;
- Functional convergence reflects adaptation to heat and drought;
- Consistent with global Leaf Economics Spectrum (LES) patterns (Wright et. al., 2004).



# Limitations of LDMC alone

Does not reflect hydraulic vulnerability or water potential;



Cannot predict rooting depth or stomatal behavior;



Should be combined with SLA, turgor loss point, xylem traits;



Best used as a preliminary screening tool.



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## 04. CONCLUSIONS

- All target species showed comparable LDMC and respectively - similar drought strategies;
- Urban conditions could potentially reduce interspecific trait divergence;
- LDMC is a practical indicator for urban species selection;
- Further trait and hydraulic studies is recommended for a more in-depth understanding.



Photo credit: „Publish Central”

## 05. REFERENCES

### Literature:

1. Pencheva A. (2015). Protection of park plants. Part I Phytopathology: Diseases caused by abiotic and biotic factors, Intel Entrans Publishing House, Sofia. 2015. 228p. ISBN 978-954-2910-51-0. (In Bulgarian)
2. Wright, I., Reich, P., Westoby, M. et al. (2004). The worldwide leaf economics spectrum. Nature 428, 821–827 <https://doi.org/10.1038/nature02403>

### Photo references credits:

1. Dr. Ali Samer Muhsan
2. Ivan Shishiev – “Sketches of Sofia”
3. “Publish central”

# Thank you for your attention!

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