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Studying indicator parameters of ecological tolerance of trees under conditions of the city of Yerevan

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BIOCHEMISTRY DEPARTMENT CENS NAS RA

Biochemistry Department

Main activities:

- Ecobiochemical assessment of urban plants,
- Urban greening,
- Phytoindication and phytomonitoring,
- Assessment of eco-toxicological risk and safety of vegetable- origin food.

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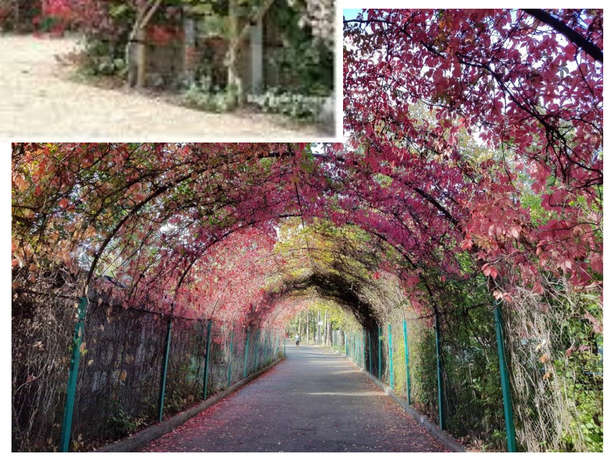
Nature based solution

Urban greening

Vertical greening



Green streets

Roof greening

Biochemistry Department

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Biochemistry Department

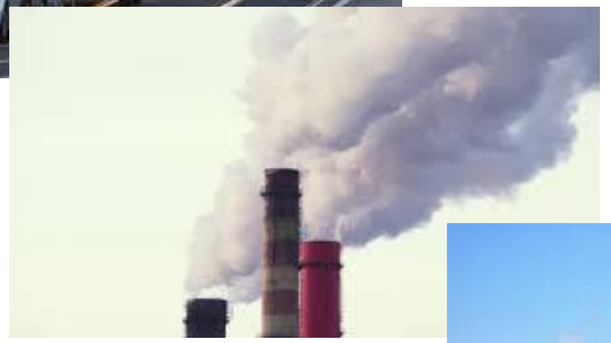
Yeravan - Armenia's capital

Population: 1,068 mil.

Total area: 223 sq. km

Total area of green spaces 6758.5 ha

Climate: sharply continental



Negative impact on the Yerevan's environment are:

- Traffic,
- Industrial enterprises,
- Construction,
- Power and heat generating facilities,
- Housing and communal facilities.

Republic of Armenia – *a landlock country located in the South Caucasus*

STUDIED OBJECT

10 Parks and Squares

20 Streets

The research period: 2007 - 2017.

The research goal: providing indicator parameters of ecological tolerance of trees and selection of tree species with phytofiltration properties appropriate for Yerevan greening.

The research was implemented by stages employing a complex method of ecological assessment of plants developed by us:

- Studying the biodiversity of urban plants,
- Plant condition assessment,
- Geochemical investigations,
- Selection of tolerant tree species for urban greening

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RESEARCH METHODS

1. Assessment of ecological status of plants.

Assessing condition of trees

- I - *normal,*
- II - *good,*
- III - *poor,*
- IV - *extremely poor,*
- V - *dead:*

2. SAMPLE COLLECTION

SAMPLE TREATMENT

- washing,
- air drying,
- chopping into small pieces

3. SAMPLE ANALYSIS

Cu, Pb, Mn, Mo, Ni, Zn, Hg

Atomic-absorption spectrometer: AAnalyst 800 (Perkin Elmer, USA)

The Central Analytical Experimental Laboratory CENS

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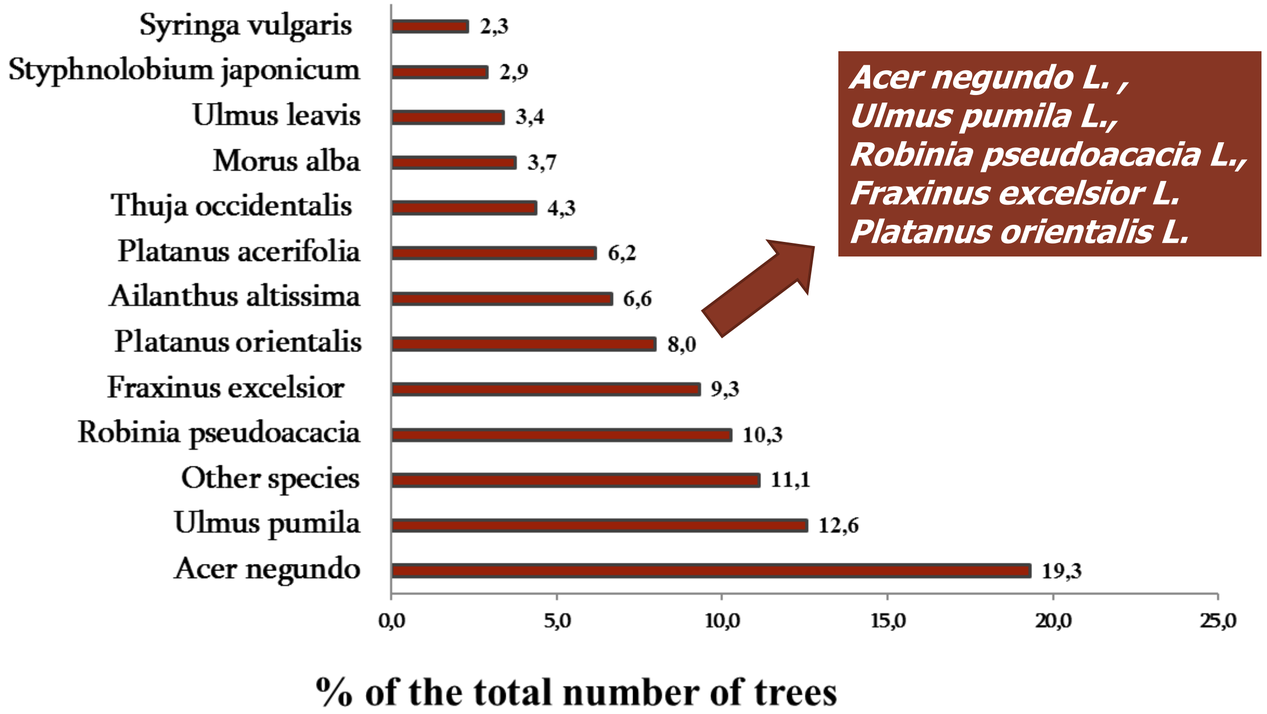
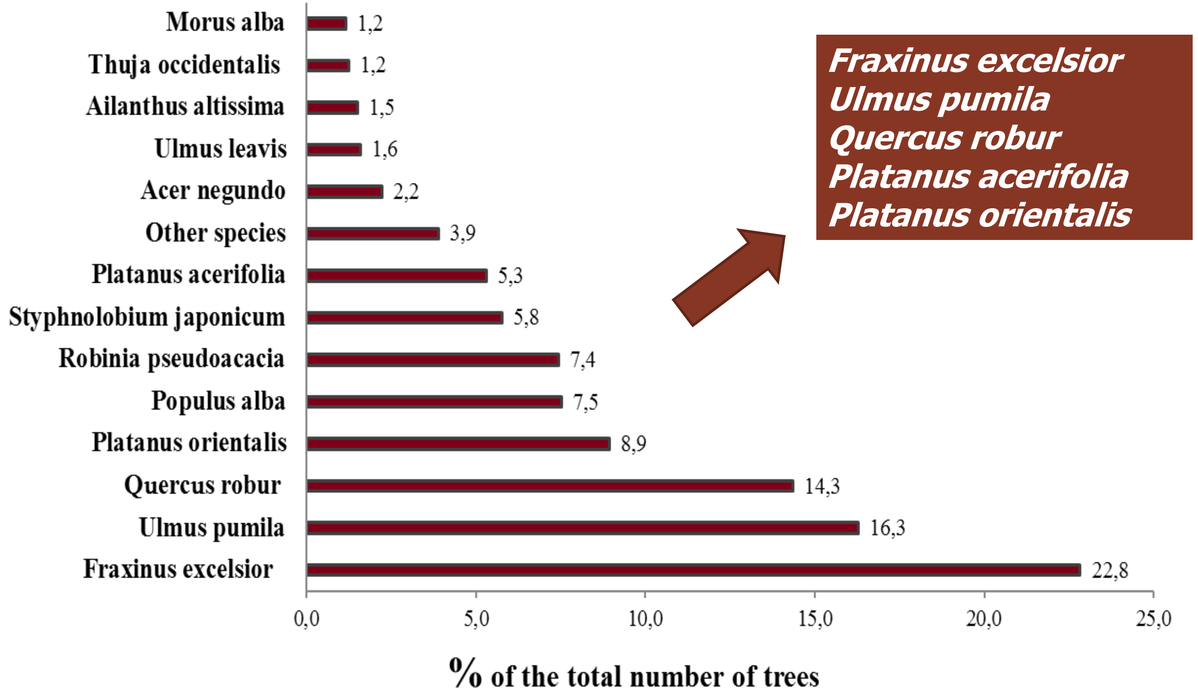
OBTAINED RESULTS

Parks and squares



Acer negundo L. ,
Ulmus pumila L.,
Robinia pseudoacacia L.,
Fraxinus excelsior L.
Platanus orientalis L.

Street trees



Fraxinus excelsior
Ulmus pumila
Quercus robur
Platanus acerifolia
Platanus orientalis

Fig. 1. A basic assortments of tree species planted in Yerevan

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OBTAINED RESULTS

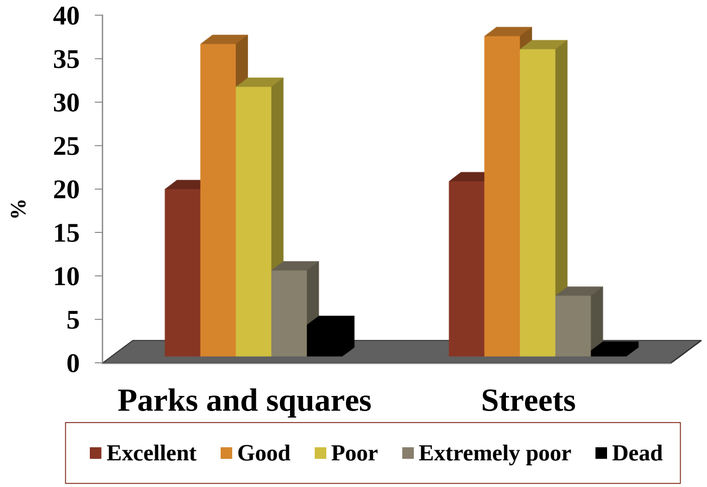

Fig. 2. Assessing condition of trees growing in Yerevan parks and squares

Fig. 3. Visible foliar injuries in polluted

Parks and Squares	
Ash tree	*Fraxinus excelsior*
Green Ash	*Fraxinus pensilvanica*
Robinia	*Robinia pseudoacacia L.*
Marple tree	*Acer negundo L.*
Golden rain tree	*Koelreuteria paniculata*
Ailanthus	*Alianthus altissima swingle*

Streets	
Marple tree	*Acer negundo*
Ailanthus	*Alianthus altissima swingle*
Ash tree	*Fraxinus excelsior*
Green Ash	*Fraxinus pensilvanica*
Poplar	*Populus alba*
White morus	*Morus alba*

1. **Robinia - *Robinia pseudoacacia L.***
2. **Ash tree - *Fraxinus excelsior L.***
3. **Green Ash – *Fraxinus pensilvanica Marsh.***
4. **Poplar – *Populus alba L.***
5. **Golden rain tree – *Koelreuteria paniculata Laxm.***

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OBTAINED RESULTS

Tab. 1. Mean contents of heavy metals in Yerevan soils and plants (mg/kg)(2007-2008).

Elements	Soil		Plant	
	MAC* (mg/kg)	Observed conc. (mg/kg)	Normal conc.* (mg/kg)	Observed conc. (mg/kg)
Cu	55	88.8	3-40	21.11
Mn	1500	786	15-150	75.8
Pb	32	39	0.1-5.0	4.31
Ni	85	118.5	0.1-1.0	5.3
Mo	4	4	0.2-1.0	1.82
Zn	100	116.7	15-150	31.7

* **Kabata-Pendias A., Trace elements in soils and plants. – Warszawa, 2001, 432 pp.**

* * ***Baker D.E., Chestin L.*** **Chemical monitoring of soil for environmental anality and animal and human health. – Advances in Agronomy, 1975, №27, p. 906-360.**

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Normal conc. (mg/kg)	Max. conc. (mg/kg)
0,001-0,01	0,04

Element	Normal conc. (mg/kg)*
Pb	0,1-5,0
Mo	0,2-1,0
Ni	0,1-1,0

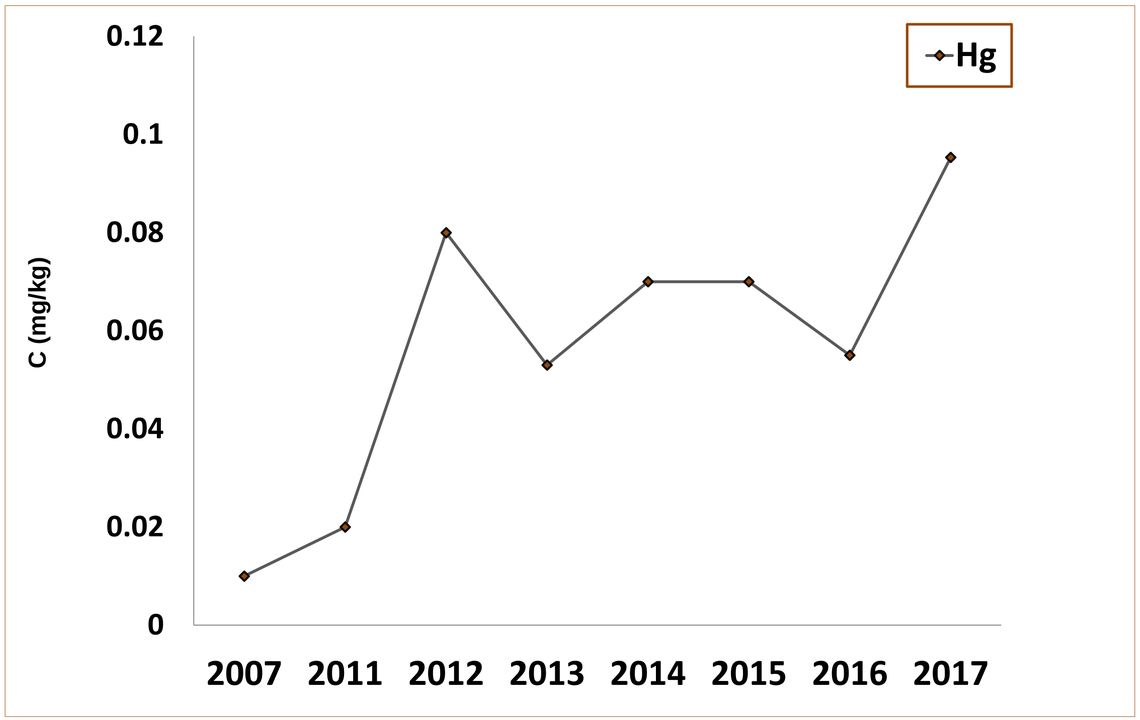

Fig. 4. The dynamics of changes in mean content of mercury
in tree species planted in Yerevan

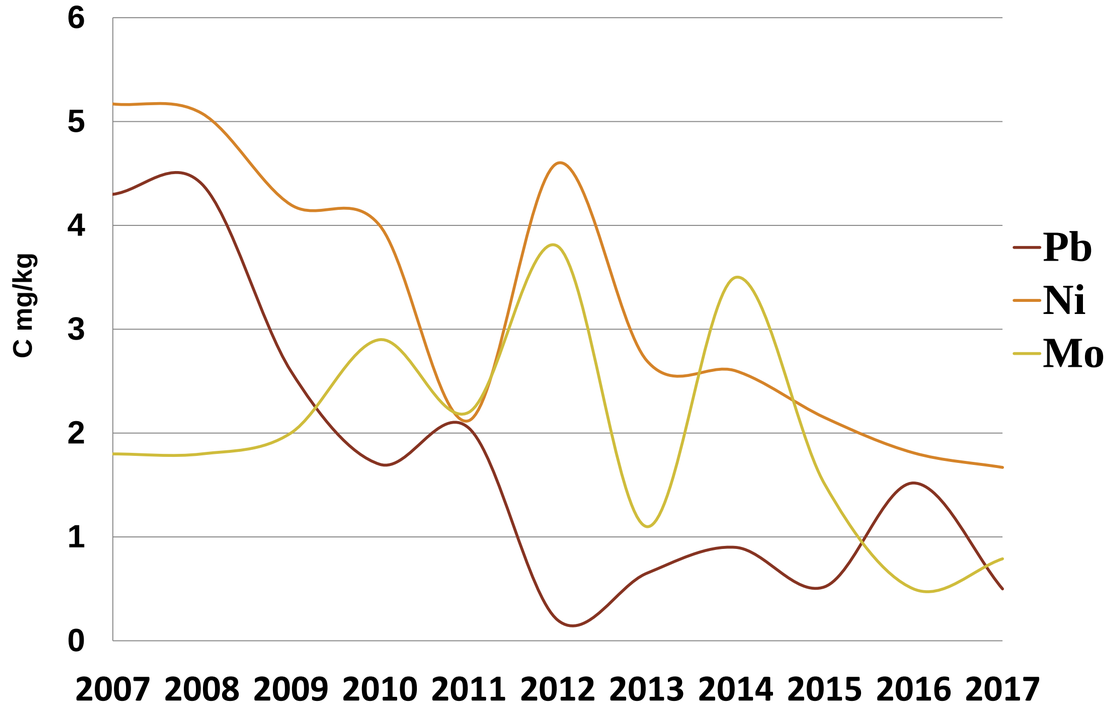

Fig. 5. The dynamics of change in mean contents of heavy metals in the foliage of Yerevan trees

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OBTAINED RESULTS

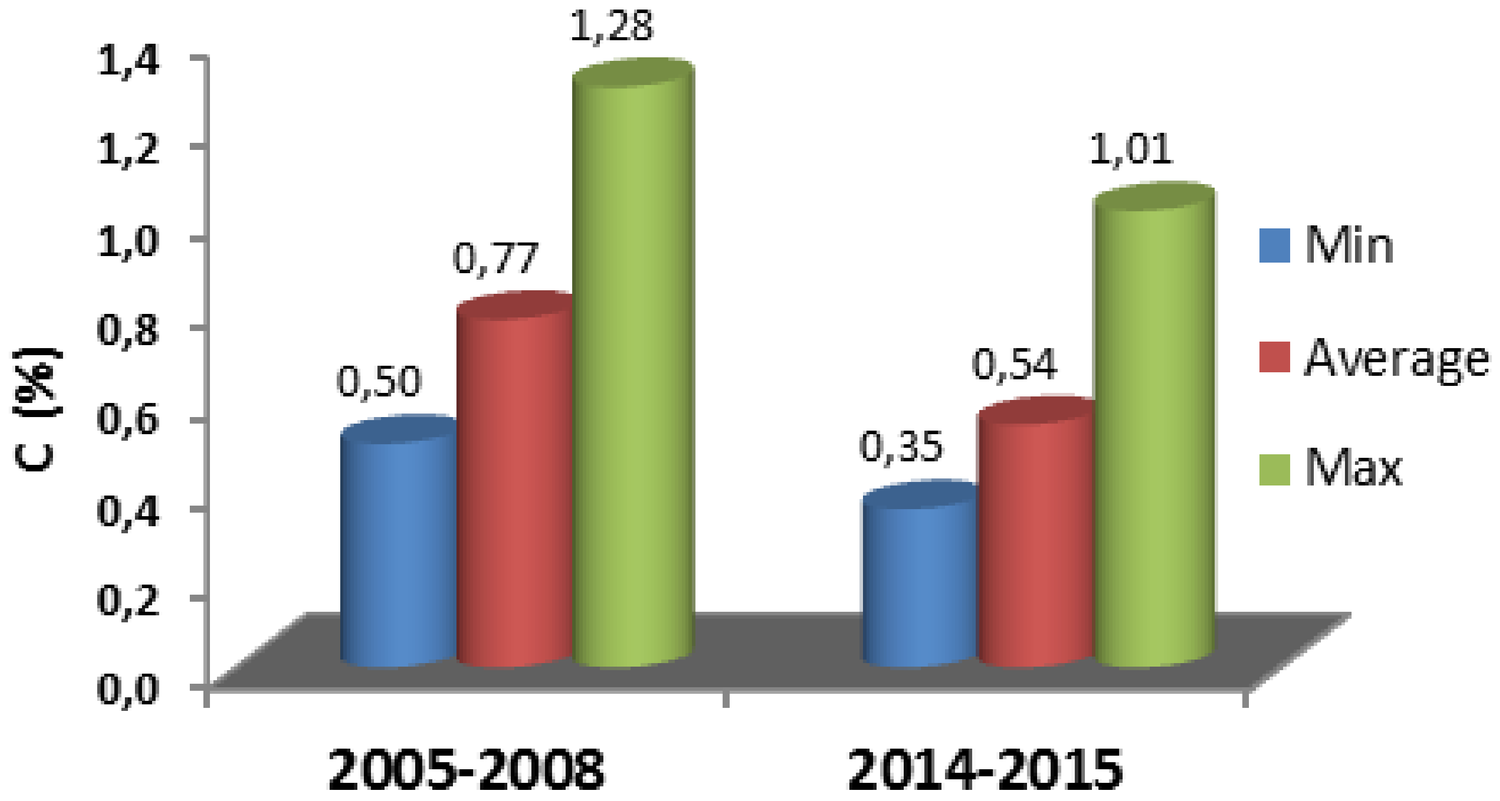

Fig. 6. Collation of monitoring data on chlorine concentrations in the leaves of Fraxinus excelsior L.

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OBTAINED RESULTS

Tree species	Variant	N/Cu	N/Mo	N/Zn	$N/\sum_{M}^{T.}$
Robinia pseudoacacia	Background	1870	32258	840	176
	Pollution site	917.1	10645	614	145
	Strong pollution site*	330	4954	461	96.5
Fraxinus excelsior	Background	949	50000	631	126.5
	Pollution site	846.7	7022	775	130
	Strong pollution site*	259.5	5105	327	79.59
Populus alba	Background	833	36585	559.7	121
	Pollution site	670	7414	533.5	111.6
	Strong pollution site*	624	6496	364	113.9

*** - a strongly polluted site with visible injuries of plants**

Table 2. Values of relations between nitrogen/metal and nitrogen/chlorine in the leaves of plants growing on polluted sites

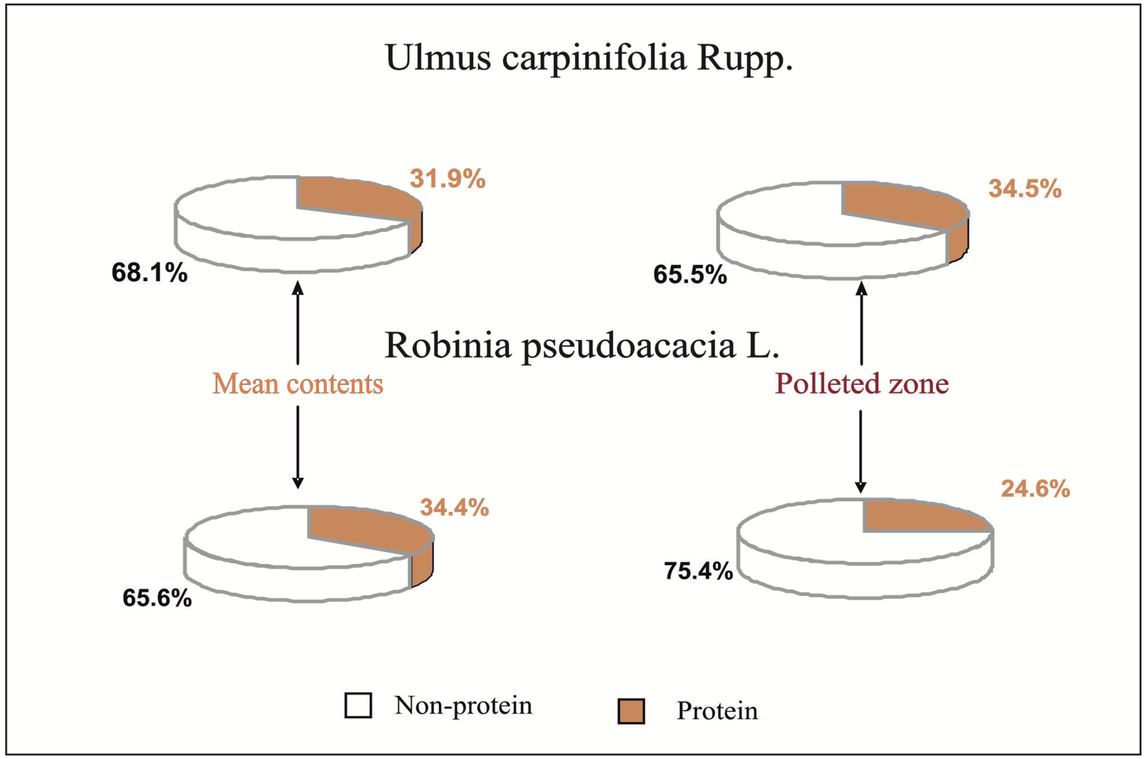

Fig. 7. Protein and non-protein nitrogen in different trees

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CONCLUSIONS

The obtained research results support the following conclusions:

- The assortment of tree growing in Yerevan parks and squares and strees includes some 50 and 30 species, respectively.
- The selected ecologically tolerant tree species having good phytofiltration properties include *Robinia pseudoacacia L.*, *Fraxinus excelsior L.*, *Fraxinus pennsilvanica March.*, *Populus alba L.* and *Koelreuteria paniculata*.
- The concentrations of trace elements exceed the accepted norms in Yerevan soils and plants.
- The best chlorine absorption and phytomelioration property as well as ecological tolerance under conditions of chlorine pollution is typical of Robinia pseudoacacia L., Fraxinus excelsior L., Platanus orientalis L.,
- Recent researches have indicated Pb, Mo, Ni and Hg in Yerevan plants.
- Within strongly polluted zones nitrogen/ metals correlation values dramatically decreased.
- In tolerant species under the impact of toxicants, an increase in protein nitrogen and in intolerant species – accumulation of non-protein forms of nitrogen is detectable.

Thus, our research continues in this direction, which allows us to choose the most sustainable species having best phytopiltration properties for urban greening sites.

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Tab. 3. A set of tree and shrub species recommended for sites with different pollution level

Low pollution zone	Mean pollution zone	High pollution zone
Juniperus virginiana L. *Malus domestica L.* *Pyrus communis Borkh.* *Picea pungens Engelm* *Picea abies (L.) Karst.* *Kochiana Klotzsch ex C Koch* *Pinus pallasiana D.Don* *Philadelphus caucasicus* *Forsythia intermedia* *Acer tataricum L.* *Acer campestre L.* *Acer platanoides L.* *Morus alba L.* *Styphnolobium japonicum (L.) Schott Aesculus hippocastanum L.* *Populus alba L.* *Populus nigra L.* *Populus gracilis Grossh.* *Juglans nigra L.* *Salix alba L.* *et. st.*	*Sorbus domestica L.* *Acer tataricum L.* *Robinia pseudoacacia L.* *Aesculus hippocastanum L.* *Populus nigra L.* *Acer campestre L.* *Acer platanoides L.* *Morus alba L.* *Morus nigra L.* *Juglans nigra L.* *Salix alba L.* *Acer pseudoplatanus L.* *Tilia cordata Mill.* *Styphnolobium japonicum (L.) Schott* *Gleditcshia triacanthos L.* *Thuja occidentalis L.* *Elaeagnus angustifolia L.* *Hedera helix L.* *Lonicera tatarica L.*	*Fraxinus excelsior L.* *Fraxinus lanceolata Borkh.* *Platanus orientalis L.* *Populus alba L.* *Quercus L.* *Acer negundo L.* *Juniperus communis Ulmus L.* *Rosa canina L.* *Ailanthus altissima (Mill.) Swingle* *Syringa vulgaris L.* *Buxus sempervirens L.* *Parthenocissus quinguefolia L.*


Thank you