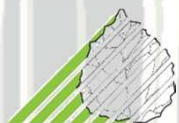




Water in Forests
International Conference of KASZÓ-LIFE project
29-30. May 2018.

CLIMATE CHANGE AND INVASIVE INSECT SPECIES IN FORESTS, URBAN AREAS AND NURSERIES IN SERBIA

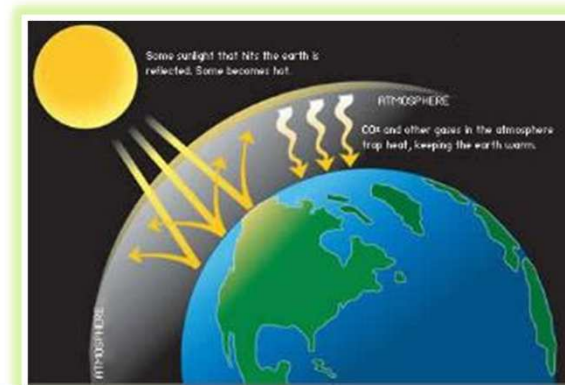
**Poljaković-Pajnik Leopold, Dejan Stojanović, Drekić Milan,
Andrej Pilipović, Vasić Verica**



University of Novi Sad
Institute of Lowland Forestry and Environment
www.ilfe.org

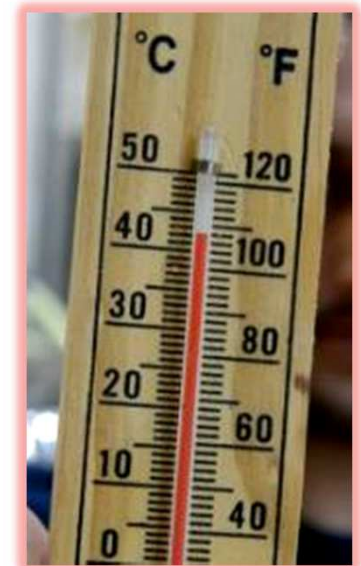
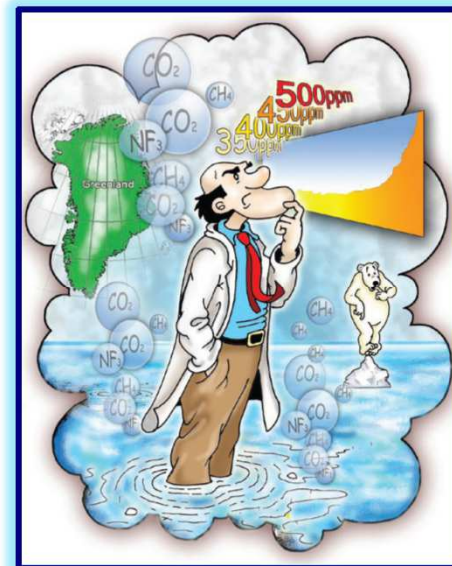
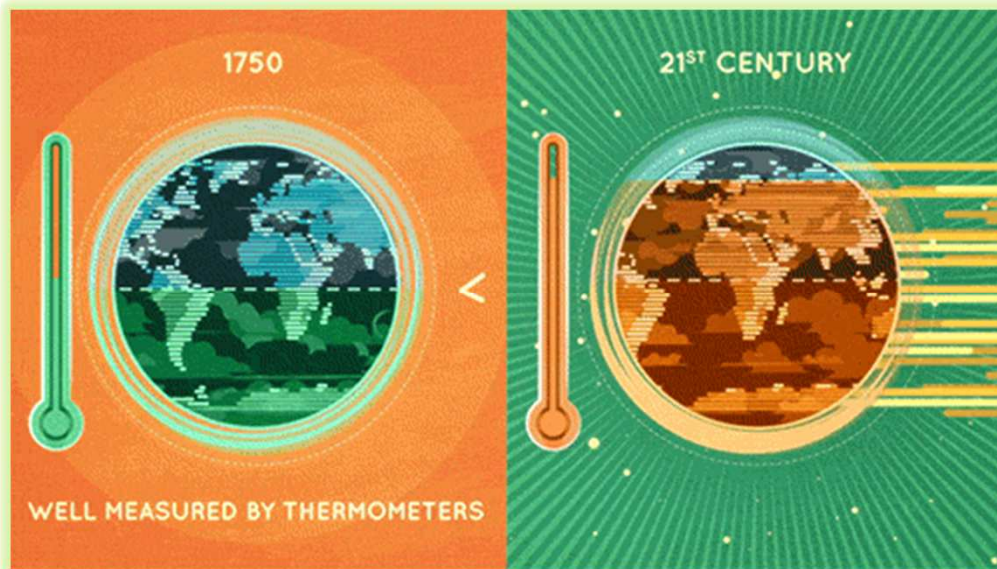
Climate change

- Projections of climate change in the 21st century are in direct correlation with the projections of the development of human society
- There are **40 different scenarios** of the Intergovernmental Panel on Climate Change based on different assumptions regarding the speed of economic growth, the integration of the world, technological development, and the use of fossil fuels and the size of the human population
- In the first decade of the 21st century **carbon dioxide emissions from fossil fuels exceeded** the forecasts of most of the scenarios made in 2000
- Current trends in energy use and population growth on Earth will most likely **continue** to contribute to an **increase in the greenhouse effect** and an even **more dramatic climate change**



1. Introduction: Climate change

- In the 21st century, until 2007 the average **temperature** (land and ocean) was **0.8 °C higher** compared to the period of 1850-1899
- The growth rate of the average temperature **increased** from **0.1 °C** per decade in the **past century** to **0.2 °C** over the **past few decades**
- Climate change was especially evident in **Europe**. In the 21st century, the average annual temperature of European land was **1.2 °C higher** compared to the pre-industrial level



Invasive forest insects

- **Invasive insect species** are those that are **not native** to specific ecosystems and whose **introduction** has led or can **lead to economic or environmental damage**
- The worse aspect of exotic pests is that when they **enter a new country**, the pests have not brought along their **natural enemy**
- **Trees** are extremely **susceptible to exotic pest infestation**
- Invasive insect species impose **big costs** to the economy and **damage** to the **environment**
- 102 invasive species of aphids have been recorded in Europe until June 2008 (Coeur d'acier et al. 2010)



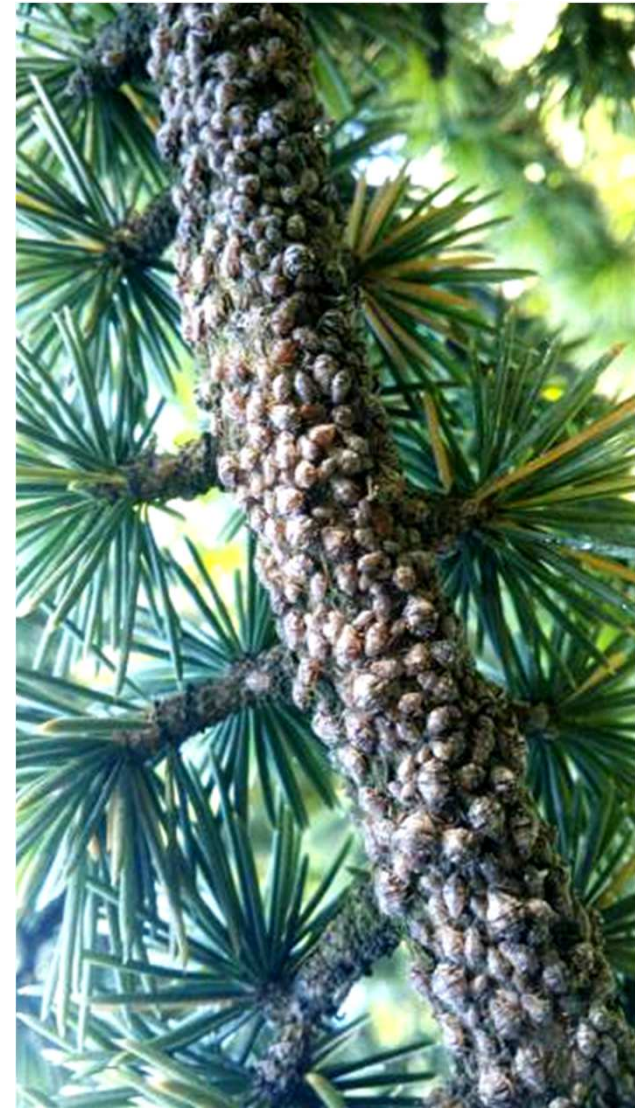
Invasive forest insects

- Insects constitute almost **75% of all described species**
- Their life activities are **temperature dependent**, and therefore climate change can impact both insect populations and ecosystems inhabited by them
- Climate change can affect insect's **biology, physiology, distribution and abundance**
- In much the same way that the magnitude of changes in temperature and precipitation patterns are globally variable, insect species living in **different habitats** will also **vary** both in the amount of climate change they experience and their sensitivity to such changes



Possible Impacts on Insects under Climate change.....

- Extension of geographical range of insect pests
- Increased over-wintering and rapid population growth
- Changes in insect – host plant interactions
- Increased risk of invasion by migrant pests
- Impact on arthropod diversity and extinction of species
- Introduction of alternative hosts as green bridges
- Reduced effectiveness of crop protection technologies



- **Higher temperatures** will lead to shifting of insect's distributions by **expanding into new areas**



Thaumetopoea pityocampa



Neodiprion sertifer



Operoptera brumata



Thaumetopoea processionea



Tomiscus destruens



- Records of changes as a result of a pest-host-climate change interaction *are a crucial point of forest monitoring* which forms the basis for *control strategies and forest management strategies*
- Some native and commonly present insect species could become a serious threat to forests due to the climate change

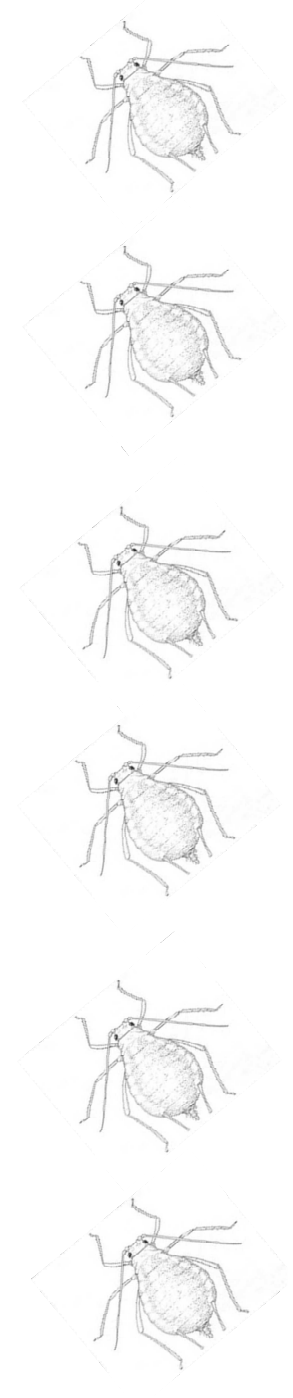
Alien and invasive species
Aphids



- Aphids (Hemiptera, Aphididae) are small insects which can be very easily transferred to new countries and continents.
- Totally 37 alien and invasive species have been found in Serbia in last 30 years.
- The most numerous species are from subfamily Aphidinae (25), then from subfam. Myzocallidinae (7), Lachninae (3) and one species is from subfamilies Chaitophorinae and Pemphiginae
- They are pests in forestry specially in poplar and willow plantation
- One of the most important pests in urban areas and nursery production



- Origin of the most species
- North America 17 species
- Asia has come 15 species
- tropical origin has 2 species
- one is from Africa
- and two species are from unknown origin.



- The most important **aphid pests** on forest trees and urban greenery and in the nursery production of forest end decorative trees and shrubs :
- *Myzus persicae* , *Aphis gossypii*, *Aphis spiraecola* and *Eriosoma lanigerum*
- In urban areas: *Aphis spiraephaga*, *Appendiseta robiniae*, *Cinara cedri*, *Cinara curvipes* and *Prociphilus fraxinifolii*
- Recently found alien aphid species: *Chaitophorus populifolli* and *Myzocallis walshii*



- In urban ecosystems, plants grow in extremely harsh conditions.
- This applies especially to the alleys.
- In parks and other forms of urban greenery those conditions are slightly better.
- Air pollution, water and soil result in shortening of the life cycle of plants.
- Such plants achieve smaller dimensions and are more susceptible to diseases and insect attack.
- Woody species that grow in such conditions have a disrupted duration of phenophases and there is an increase of nitrogen content and of some amino acids in their leaves, which leads to an increase in the number of insects treated up to 1000 times

Invasive aphid species

- In recent years, five new invasive aphids species have been discovered in Serbia:
- *Cinara curvipes* Patch (Poljaković-Pajnik i Petrović-Obradović, 2002),
- *Cinara cedri* (Glavendekić i sar., 2005),
- *Chaitophorus populifolli* Essi (Poljaković-Pajnik i Petrović-Obradović, 2009),
- *Prociphilus fraxinifolii* Riley (Petrović-Obradović i sar. 2010)
- *Myzocallis walshii* Monell (Petrović-Obradović i sar. 2010).

	Species	Natural areal	Host
1.	<i>Aphis gossypii</i> (Glover, 1877)	Tropic and sub tropic	<i>Hibiscus syriacus</i> <i>Catalpa bignonioides</i>
2	<i>Aphis spiraecola</i> (Patch, 1914)	Asia	<i>Pyracatha</i> <i>Cydia, Spiraea</i>
3	<i>Aphis spiraephaga</i> (F.P. Müller, 1961)	Asia	<i>Spiraea</i>
4	<i>Chaitophorus populifolii</i> (Essig, 1912)	North America	<i>Populus</i>
5	<i>Chromaphis juglandicola</i> , (Kaltenbach, 1843)	Asia	<i>Juglans</i>
6	<i>Cinara cedri</i> (Mimeur, 1936)	Africa	<i>Cedrus atlantica</i> <i>Cedrus deodara</i>
7	<i>Cinara curvipes</i> (Patch, 1912)	North America	<i>Abies concolor</i> , <i>Cedrus atlantica</i>
8	<i>Drepanaphis acerifoliae</i> (Thomas, 1878)	North America	<i>Acer</i>
9	<i>Eriosoma lanigerum</i> (Hausmann, 1802)	North America	<i>Malus sp.</i>
11	<i>Myzocallis walshii</i> (Monell ex Riley & Monell, 1879)	North America	<i>Quercus rubra</i> <i>Quercus robur</i>
12	<i>Myzus persicae</i> , (Sulzer 1776)	No significant data of origin	<i>Polifagna</i>
12	<i>Panaphis juglandis</i> (Goeze, 1778)	Asia	<i>Juglans</i>
13	<i>Prociphilus fraxinifolii</i> (Riley ex Riley & Monell, 1879)	North America	<i>Fraxinus</i>
14	<i>Pterocomma populeum</i> , (Palmer, 1952)	North America	<i>Populus</i>
15	<i>Appendiseta robiniae</i> , (Gillette, 1907)	North America	<i>Robinia pseudoacacia</i>

prema Coeur d'acier et al., 2010.

Aphid species	Colonized plants	Colonized part of plant	Harmfulness
<i>Anoecia corni</i>	<i>Cornus sanguinea</i> <i>Cornus sericea</i> <i>Cornus alba</i> <i>Cornus sp.</i>	leaf , shoot	++
<i>Aphis craccivora</i>	<i>Robinia pseudoacacia</i>	leaf , shoot	++++
<i>Pterocallis alni</i>	<i>Corylus avellana</i>	leaf	++
<i>Aphis fabae</i>	<i>Philadelphus coronarius</i> <i>Jasminum officinalis</i> <i>Caragana arborescens</i> <i>Cydonia japonica</i>	leaf	+++
<i>Aphis gossypii</i>	<i>Hibiscus syriacus</i> , <i>Catalpa bignonioides</i>	leaf , shoot	++++ ++++
<i>Aphis hederæ</i>	<i>Hedera helix</i>	leaf	++
<i>Aphis nerii</i>	<i>Nerium oleander</i>	leaf, flower, shoot	+++

<i>Aphis pomi</i>	<i>Crataegus sp.</i> <i>Malus sp.</i> <i>Malus floribunda</i>	leaf	+++
<i>Aphis sambuci</i>	<i>Sambucus nigra</i> <i>Sambucus racemosa</i>	leaf, shoot	+++
<i>Aphis spiraecola</i>	<i>Spiraea vanhouttei</i> <i>Spiraea sp.</i> <i>Pyracantha coccinea</i> <i>Pyracantha sp.</i> <i>Cydia japonica</i>	leaf, shoot	++++
<i>Aphis viburni</i>	<i>Viburnum sp.</i>	shoot, leaf	++
<i>Hyalopterus pruni</i>	<i>Prunus persica</i> <i>Prunus sp.</i>	leaf	++
<i>Liosomaphis berberidis</i>	<i>Berberis sp.</i> <i>Berberis vulgare</i> <i>Berberis thunbergii</i>	leaf, shoot	++
<i>Corylobium avellanae</i>	<i>Corylus avellana var.</i> „Artropurpureum“	leaf	++
<i>Macrosiphum rosae</i>	<i>Rosa sp.</i>	leaf, bud, flower	++++

<i>Myzus cerasi</i>	<i>Prunus avium</i> <i>Prunus cerasus</i>	leaf	+++
<i>Chaitophorus leucomelas</i>	<i>Populus deltoides</i> <i>Populus x euramericana</i> <i>Populus tr. x Populus deltoides</i>	leaf	++++
<i>Chaitophorus populeti</i>	<i>Populus x euramericana</i> <i>Populus nigra</i> <i>Populus alba</i>	leaf	++++
<i>Chaitophorus populialbae</i>	<i>Populus albae</i> <i>Populus tremulae</i>	leaf, shoot	++++
<i>Chaitophorus vitellinae</i>	<i>Salix alba</i> <i>Salix alba var. „Pendula“</i>	leaf	++
<i>Periphyllus acericola</i>	<i>Acer pseudoplatanus</i>	leaf	+
<i>Prociphilus fraxinifolii</i>	<i>Fraxius pennsylvanica</i>	leaf	+++

<i>Periphyllus aceris</i>	<i>Acer campestre</i>	leaf	+
<i>Drepanosiphum aceris</i>	<i>Acer pseudoplatanus</i> <i>Acer atropurpureum</i>	leaf	++
<i>Drepanosiphum platanoidis</i>	<i>Acer negundo</i> <i>Acer platanoides</i> var. „Globosa“ <i>Acer pseudoplatanus</i>	leaf	+++
<i>Cinara cedri</i>	<i>Cedrus atlantica</i>	bark	++++
<i>Cinara curvipes</i>	<i>Abies concolor</i> <i>Cedrus atlantica</i>	bark	+++ ++
<i>Cinara pini</i>	<i>Pinus nigra</i>	shoot	++
<i>Cinara (Cupressobium) tujafilina</i>	<i>Thuja oreintalis</i> <i>Thuja sp.</i>	bark	++
<i>Cinara juniperi</i>	<i>Juniperus communis</i> <i>Cinara juniperi</i> var. „Compacta“	bark	++
<i>Schizolachnus pineti</i>	<i>Pinus nigra</i> <i>Pinus sylvestris</i> <i>Pinus mugho</i>	needles	++

<i>Tuberolachnus salignus</i>	<i>Salix alba</i>	bark	+++
<i>Eulachnus rilleyi</i>	<i>Pinus nigra</i> <i>Pinus sylvestris</i>	needles	+
<i>Mindarus abietinus</i>	<i>Abies concolor</i>	bark	+
<i>Euceraphis betulae</i>	<i>Betula alba</i> <i>Betula sp.</i>	leaf	+++
<i>Chromaphis juglandicola</i>	<i>Juglans regia</i>	leaf	+
<i>Eucallipterus tiliae</i>	<i>Tilia cordata</i> <i>Tilia argentea</i> <i>Tilia sp.</i>	leaf	++++
<i>Myzocalli carpini</i>	<i>Corylus avellana</i> <i>Corylus avellana</i> <i>Arthropurpureum</i>	leaf	+
<i>Panaphis juglandis</i>	<i>Juglans regia</i>	leaf	+
<i>Pterocallis alni</i>	<i>Alnus glutinosa</i>	leaf	+
<i>Pemphigus bursarius</i>	<i>Populus nigra var. „Italica“</i>	petiole leaf	++
<i>Pemphigus protospirae</i>	<i>Populus nigra var. „Italica“</i>	petiole	++
<i>Pemphigus populi</i>	<i>Populus nigra var. „Italica“</i>	leaf	+
<i>Pachypappa warsharensis</i>	<i>Populus alba</i>	leaf	+

<i>Colophna compressa</i>	<i>Ulmus sp.</i>	leaf	+
<i>Eriosoma lanigerum</i>	<i>Pyracantha coccinea</i>	shoot, leaf	+
<i>Eriosoma lanuginosum</i>	<i>Ulmus sp.</i>	leaf	++
<i>Eriosoma ulmi</i>	<i>Ulmus pumila</i>	leaf	+
<i>Tetraneura ulmi</i>	<i>Ulmus sp.</i>	leaf	++
<i>Prociphilus fraxini</i>	<i>Fraxinus angustifolia</i>	leaf	++++
<i>Prociphilus fraxinifolii</i>	<i>Fraxinus pensylvanica</i>	leaf	++
<i>Kaltenbachiella pallida</i>	<i>Ulmus montana</i> var. „Pendula“	leaf	+
<i>Dysaphis plantaginea</i>	<i>Malus sp.</i>	leaf	+
<i>Hyalopterus pruni</i>	<i>Prunus persica</i>	leaf	++
<i>Patchiella reaumuri</i>	<i>Tilia argentea</i>	leaf	+
<i>Myzocallis walshi</i>	<i>Quercus robur</i> var. „Pyramidalis“ <i>Quercus rubra</i>	leaf	++
<i>Appendiseta robiniae</i>	<i>Robinia pseudoacacia</i>	shoot, leaf	++
<i>Phylloxera quercus</i>	<i>Quercus robur</i>	leaf	++++

Aphids in forest nurseries, horticultural nurseries and urban areas

- In total **59** aphid species were found
- In forest nurseries **8** species of aphids were found,
- in nurseries for the production of ornamental plant material **31** species were found ,
- while **44** species, the highest number, was found on the urban greenery.
- In nurseries for the production of forest seedlings a relatively small number of plant species is grown in relation to nurseries for production of ornamental seedlings where the number of cultivated species is several times higher.
- For this reason, the number of identified species of aphids is almost **4** times greater in ornamental nurseries for the production of seedlings.

- Two species are new for entomofauna of Serbia: ***Melanaphis donacis* (Passerini)** on *Arundo donax* and ***Patchiella reaumuri* (Kaltenbach)** on *Tilia argentea*.



- The greatest damage in forest nurseries are caused by ***Chaitophorus leucomelas*, *Chaitophorus populeti*, *Chaitophorus populiaalbae*** on poplar seedlings and ***Aphis craccivora*** on seedlings of black locust.

- Aphids that caused the greatest damage on the urban greenery and in ornamental nurseries are:
- ***Aphis gossypii*** (on *Hibiscus syriacus*, *Catalpa bignonioides*),
- ***Aphis spiraecola*** (on *Spiraea vanhouttei*, *Spiraea sp.*, *Pyracantha coccinea*, *Pyracantha sp.* and *Cydia japonica*),
- ***Macrosiphum rosae*** (on *Rosa sp.*),
- ***Cinara cedri*** (on *Cedrus alantica*),
- ***Eucalipterus tiliae*** (on *Tilia cordata*, *Tilia argentea*) and
- ***Prociphilus fraxini*** (on *Fraxinus sp.*).

Aphis craccivora on *Robinia pseudoacacia*



Aphis fabae* on *Caragana arborescens



Aphis gossypii* on *Catalpa bignonioides



Aphis gossypii* on *Catalpa bignonioides



Aphis spiraecola* on *Cydonia japonica



Aphis spiraecola* on *Pyracantha coccinea



Aphis spiraeicola* on *Spiraea x vanhouttei



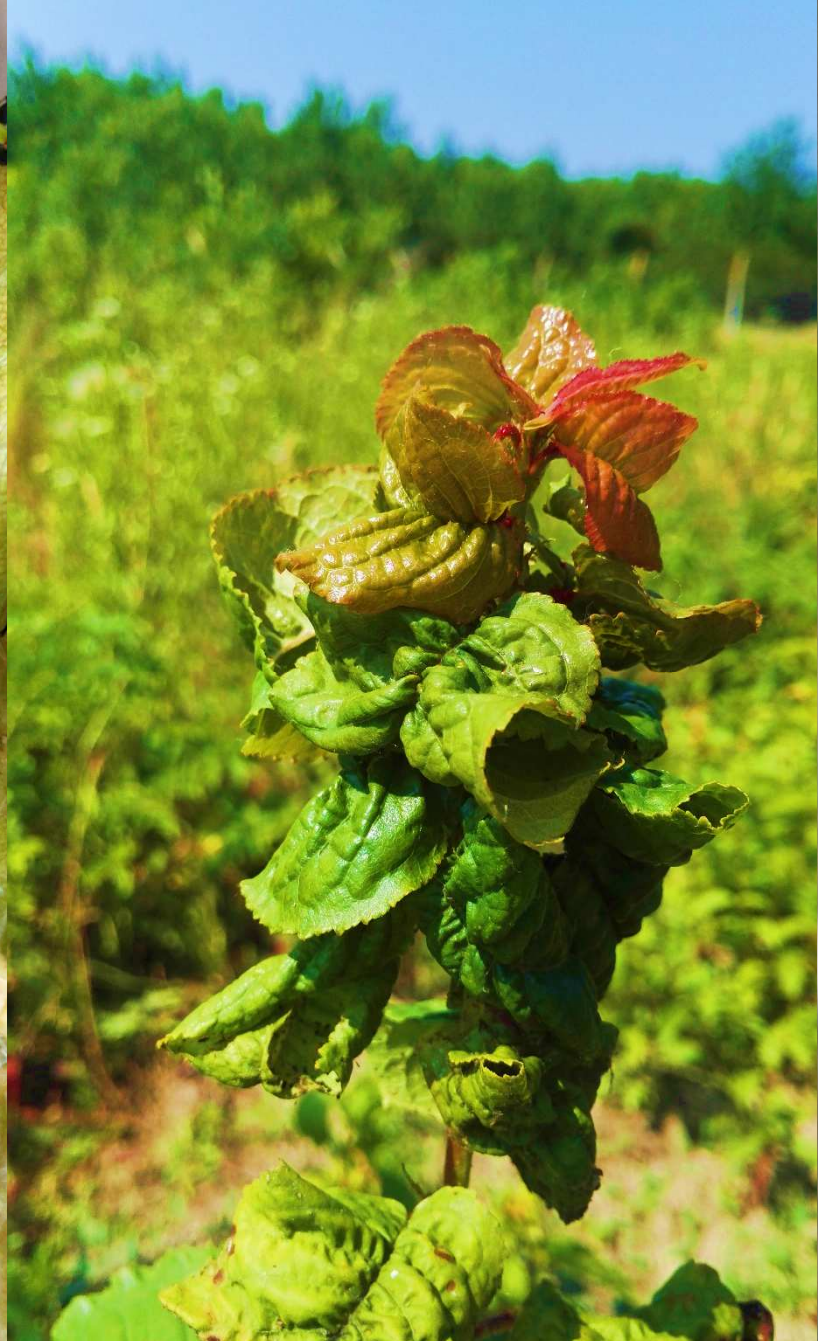
Hyalopterus pruni on *Prunus persica*



***Macrosiphum rosae* on *Rosa* sp.**



Myzus cerasi* on *Prunus avium



Chaitophorus leucomelas* on *Populus x euramericana



Chaitophorus populeti* on *Populus alba



Chaitophorus populialbae na *Populus alba*



Cinara cedri* on *Cedrus atlantica



Cinara cedri* on *Cedrus atlantica



Cinara curvipes* on *Abies concolor



Cinara curvipes



Lachnus roboris on *Quercus robur*



Tuberolachnus salignus* on *Salix alba



Tuberolachnus salignus



Eucallipterus tiliae* on *Tilia argentea



Eriosoma lanigerum* on *Pyracantha coccinea



***Eriosoma lanuginosum* on *Ulmus* sp.**



***Tetraneura ulmi* on *Ulmus* sp.**



Pemphigus bursarius* on *Populus nigra* var. *Italica



Pemphigus populi* na *Populus nigra* var. *Italica



Prociphilus fraxini* na *Fraxinus angustifolia



Prociphilus fraxinifolii* na *Fraxinus pensylvanica



Phloeomyzus passerinii



Phyllaphis fagi* on *Fagus sylvatica



Aphis farinosa on *Salix viminalis*



- ***Corythucha arcuata***

- The **oak lace bug** *Corythucha arcuata* (Say, 1832) (Hemiptera: Tingidae) is native to North America
- It was found for the **first time in Europe in northern Italy in spring 2000**
- Later, the bug was reported in southern Switzerland in 2002 and in north-western Turkey, the Asiatic part, in 2003
- After 2010, the species was detected in Iran in 2011, then in Hungary, Croatia and Serbia in 2013, Romania and Russia 2017





Measurement of gas exchange using the
Portable Systems PP Systems Ciras 3

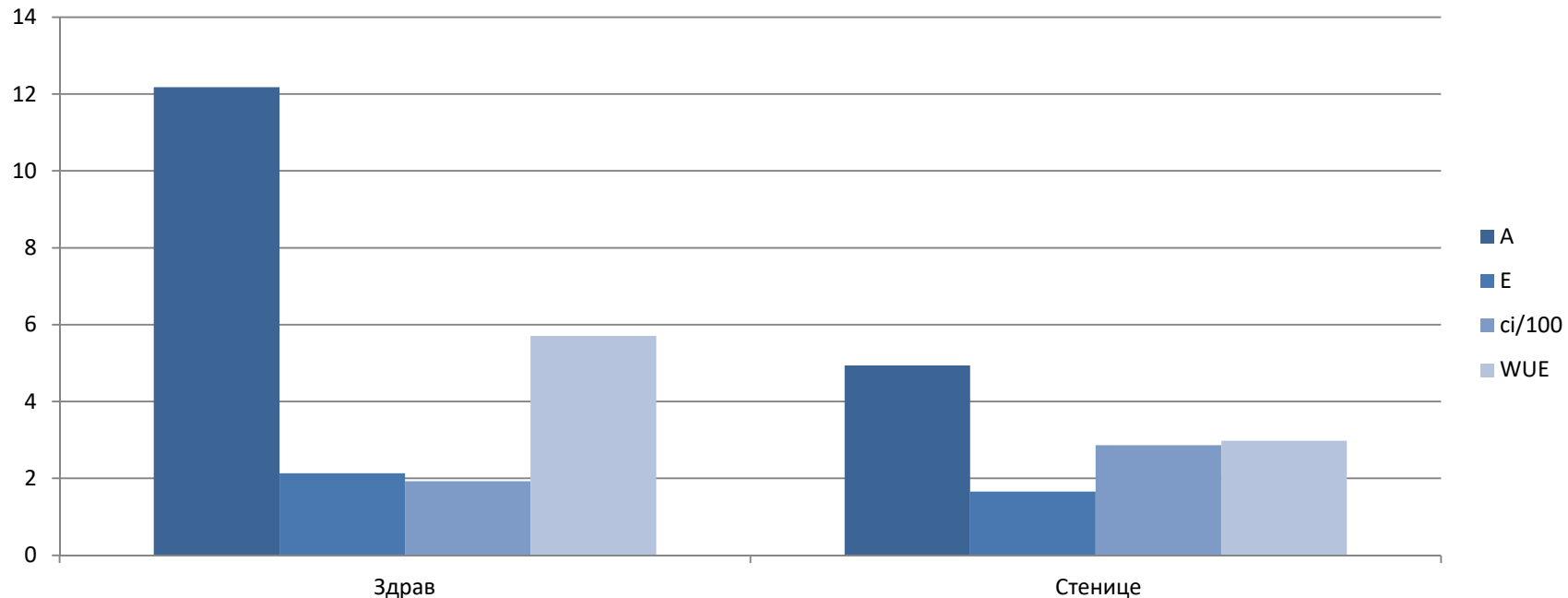


Leaves with different intensity of damage
(from left to right) 0%, 50% and 100%



Corythucha arcuata

Influence to some physiological parameters



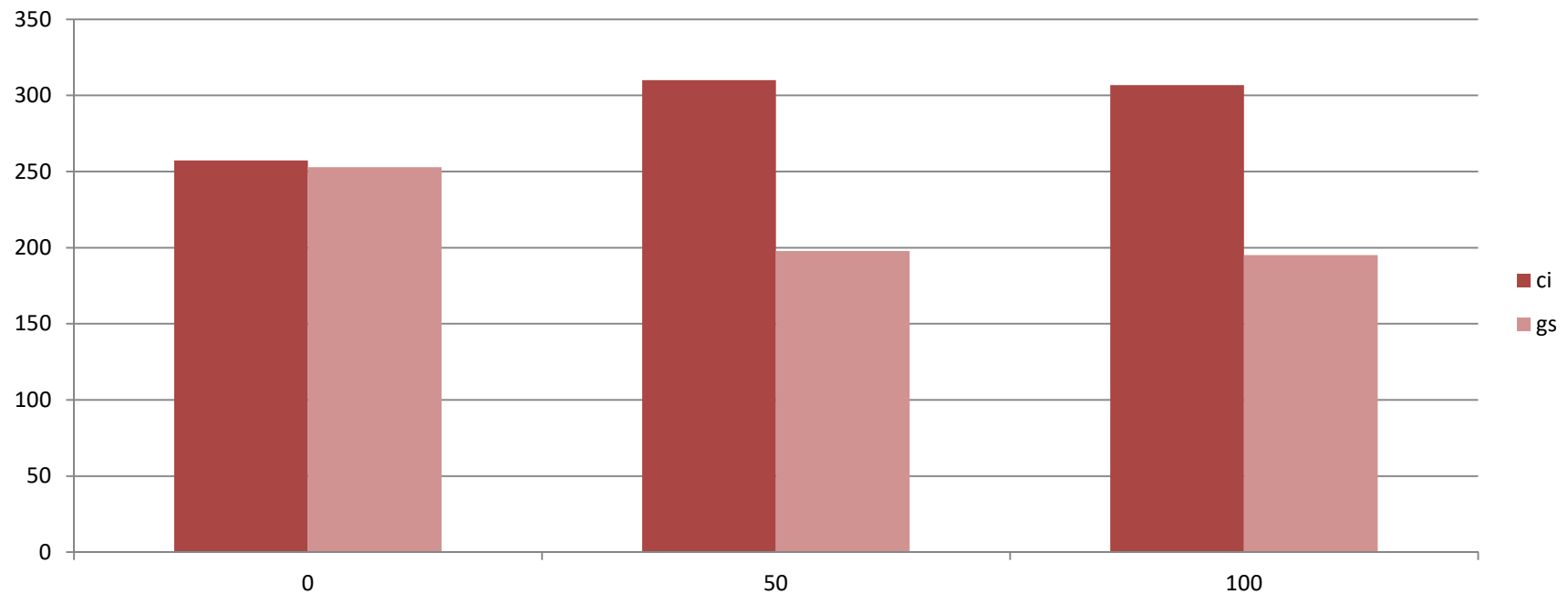
Influence of colonization of *C. arcuata* on gas exchange in oak leafs of English oak

(A – Photosynthesis $\mu\text{molCO}_2\text{m}^{-1}\text{s}^{-1}$;

E – Transpiration intensity $\text{mmolH}_2\text{O}\text{m}^{-1}\text{s}^{-1}$;

ci/100 – intercellular concentration $\text{CO}_2/100$ vpm;

WUE – water efficacy usage $\text{mmolCO}_2/\text{molH}_2\text{O}$)

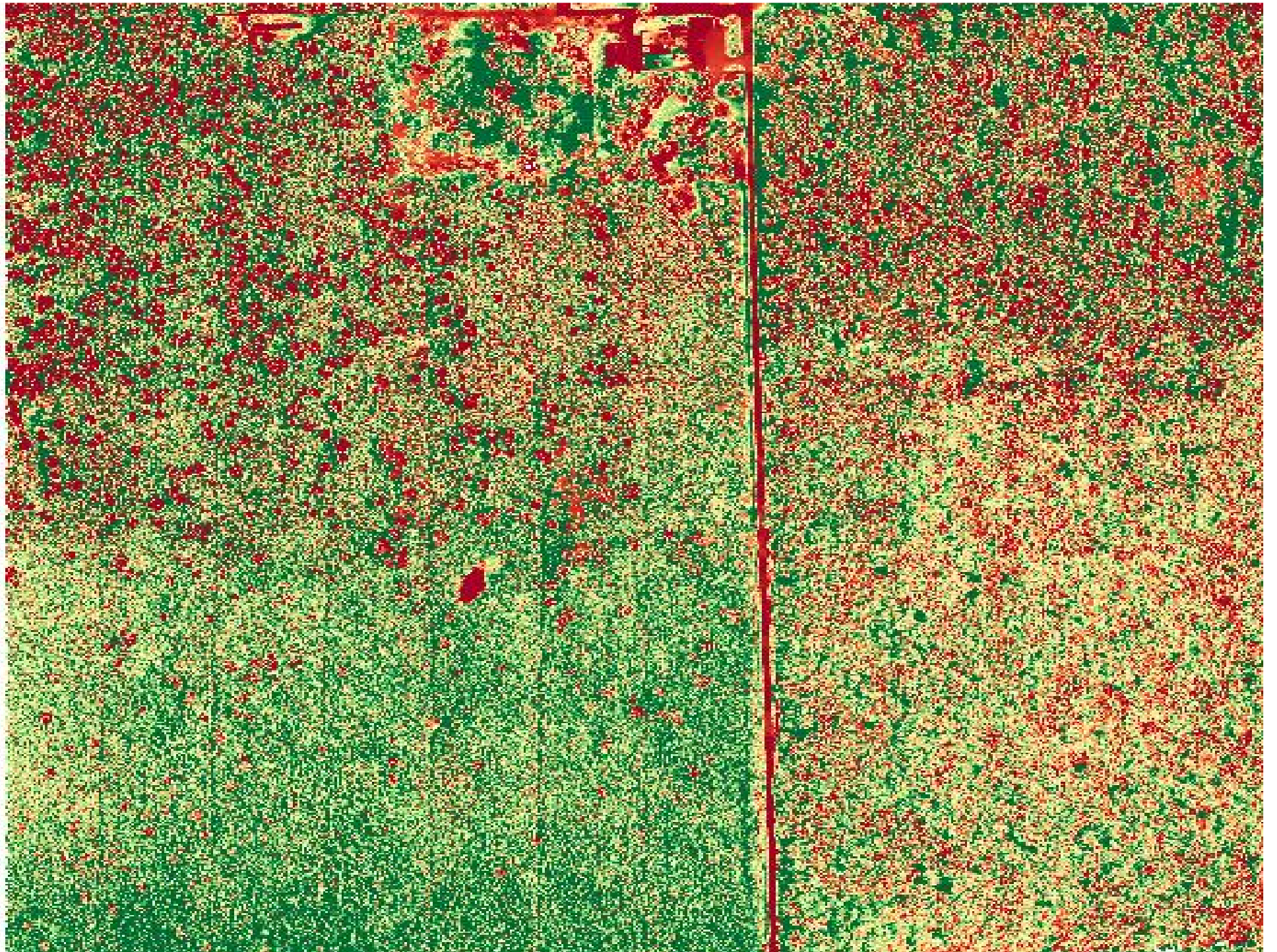


Influence of different intensity of *Corythucha arcuata* attacks on stomatal conductivity (gs) and intercellular concentration of carbon dioxide (ci) in oak leaves

Regarding the *C. arcuata* infestation, in the present study we investigated physiological responses of *Q. robur* plants, in order to estimate their responses to the insect attack

- According to results gas exchange parameters were considerably changed in infested plants
- Rates of photosynthesis and transpiration were lowered by 58.84 and 21.66%, respectively, with respect to uninfested plants.
- A 35.71% decrease of stomatal conductance was recorded in infested plants,
- intercellular CO₂ concentration was increased by 47.44%.
- Obtained results corroborate previous findings on photosynthetic activity in plants infested by mesophyll-feeding insects (Welter, 1989; Buntin et al. 1996; Haile and Higley, 2003).





- *Cydalima perspectalis*
- **Box tree moth** was detected for the first time in Belgrade, **Serbia in 2014**
- In the next several months, and years the pest rapidly spread across the country
- The tendency of spreading continued in the following years. Severely infested box trees were completely **dried out**, those that were still partially green had leaves that were markedly chewed and webbed by silk together with twigs
- **Damages** are usually **noticed late** because young **larvae are deeply hidden** among Box tree twigs and leaves. Mature larvae can completely **defoliate Box tree** and the tree can lose all the leaves within a short period.
- Box trees are **important horticultural plants** in Serbia, which makes *Cydalima perspectalis* a serious pest problem for urban areas, urban greenery and nursery production







• Future...

- New invasive pests, plant diseases and plants on Serbian border
- Further climate changes
- Higher and unpredictable costs of protection
- Globalization
- **What should we look for on our borders...**





Under quarantine surveillance

- **Analophora chinensis and Alanophora glabripennis**
- Came to Europe from Asia-China housed in crates and pallets
- Attack maples and other hardwoods
- Trees have been cut down in an attempt to eliminate further infestation
- Found in Austria, Croatia, Montenegro, Italy.....





Under quarantine surveillance



- ***Dryocosmus kuriphilus***
- Native in **northern China** and is widely distributed in Asia and the United States
- In Europe, it was first found in 2002 in Italy, in 2010 in Croatia, in Bosnia and Herzegovina in 2015
- Attacks European chestnut (*Castanea sativa*), *Castanea crenate*, *Castanea dentata* and *Castanea mollissima* as well as their hybrids





Under quarantine surveillance



- ***The Japanese beetle (Popillia japonica)***
- *Popillia japonica* Newman, 1838
- Native in Japan and Northern China
- Over 400 host plant species
- Problem in agriculture forestry and urban forestry



Thank you for your attention



Institute of Lowland Forestry and Environment
www.ilfe.org