



The role of changing climate in the invasion of exotic forest insects

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Outline



- Climate change and forests health in Hungary
- Temperature and insects
- Stressed trees and insects
- Range shifts



Hungary – a flat country



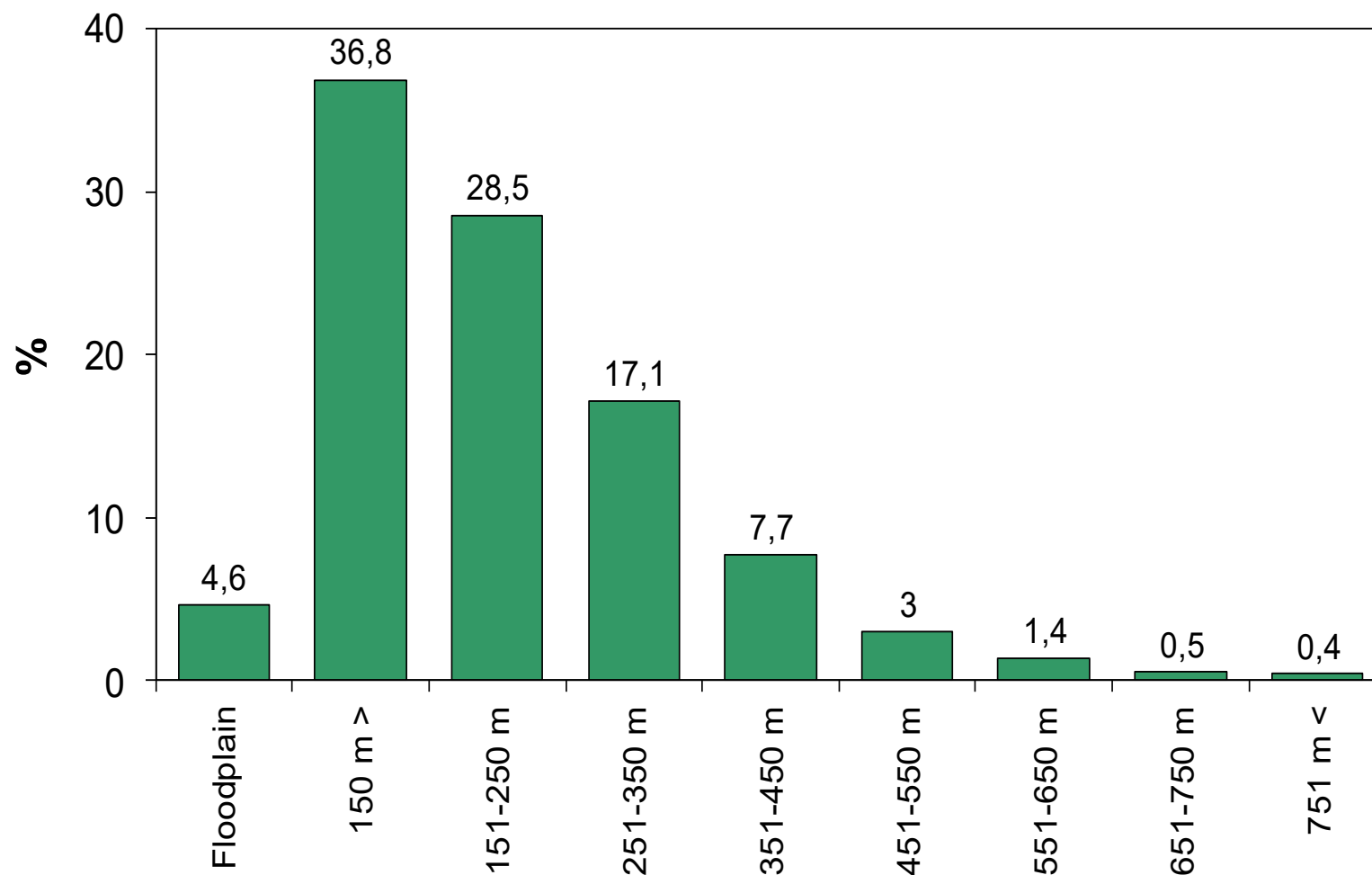
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Distribution of the Hungarian forests by ellevation categories



Forest steppe of Hungary “forests at the xeric limit” (Cs. Mátyás)



Forecasts needed for retreating forests

As tree habitats shift towards the poles in response to climate change, we must study the neglected, trailing edges of forests, warns **Csaba Mátyás** — they are economically and ecologically important.

Ecologists generally agree that trees and forests in the temperate zone will shift polewards in a warming world. Much research has been focused on the advancing edges of these ranges. Oddly, the retreating low-latitude and low-elevation limits of forests have been left largely unexplored until very recently. This is despite grim forecasts: the retreat threatens multiple ecological and socioeconomic services, and will require an active human response. Our understanding of how forests will behave at these trailing ends is surprisingly insufficient.

In the 1970s and 1980s, central Europe was hit by mass forest dieback. The damage affected many commercial species, wiping out about 15% of oaks in a decade. Losses were so serious that some countries kept their tree mortality data secret to avoid scaring importers. The culprit was thought to be acid rain, pests or disease.

Looking for alternatives to replace

and the dominant type of vegetation at various altitudes has changed — oak forests have turned to scrub lands, for example.

But these events have typically been treated as isolated, transient problems, rather than as a consequence of a larger, persistent cause. In some regions they are not even considered problematic in the short term,

threatened regions and insufficient ecological and genetic background data.

A workshop on xeric limits that I convened in May 2009 was unanimous that the issue has wide-ranging ecological and evolutionary consequences, and requires a transdisciplinary approach. Researchers should prioritize studies of how forest ecosystems respond to

extreme environmental stress, and of their mechanisms of persistence. More monitoring systems and test plots of dominant species need to be established in areas where they will be threatened by aridity. Long-term, ground-based or remote-sensing monitoring networks have to be adjusted to improve the observation of forests, especially in drought-threatened flat-lands. These data will be needed to improve models of xeric-limit shift and for adaptive resource management, land-use policy and nature conservation.

Tree populations that are close to xeric



C. MÁTYÁS



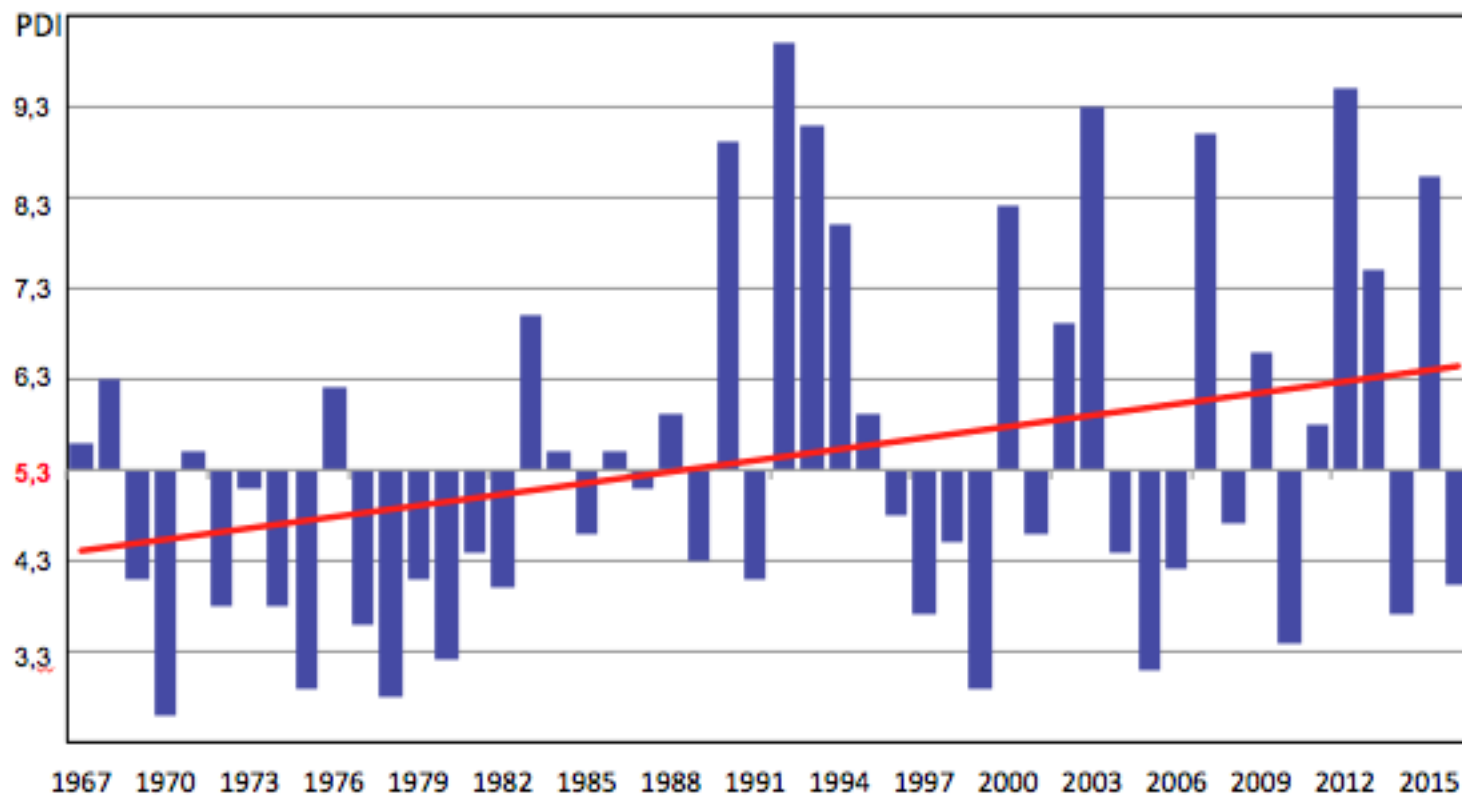
Observed change of climatic parameters



- Temperature
 - Change (absolute value)
 - More frequent extreme events
 - Interruption of the winter diapause
 - Heat waves
- Precipitation
 - Change (absolute value)
 - More frequent extreme events
 - Heavy precipitation
 - Storm, windfall, ice and snow damage
 - Flood
 - Drought (longer period)

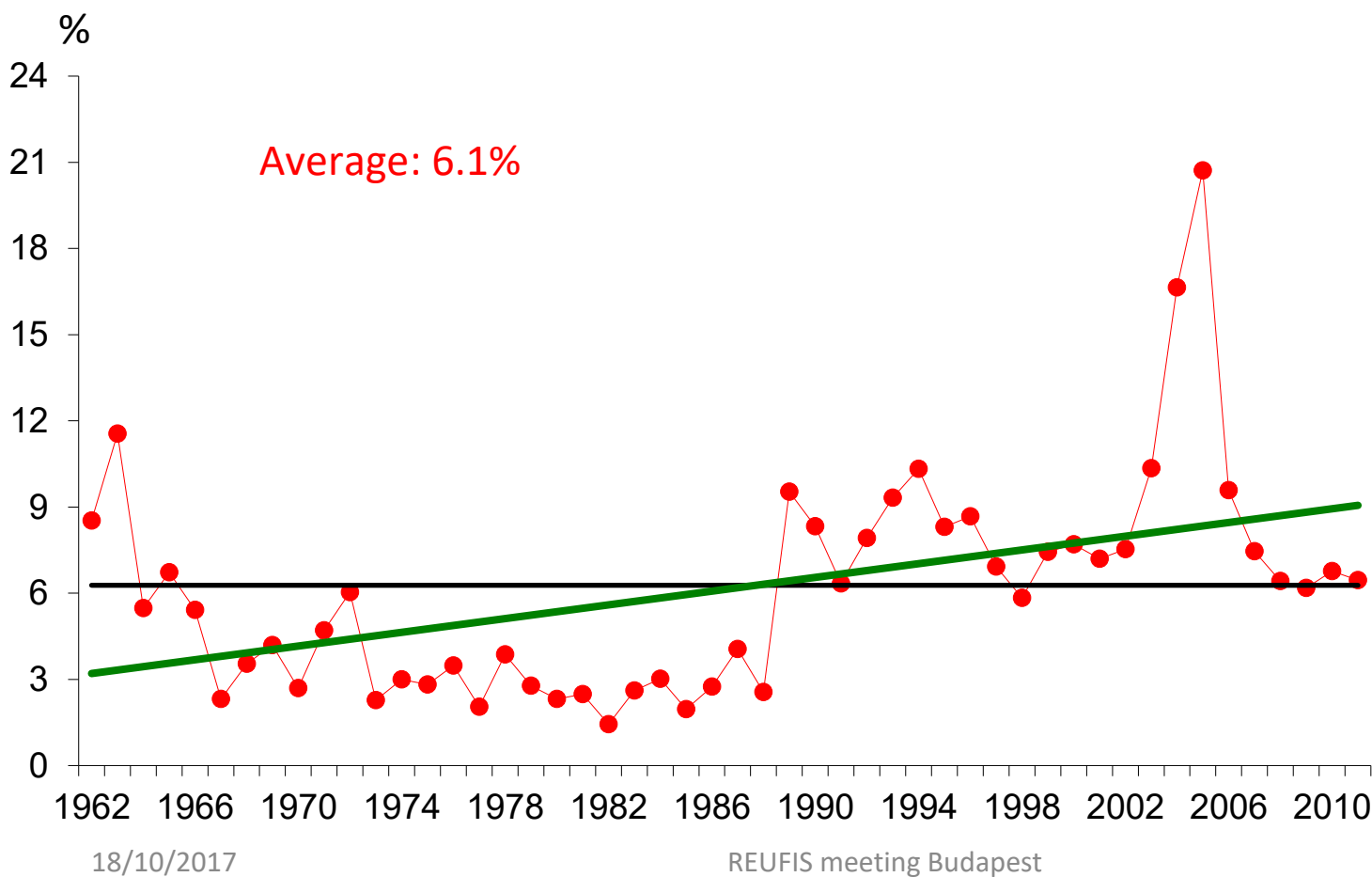


Yearly deviations of the Pálfai-Drought-Index from the 50 years (1967-2016)



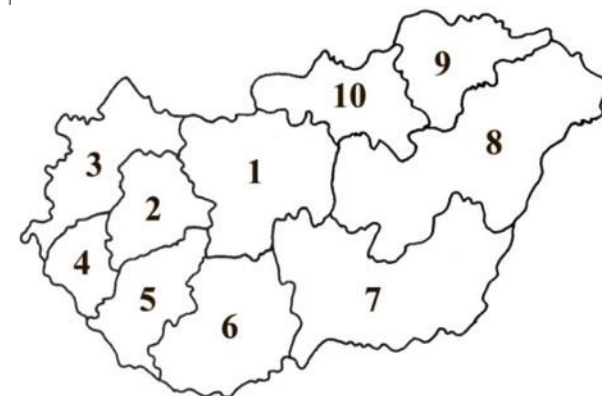
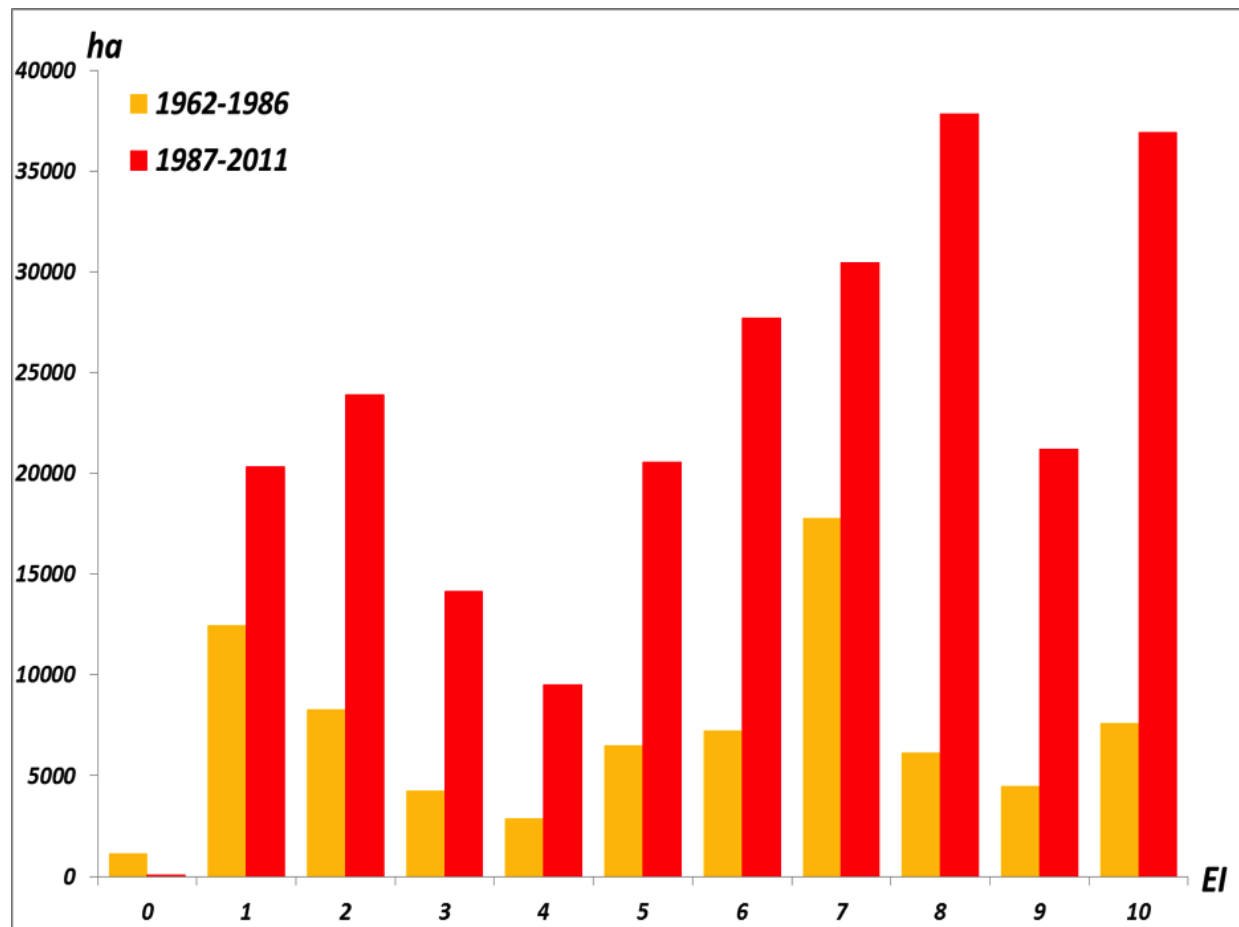


Total forest damage (Hungary)



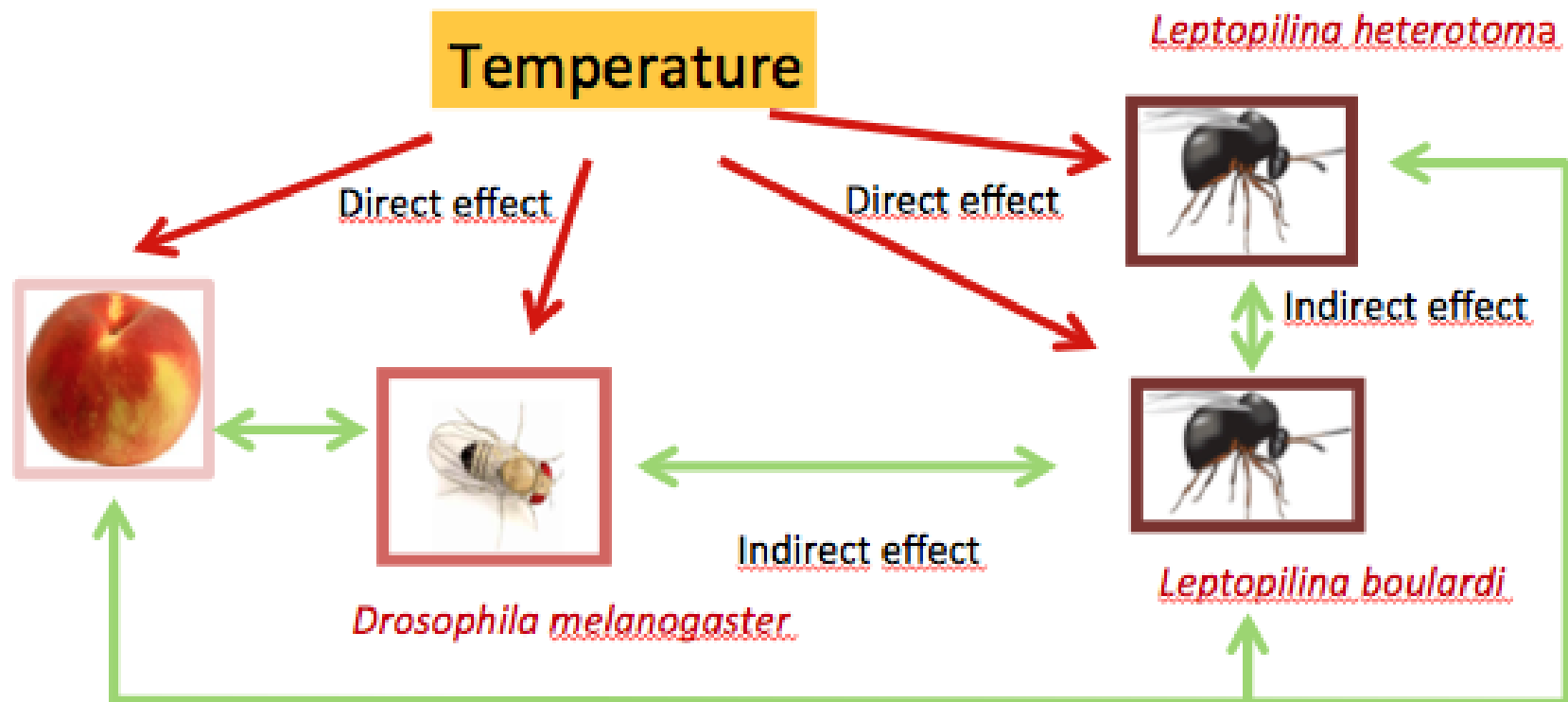


Drought damage in forests in the last 50 years





Effect of temperature to insects





Effect of temperature on insect development



Development of box tree moth (*Cydalima perspectalis*)

19 ± 1 °C

35-36 days



25 ± 1 °C

33-35 days

22-23 days



8-9 days





Stressed trees: reduced resistance



- Bark beetles



- Scale insects





Direct climate change effects on insects



- Increasing number of generation:
 - Longer vegetation period
 - Quicker insect development
- Examples (already approved):
 - Herbivorous caterpillars (*Quercus* spp.)
 - Jewel beetles (1y development instead of 2, *Pinus sylvestris*, *Fagus sylvatica*)
 - Woodwasps (2 generations instead of 1/y) (*Pinus* spp.)
 - Bark beetles (more generations) (*Picea*, *Pinus*)

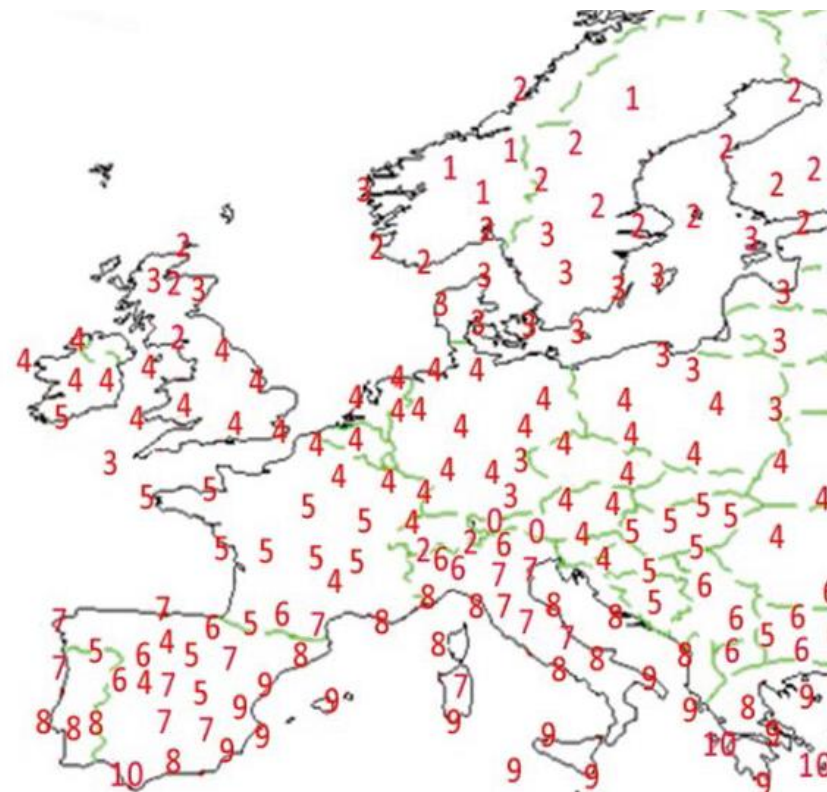


Number of generations – *Ips typographus*



Current climate parameters

The impact of a 3°C increase in
mean temperature



Simulation of the development of spruce bark beetle (*Ips typographus*)

(1,2,3... n – number of produced generations per year)

(Modified from <http://www.finessi.info/ISTO/index.php?prjpage=99>)



Northward shift of distribution areas



Decreasing distribution for Hungary

Pine sawflies
Diprion pini

Oak leaf miner (*Tischeria sp.*)



Neodiprion sertifer





Northward shift of distribution areas



Decreasing distribution for Hungary

Pine beauty moth
(*Panolis flammea*)



Nun moth
(*Lymantria monacha*)



Pine-tree Lappet
(*Dendrolimus pini*)





Northward shift of distribution areas



Increasing distribution for Hungary

Cotton bollworm
(*Helicoverpa armigera*)



Pine processionary moth
(*Thaumetopoea pityocampa*)





Northward shift of distribution areas



Increasing damaged area for Hungary

- Brow tail moth (*Euproctis chrysorrhoea*)
- Tortrix moths (*Tortrix viridana*, *Archips xylosteana*, etc.)
- Acorn and nut weevils (*Curculio* spp.)
- Bark beetles (*Ips* & *Tomicus* spp.)





Change in behavior/biology



- ‘New’ (native) pests : until the last decades these species didn’t cause any serious damage.

Leaf beetle
(*Chrysomela cuprea*)



Juwel beetle
(*Coraebus florentinus*)

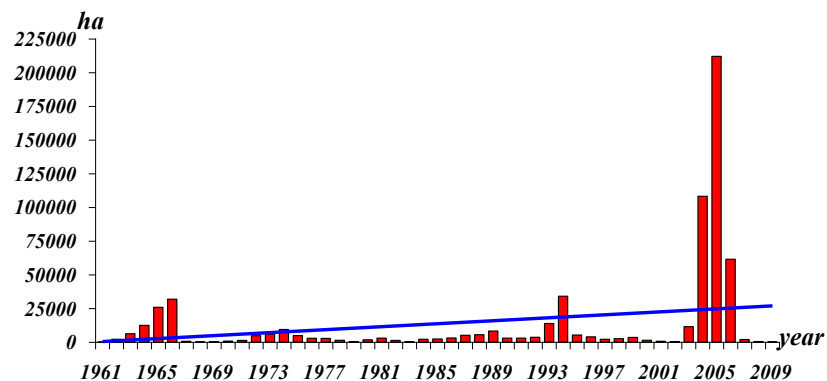




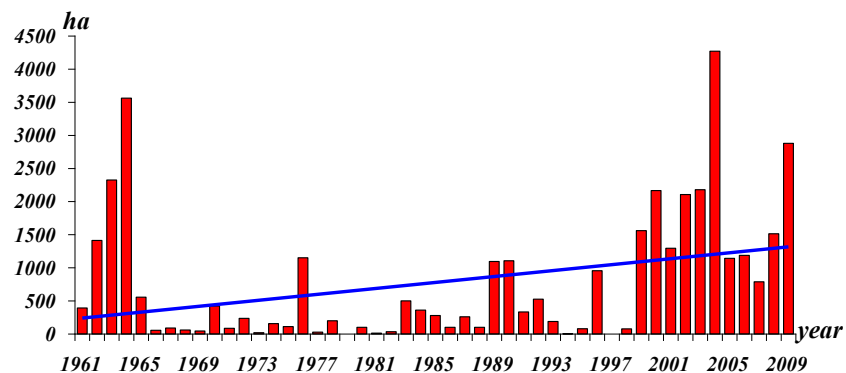
Increasing insect damage



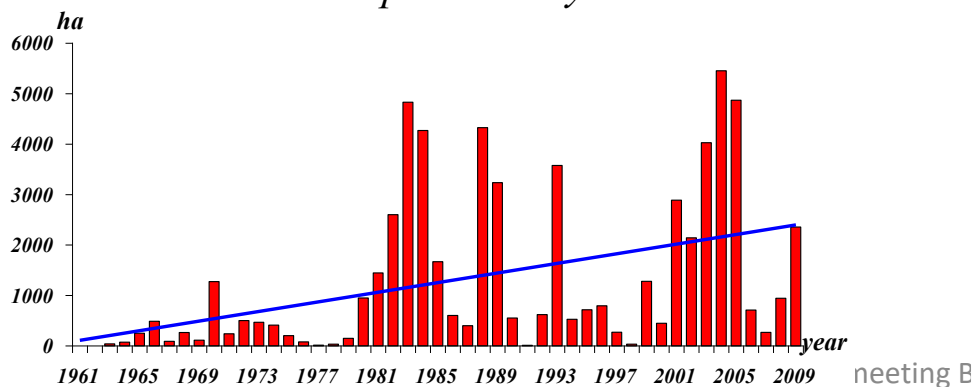
Lymantria dispar



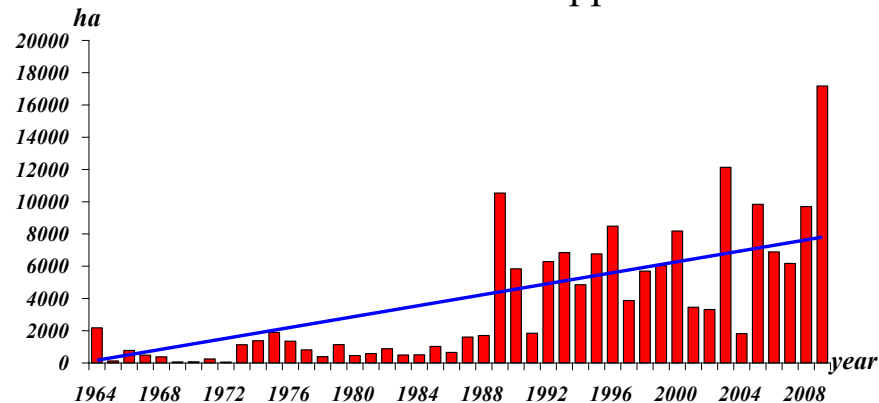
Thaumetopoea processionea



Euproctis chrysorrhoea

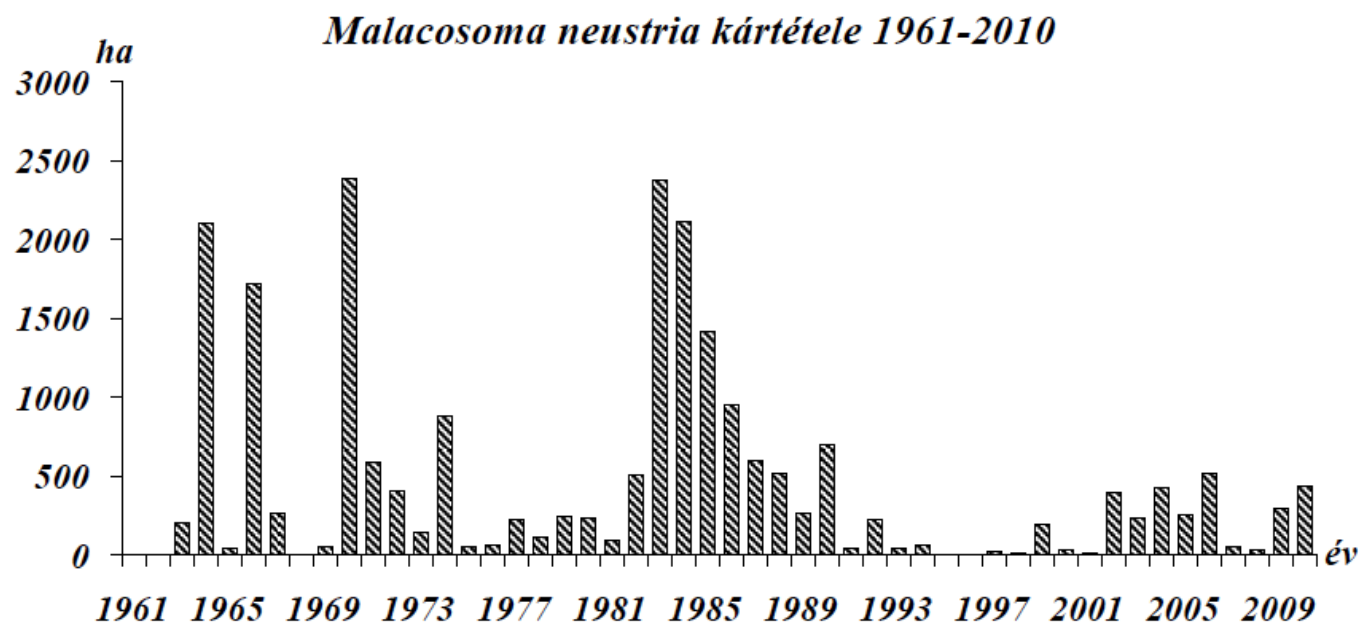


Curculio spp.





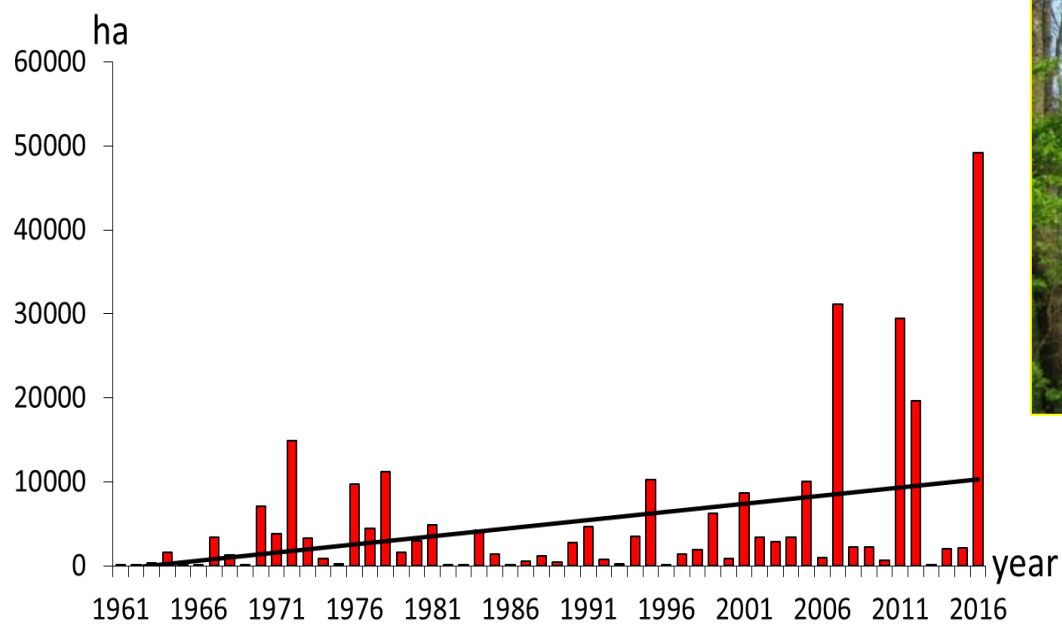
Decreasing insect damage



*Reported damage (in hectares) caused by lackey moth (*Malacosoma neustria*) between 1961 and 2010*



Frost damage 1961-2016

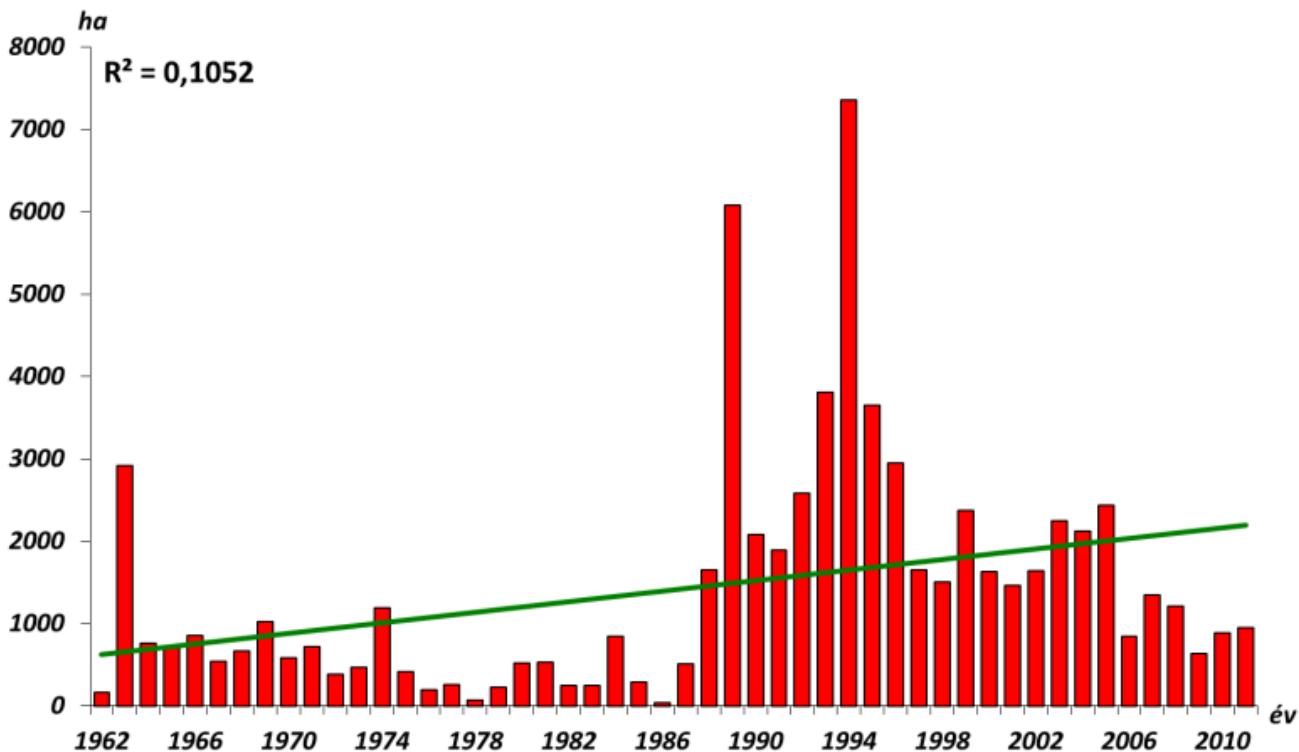




European spruce bark beetle
(*Ips typographus*)

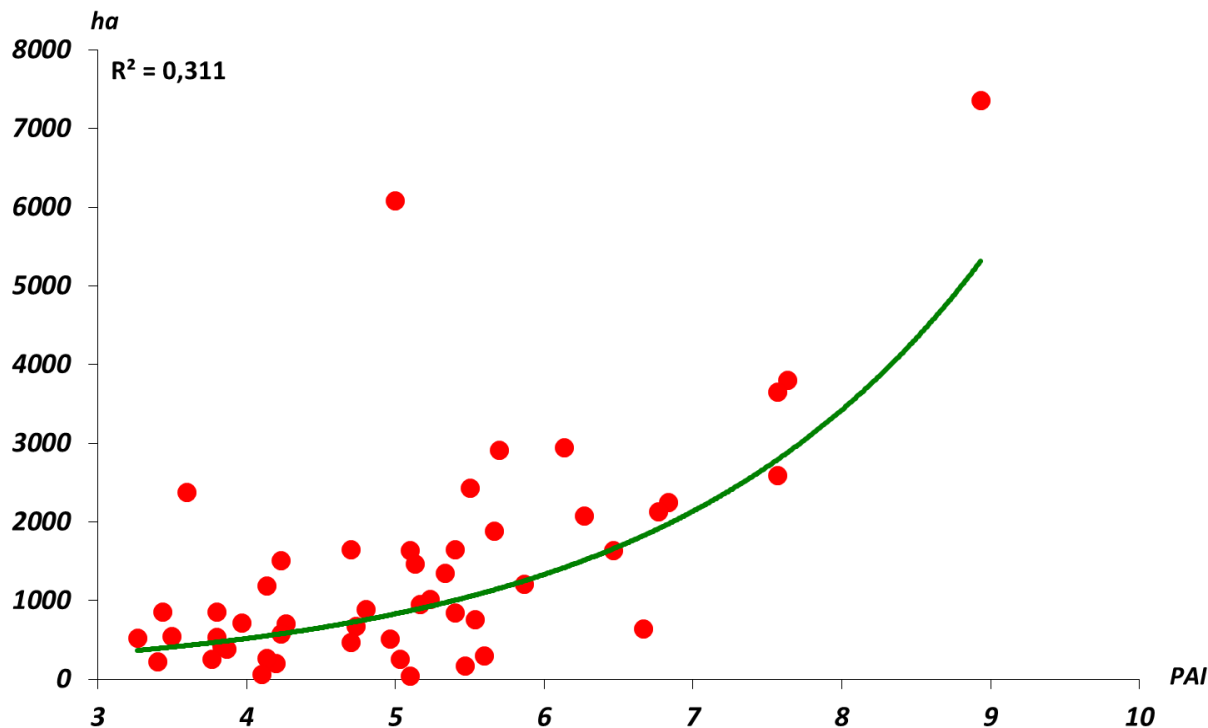


Bark beetle damages





Bark beetle damages



Yearly values of the Pálfi-Drought-Index and the bark beetle damage between 1962 and 2011





Yearly sanitary fellingings and PDI values



Sanitary fellinging (m³)

PDI

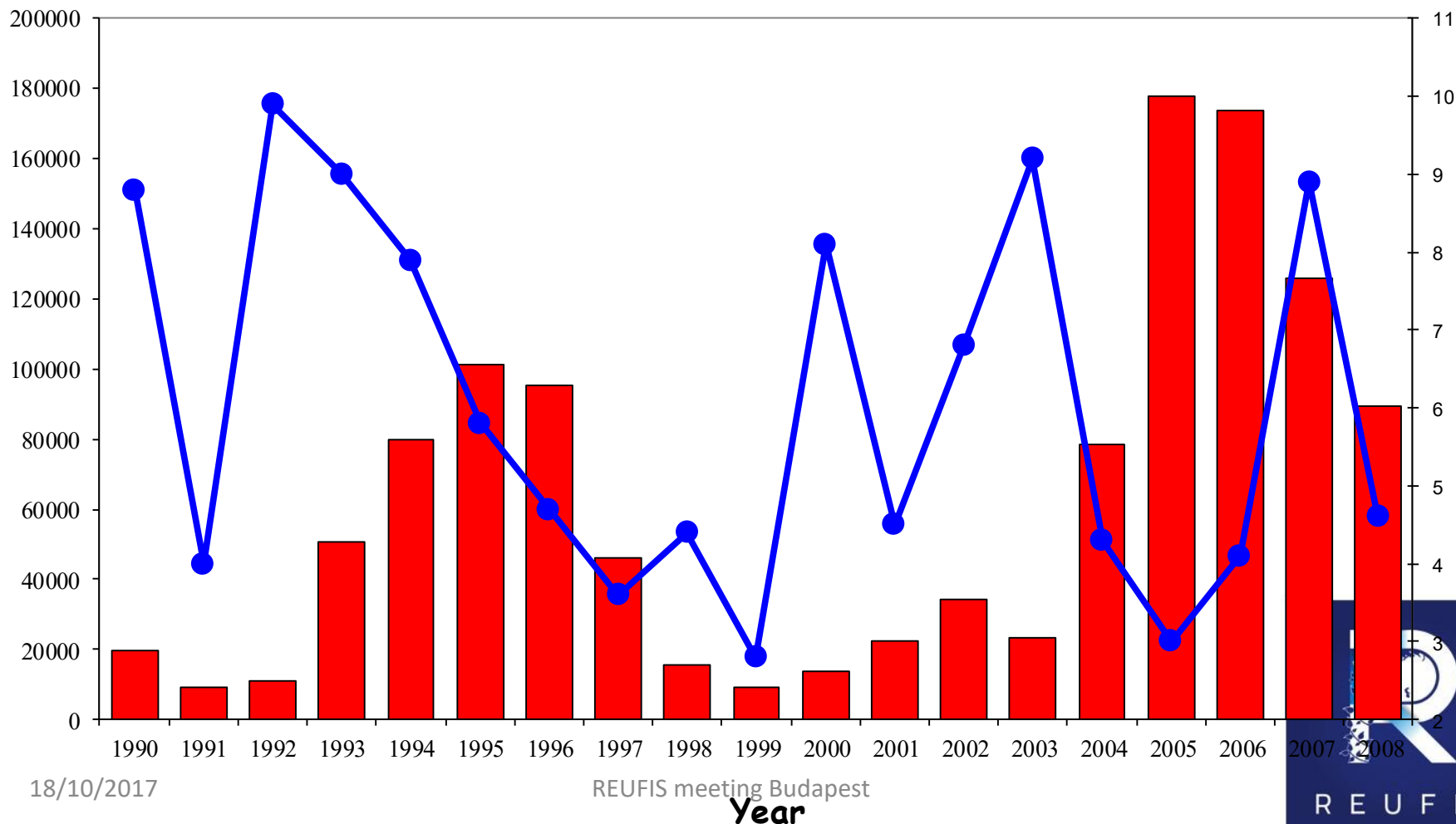


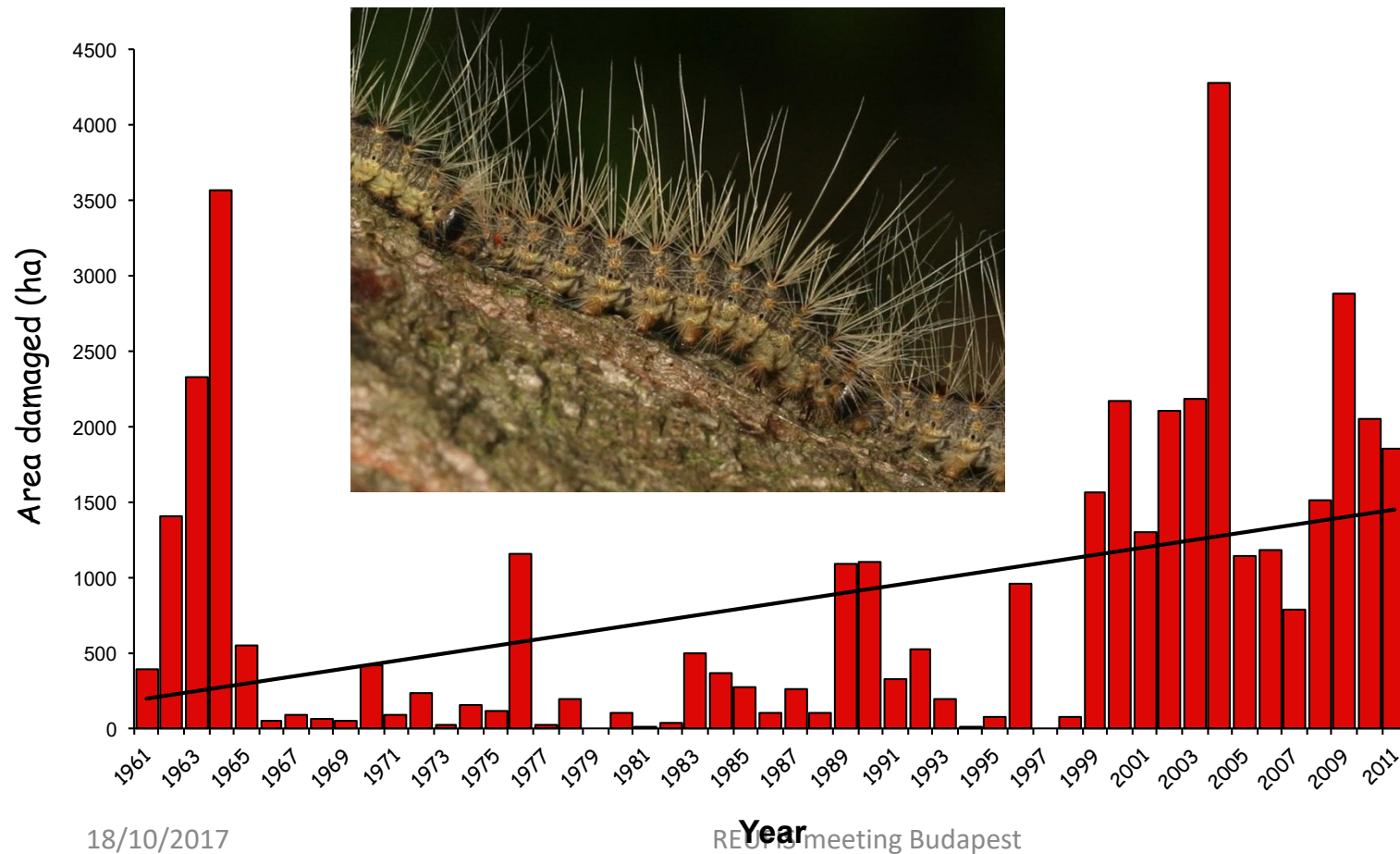




Foto: Milan Zubrik



Oak processionary moth



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Latest example



- Oak lace bug – *Corythuca arcuata* (Say, 1832)
- Origin: North America (from Alabama to Maine)
- Native hosts: *Quercus* (white oaks), rarely *Acer*, *Castanea*, *Rosa*, *Malus*, *Pyrus* and *Tilia*



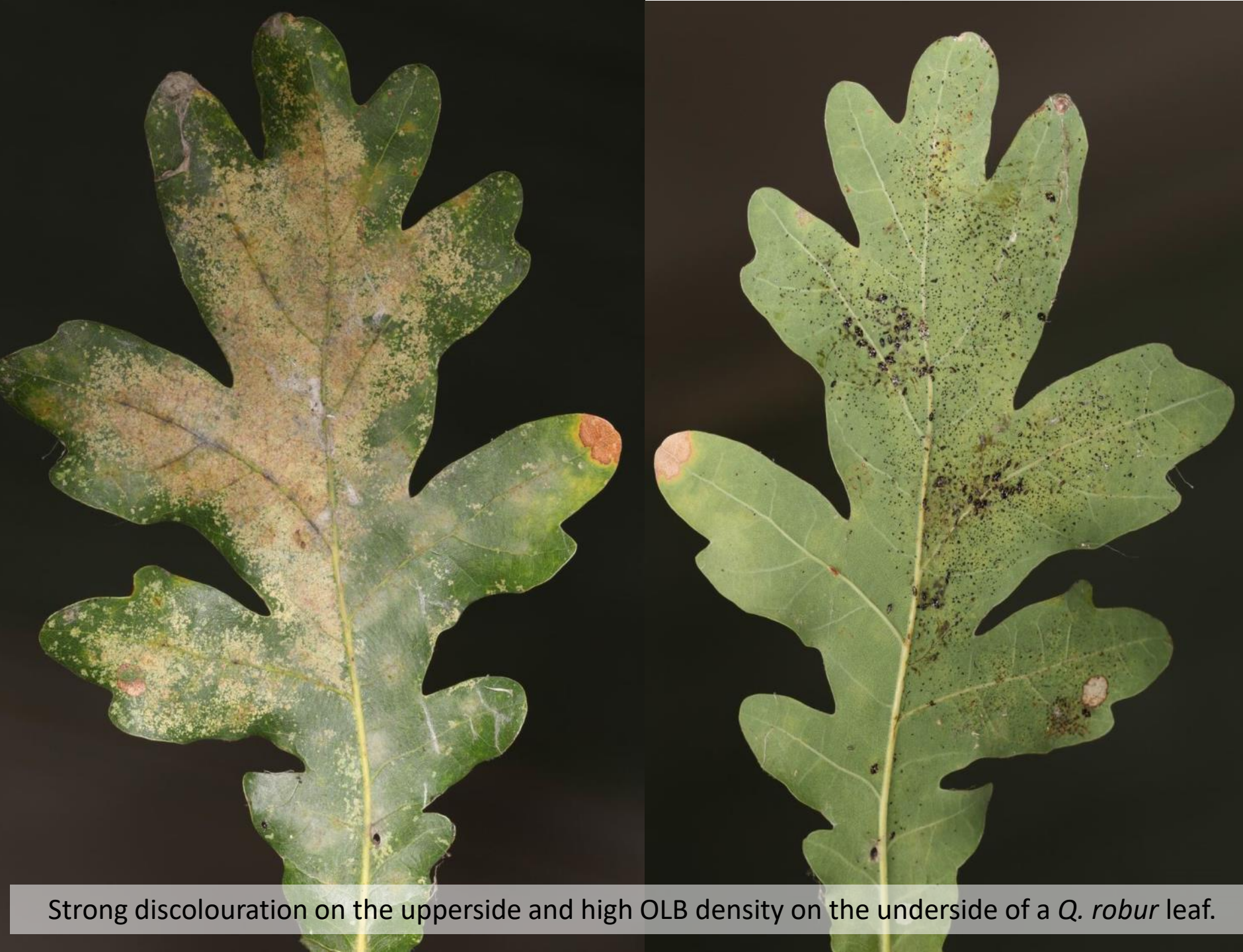


Known European country records of OLB until 2017.



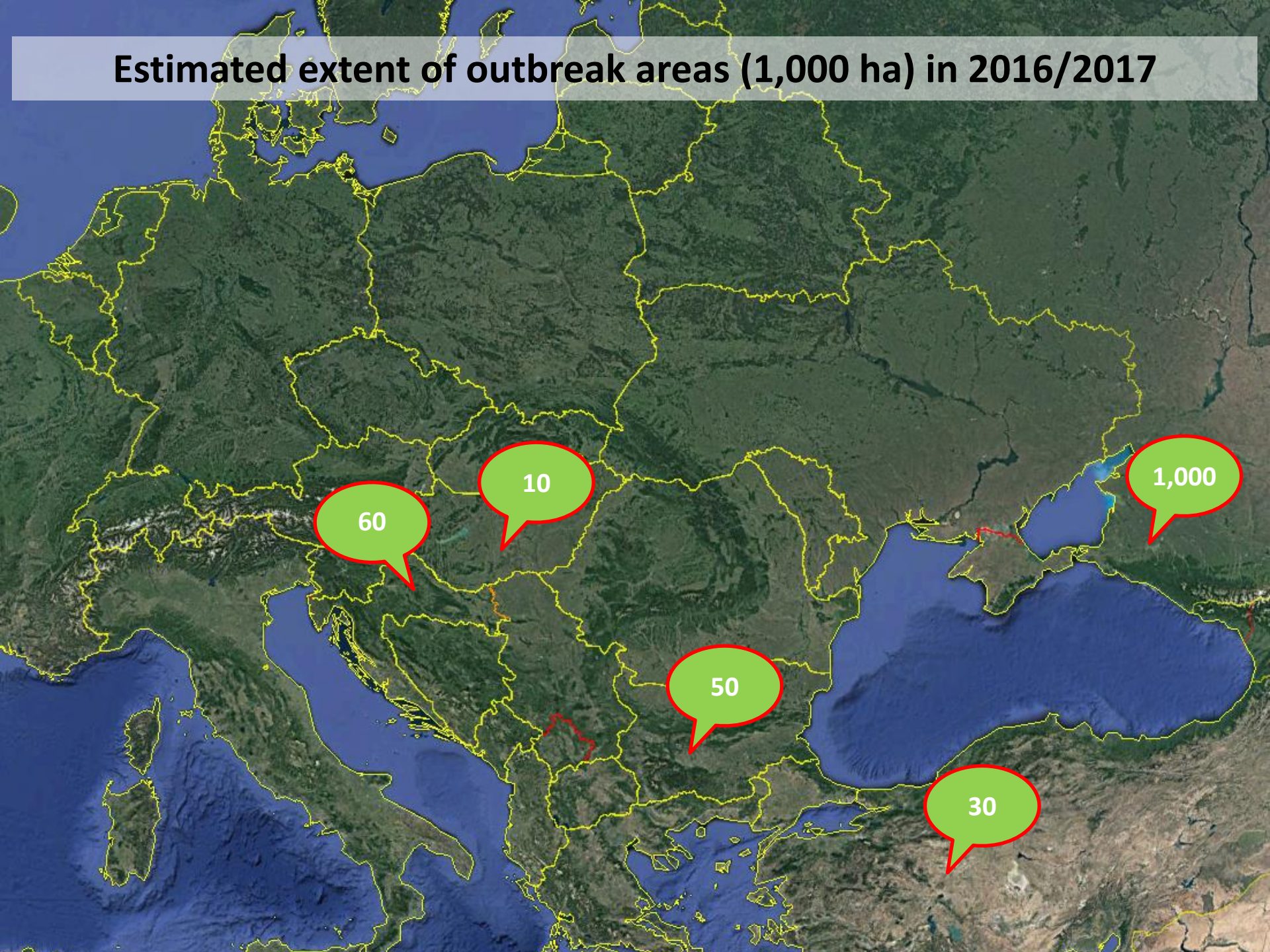


Strong discolouration on *Quercus libani* leaves (mid July).



Strong discolouration on the upperside and high OLB density on the underside of a *Q. robur* leaf.

Estimated extent of outbreak areas (1,000 ha) in 2016/2017







Large scale infestation of OLB in Croatia. The discolouration is evident in the oak stands.

Country	<i>Q. alba</i>	<i>Q. cerris</i>	<i>Q. frainetto</i>	<i>Q. hartwissiana</i>	<i>Q. ilex</i>	<i>Q. imbricaria</i>	<i>Q. libani</i>	<i>Q. macranthera</i>	<i>Q. macrocarpa</i>	<i>Q. pedunculiflora</i>	<i>Q. petraea</i>	<i>Q. pontica</i>	<i>Q. pubescens</i>	<i>Q. robur</i>	<i>Q. virgiliana</i>
Bosnia-Herzegovina											***				
Bulgaria		***	***	***						***	***		***	***	
Croatia		*	*		*						*		*	***	
Greece															
Hungary	*	***	**			*	***	**	*		**	**	**	***	
Italy	**	**	**								**		**	***	
Macedonia															
Romania		***	**							**	**			**	
Russia														***	
Serbia		***									***			***	
Slovenia														*	
Switzerland											*				
Turkey											***		***	***	***

OLB's *Quercus* hosts recorded in Europe



Native in the country

Eurasian oak, but not native

North-American „white” oak

North-American „red” oak

* Symptoms are rare and not abundant

** Symptoms common, sometimes abundant

*** Symptoms are very common and often very abundant

Country	<i>Q. cerris</i>	<i>Q. ilex</i>	<i>Q. petraea</i>	<i>Q. pubescens</i>	<i>Q. pyrenaica</i>	<i>Q. robur</i>	<i>Q. suber</i>	Other oaks	Total (th ha)
Austria	7		39	1		25		3	75
Albania									0
Bosnia-Herzegovina			300						300
Bulgaria									1,051
Croatia		29	153	294		570		121	1,167
France		700	1,651	1,390		1,990	94		5,825
Germany									1,130
Greece									1,430
Hungary	212		138	19		110		14	493
Italy									0
Macedonia									0
Poland									690
Portugal		331					737	67	1,135
Romania									1,130
Russia									3,000
Serbia	345		173	10		33			561
Slovakia	48		180			25			233
Slovenia									0
Spain					2,891	1,609		2,000*	6,500
Turkey									6,476
Ukraine						2,400			2,400
United Kingdom									219
Total:									33,315

Extent of oak forests in European countries

Albania: Ejup Cota 🌸 Austria: Gernot Hoch 🌸 Bosnia-Herzegovina: Mirza Dautbašić 🌸 Bulgaria: Georgi Georgiev 🌸 France: Rémy Petit 🌸 Germany: Björn Hoppe 🌸 Greece: Dimitrios Avtzis 🌸 Italy: Iris Bernardinelli 🌸 Poland: Jacek Hilszczański 🌸 Portugal: Manuela Branco 🌸 Romania: Constantin Ciornei 🌸 Spain: Jose Luis Nieves-Aldrey 🌸 Switzerland: Beat Forster 🌸 Ukraine: Valentina Meshkova

Non-*Quercus* hosts recorded

Occasional symptoms

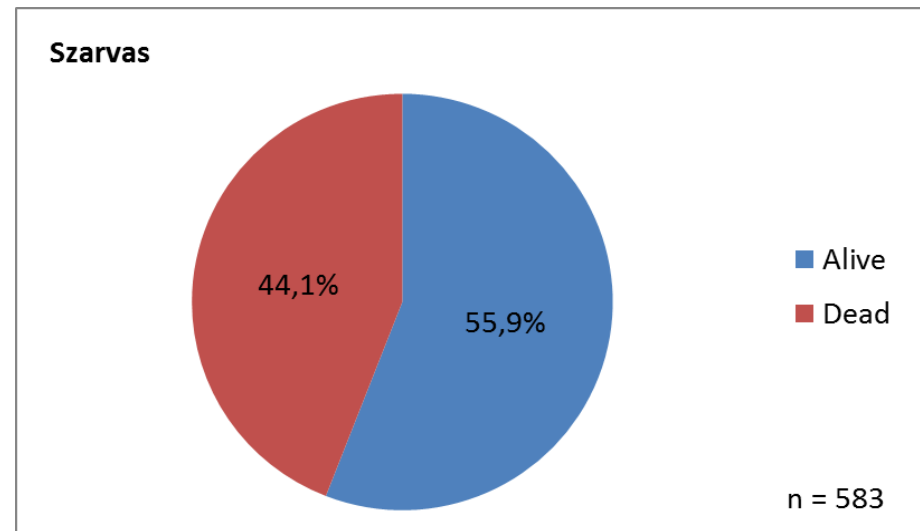
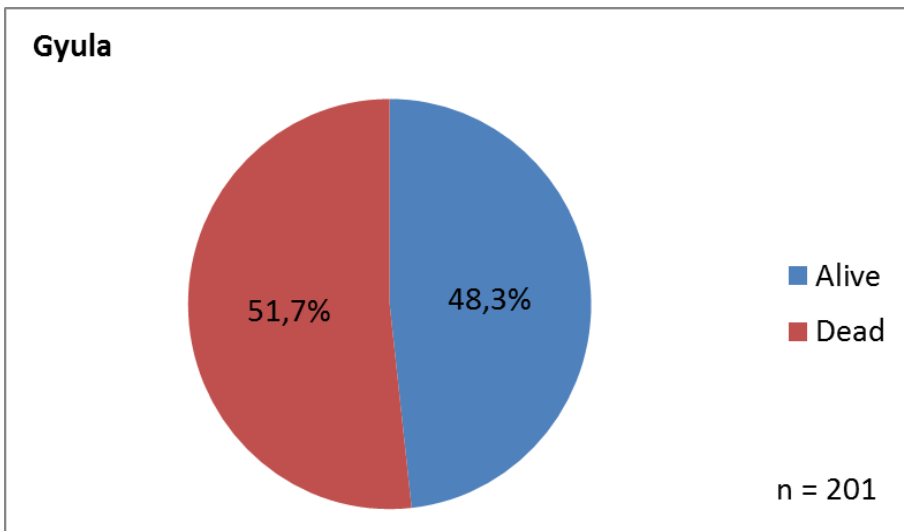
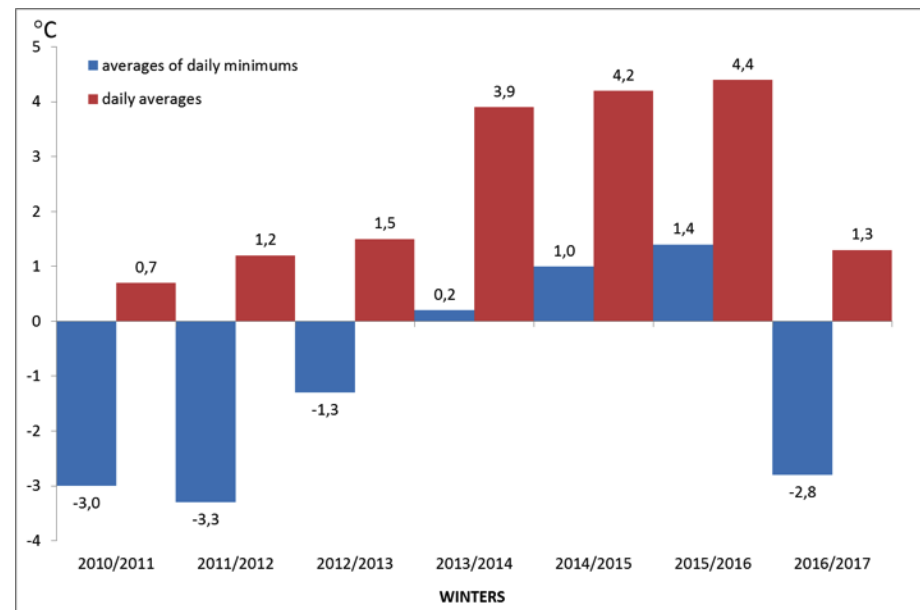
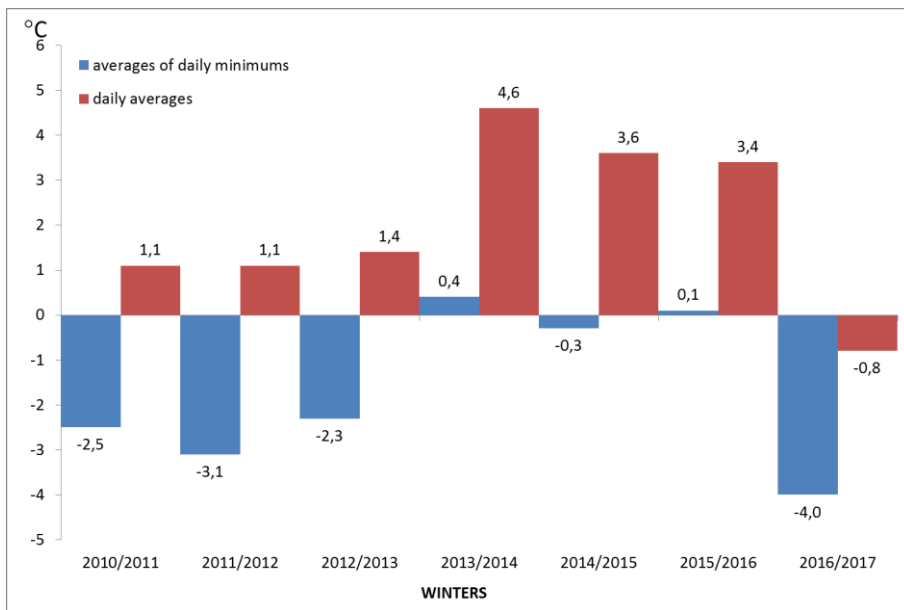
Acer campestre
Carpinus betulus
Corylus avellana
Corylus colurna
Cotinus coggygria
Fagus sylvatica
Keria japonica
Koelreuteria paniculata
Lysimachia punctata
Prunus serratula
Prunus spinosa
Robinia pseudoacacia
Rosa canina
Sorbus aria
Sorbus torminalis
Ulmus glabra
Ulmus minor

Frequent and/or mass symptoms

Castanea sativa
Prunus serotina
Rubus caesius
Tilia cordata
Tilia platyphyllos



OLB adults overwintering under the bark of a dead tree.



Overwintering mortality (winter 2016/2017) at two locations at SE Hungary

What we already know:

- ▶ OLB showed a rapid spread and outbreaks in the last 5 years in many SE European countries. Both accelerated spread and population increase were likely helped by the mild winters and the dry and hot summers.
- ▶ It may have up to three generations per year in SE Europe.
- ▶ The relatively cold winter of 2016/2017 did not cause high overwintering mortality.
- ▶ All major Eurasian oaks (both in section Cerris and section Quercus) seem prime hosts. So at least 30 million hectares of oak forests provide suitable hosts for OLB.
- ▶ Spreads as typical „hitchhiker“, first appears along main roads and cities.
- ▶ No way to stop the spread.
- ▶ The climate change may help the further area expansion and the establishment.
- ▶ Severe attack may cause mass discolouration of leaves by early July.
- ▶ No natural enemies seem to have considerable regulation potential in the invaded area in this phase.

What we still do not know (although we should really know):

- ▶ Are the Italian and Turkish introductions independent?
- ▶ Will the climate restrict the further spread to North and West?
- ▶ Will the damage become as „chronic” as damage by *C. ciliata* on *Platanus*?
- ▶ Will *C. arcuata* and *C. ciliata* hybridize?
- ▶ Direct and indirect Impacts of long term damage on tree growth and health?
- ▶ Impact on seedlings and young stands?
- ▶ Impact on the acorn crop?
- ▶ Can *C. arcuata* act as vector of some oak pathogen?
- ▶ How much and how serious damage should be expected?
- ▶ Long term impact within the oak herbivore communities?
- ▶ What should be done in order to decrease the potential negative effects?



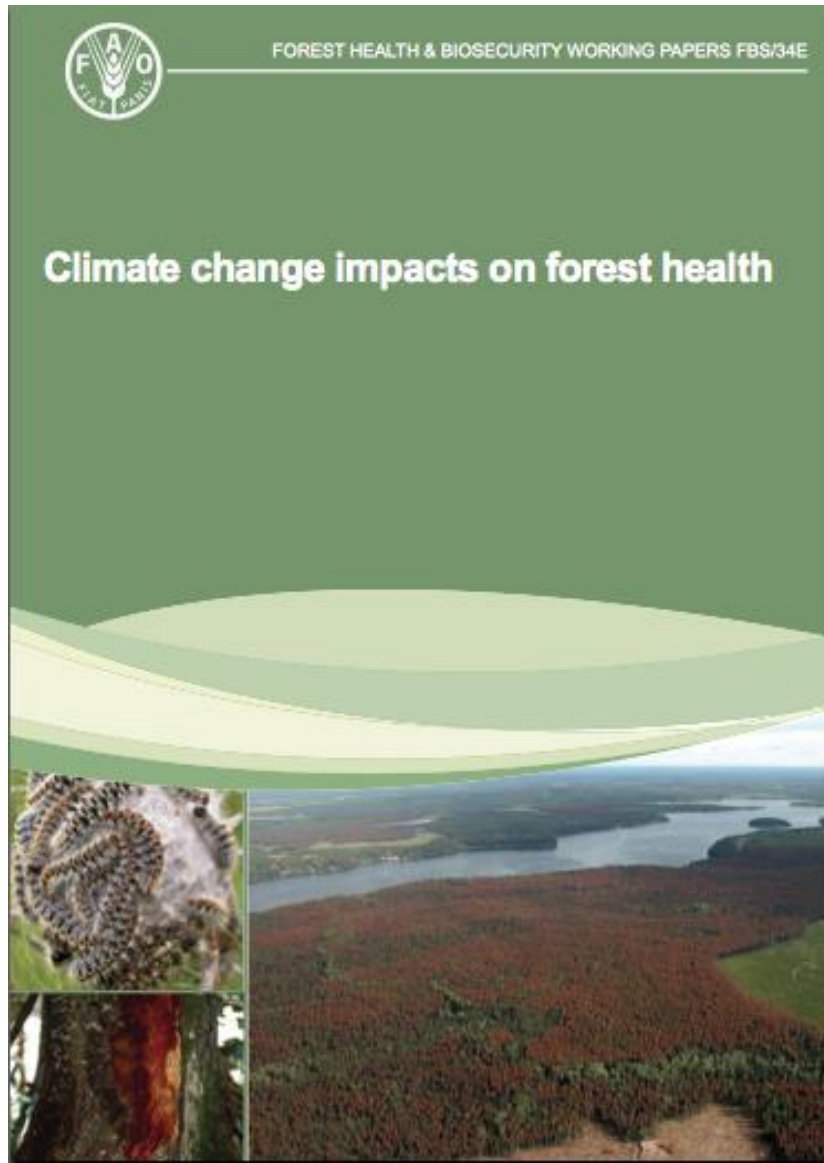
Trees can not run
away...





Thank you very much for your
attention!!!

Available further readings



Forestry Department
Food and Agriculture Organization of the United Nations

Forest Health and Biosecurity Working Papers

Climate change impacts on forest health

Beverly Moore & Gillian Allard

November 2008

Forest Resources Development Service
Forest Management Division
Forestry Department

Working Paper FBS/34E
FAO, Rome, Italy

„Elmászik” a klíma?

Bükk természetes migráció	20-30 km/100 év
Tölgy természetes migráció	8-50 km/100 év
Izoterma eltolódás (1,8 C°)	260 km/100 év
Izoterma eltolódás (3,3 C°)	480 km/100 év





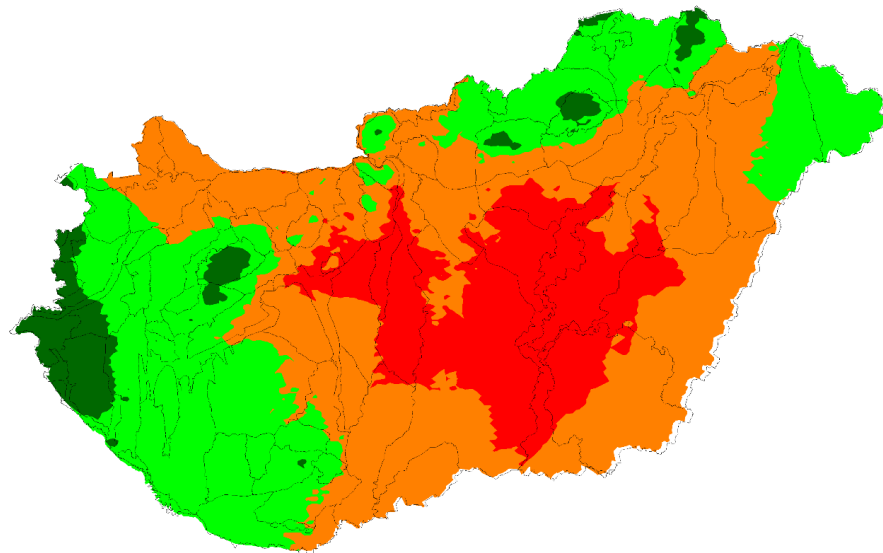
+1,8C°



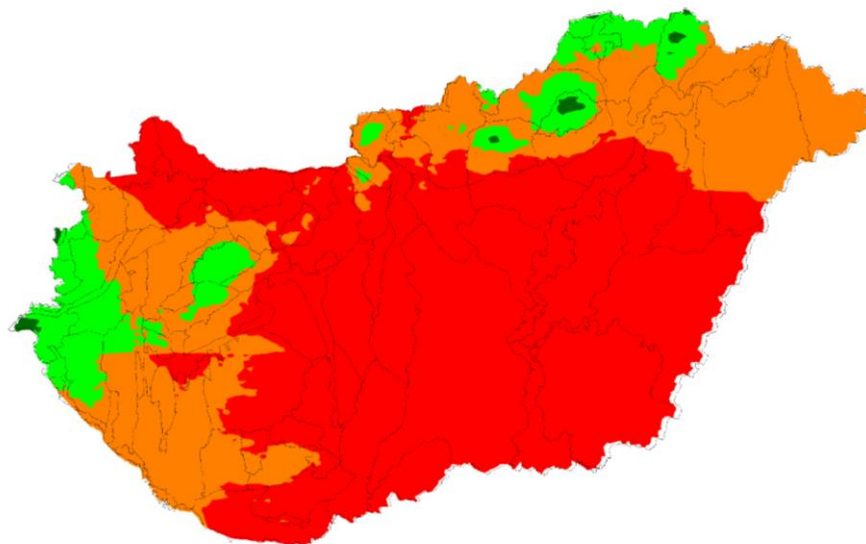
+3,3C°

1961–1990

- bükkös klíma
- gyertyános-tölgyes klíma
- kocsánytalan tölgyes, ill. cseres klíma
- erdőssztyepp klíma



2036–2065



Forrás: Führer Ernő

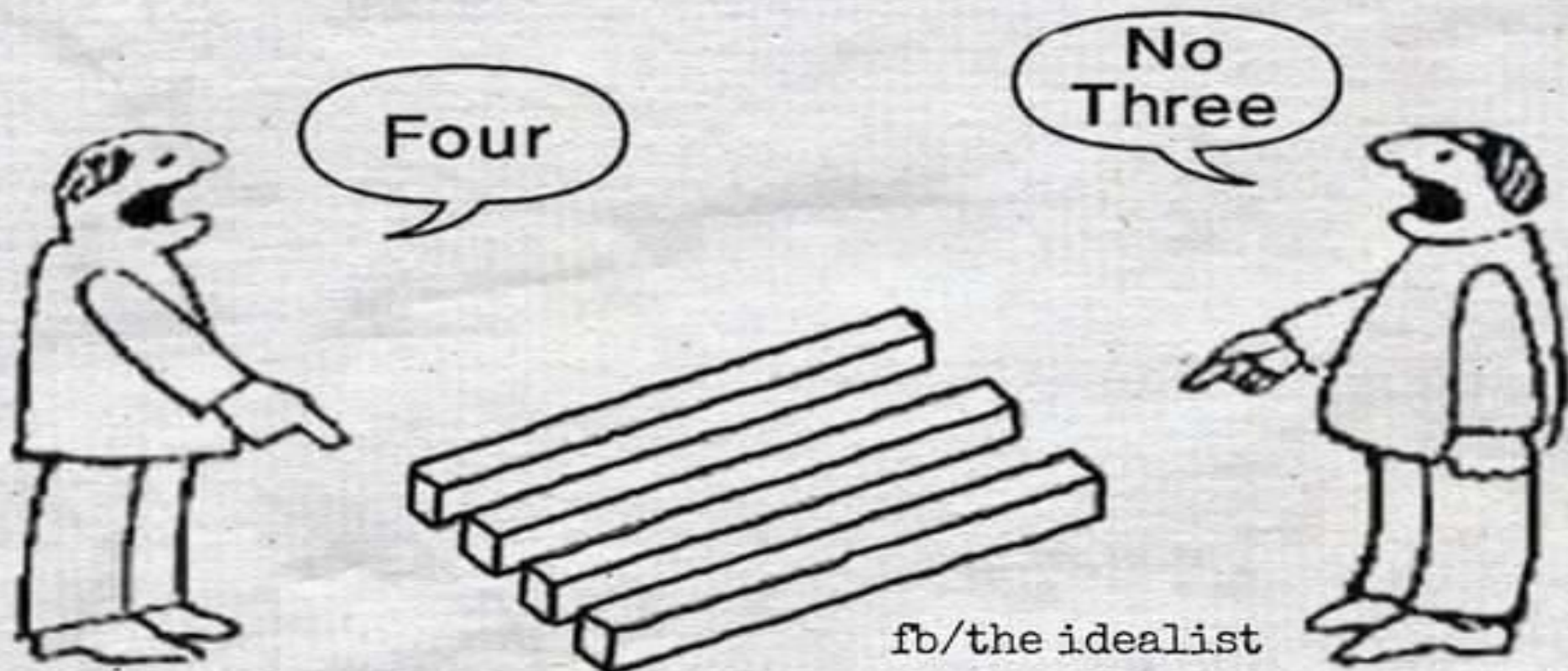
A klímaosztályok területének várható változása az 1961–1990.
bázisidőszakhoz viszonyítva (Forrás: Führer E.)

A szaporítóanyag „közlekedési szabályai”



**"Everything we hear
is an opinion, not a fact.
Everything we see
is a perspective, not the truth."**

- Marcus Aurelius



fb/the idealist



Number of invasive species

