Forest Pests Outbreaks and Climate Change

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USEK

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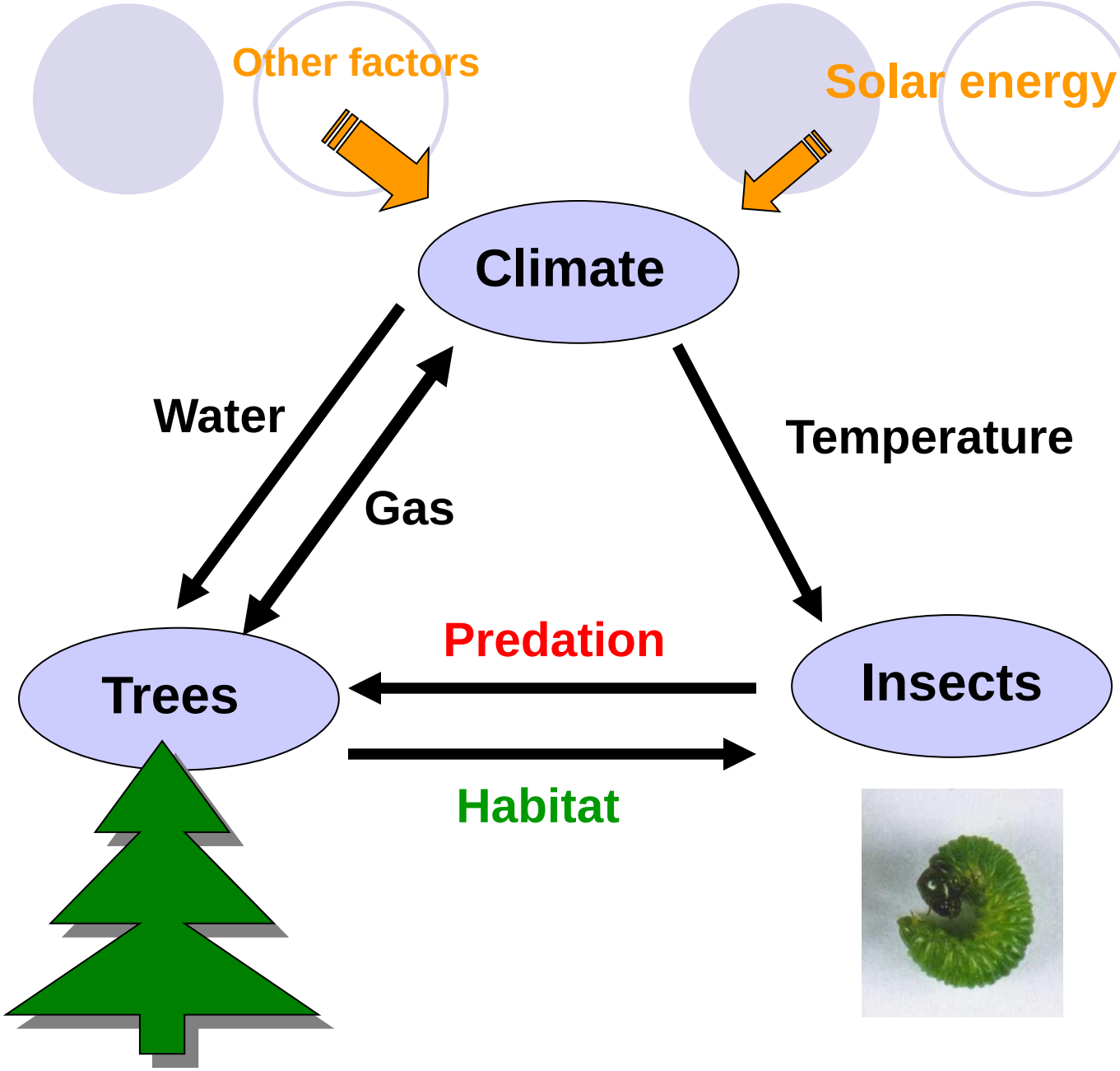

Other factors
Solar energy
Climate
Water
Gas
Temperature
Predation
Trees
Insects
Habitat

Factors affecting insect community

Pesticides

Extrinsic factors

Temperature
Wind
Rain
Light

Insect Community

Intrinsic factors

Other members of same species
Competitors
Food sources
Natural Enemies

Insect response to climate change

- The response of insects to climatic change may not always be linear
  - For example, the developmental stages of the insects can be differentially affected by the climate change, i.e. the growth can be accelerated by higher temperature, but at the same time the length of diapause may be extended.
- Insects developing without winter diapause, which are active during this season and are protected from the low temperature, are the best candidates for range expansion if the winter temperature maintain the current increasing trend
  - A good example is the pine processionary moth

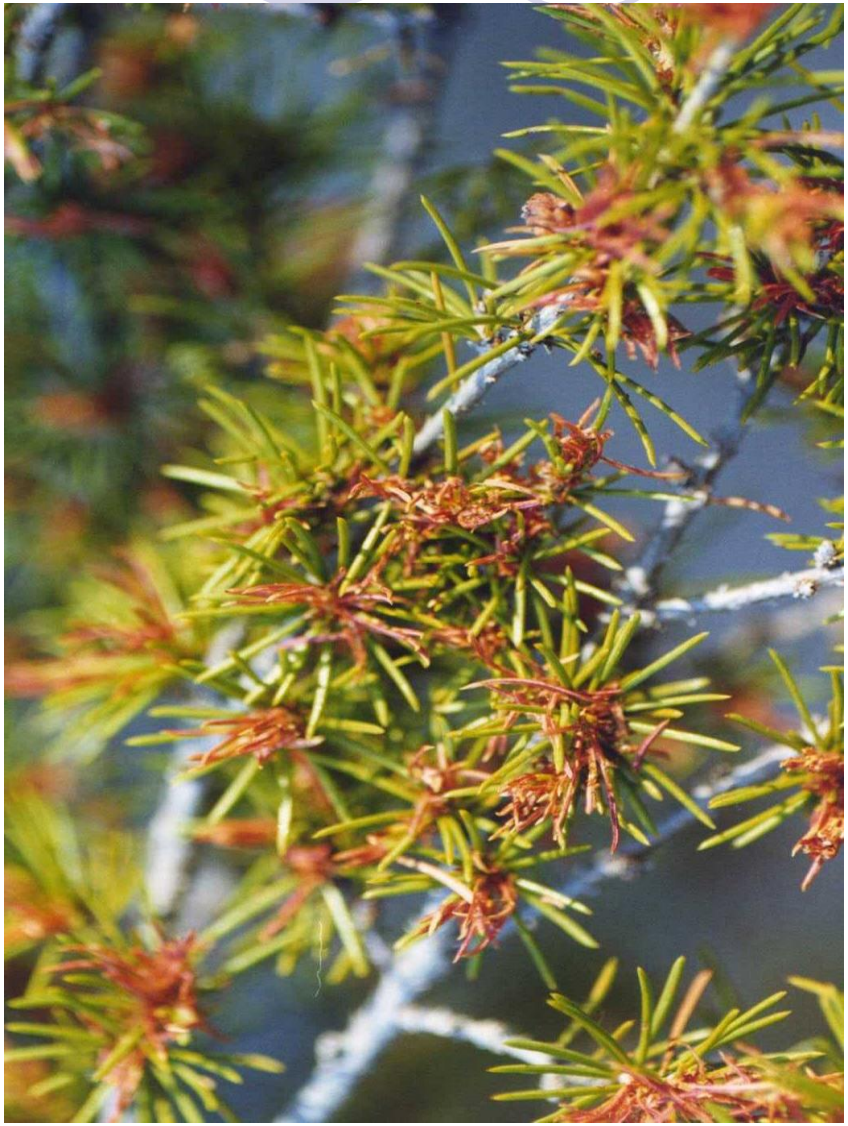
Insect response to climate change

- Most forest insects of temperate regions have a winter diapause, which in some cases can last several years.
- Temperature plays a major role in the induction and maintenance of this diapause.
- An increase of the temperature would modify the induction and maintenance of the diapause, involving changes, which could affect the development of the insect, making predictions about population dynamics quite unreliable.
  - Example of the cedar sawfly *Cephalcia tannourinensis* Chevin

1995-2000

2012-present

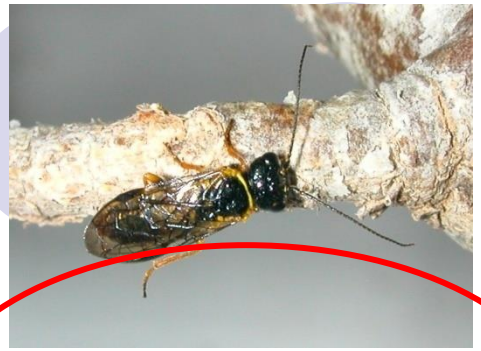
Forest Damage

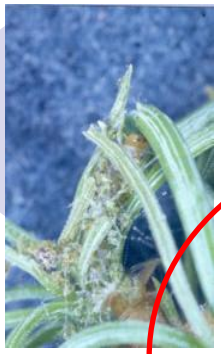


Cephalcia tannourinensis Chevin, lebanese cedar sawfly
An example of a specialist organism



Sources: Nemer et al. 2005. Monitoring of the new web-spinning sawfly, *Cephalcia tannourinensis* n.sp., in cedar forests of Lebanon. *In Entomological Research in Mediterranean forest Ecosystems 247-256.*





Snow cover

April | May | June | July

Soil temp.

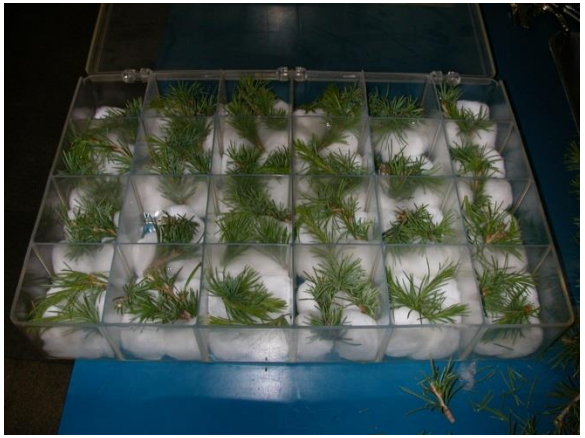
Soil temp. and humidity


August | ……. | ……. | ……. | …….. | January | Feb. | March

Life cycle of Cephalcia tannourinensis Chevin

Why this outbreak?

- **Studies on the diapause of the insect were conducted using different temperatures and moisture levels as well as snow cover period**



Sattout, E. and N. Nemer. 2008. Managing climate change effects on relic forest ecosystems: A program for Lebanese Cedar. *Biodiversity* 9(3&4): 122-130.

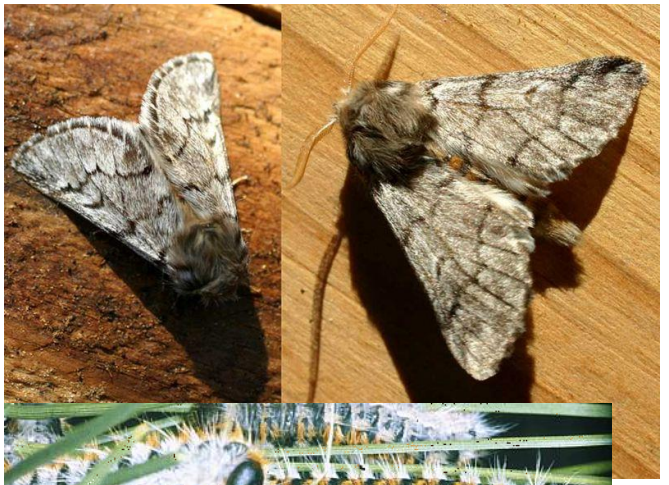
Limiting factors for the development of Cephalcia tannourinensis

- The length of snow cover period (direct and indirect ➔ phenology of trees and insect)
- Temperature ➔ direct
- Availability of food resources ➔ indirect
- Moisture level of soil ➔ direct
- And many other factors that we ignore

The pine processionary moth
What happened this year?

- Thaumetopoea wilkinsoni is a winter processionary moth

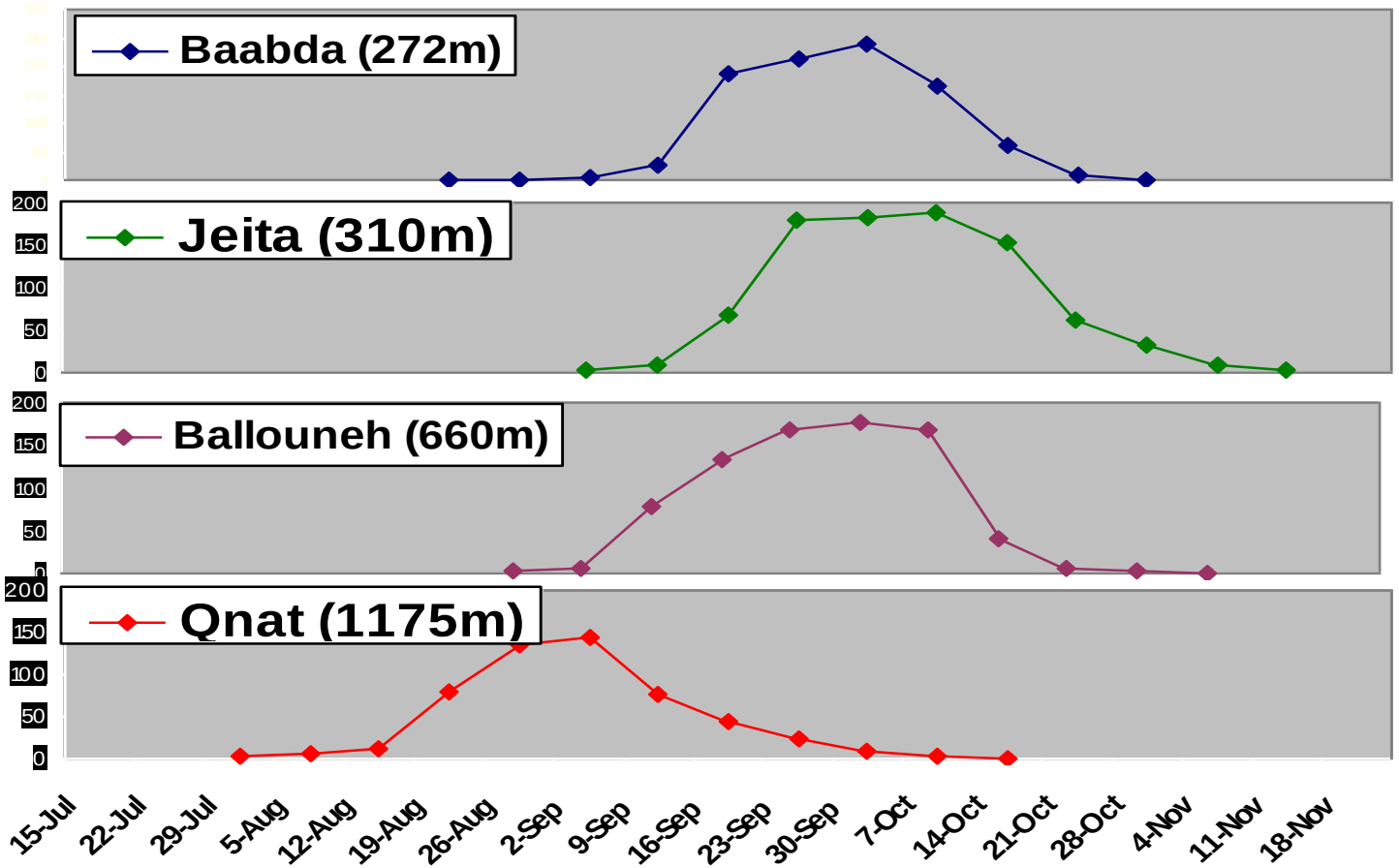




Forest Damage

2009-2010

Population dynamics of the pine processionary in Lebanon



The pine processionary moth
What happens in outbreak years?

Summer autumn

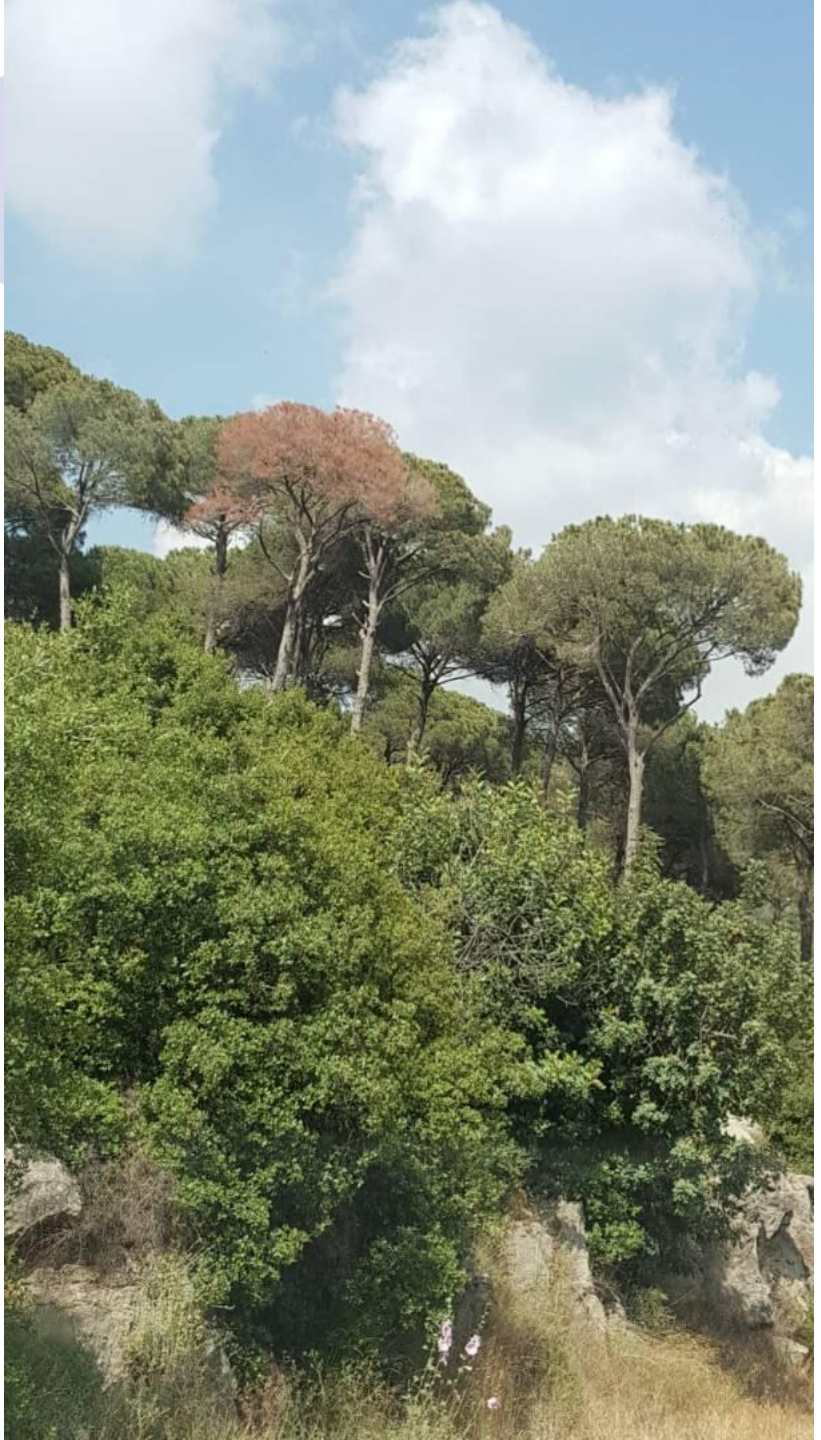
winter

Summer

The pine processionary moth
What happened this year?

- Very mild winter → minimal natural mortality
- Very hot weather in March → development faster → damage bigger
- No synchronization with natural enemies
- Lack of food resources → new resources were exploited by the insect
- Expansion upward > 1500 m asl
- Climate change or weather fluctuations?

Pine Dieback 2016-2017



The pine beetle *Tomicus destruens and other bark beetles*

Two types of damages are recorded:

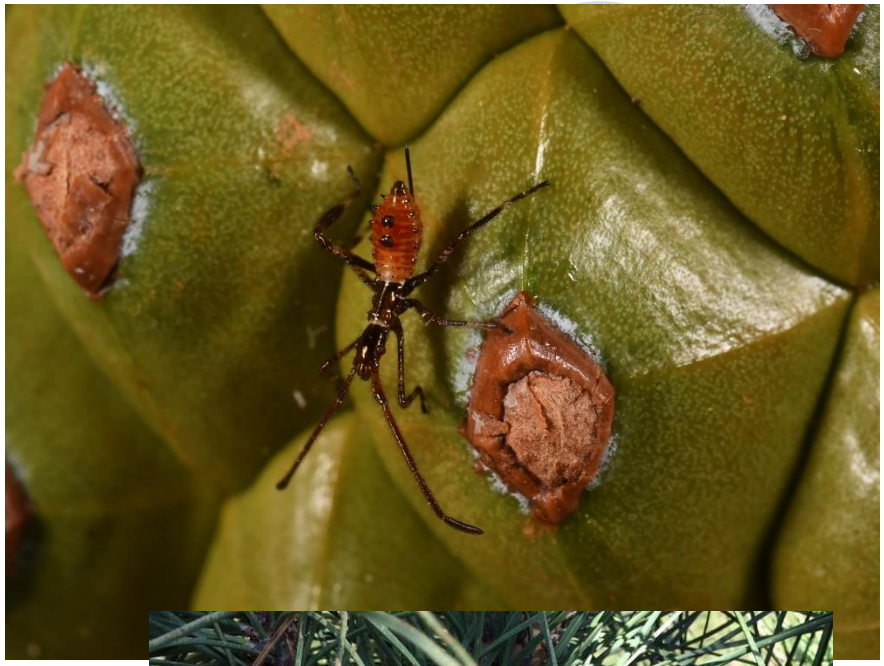
- On the shoot
- Under the bark of the trunk

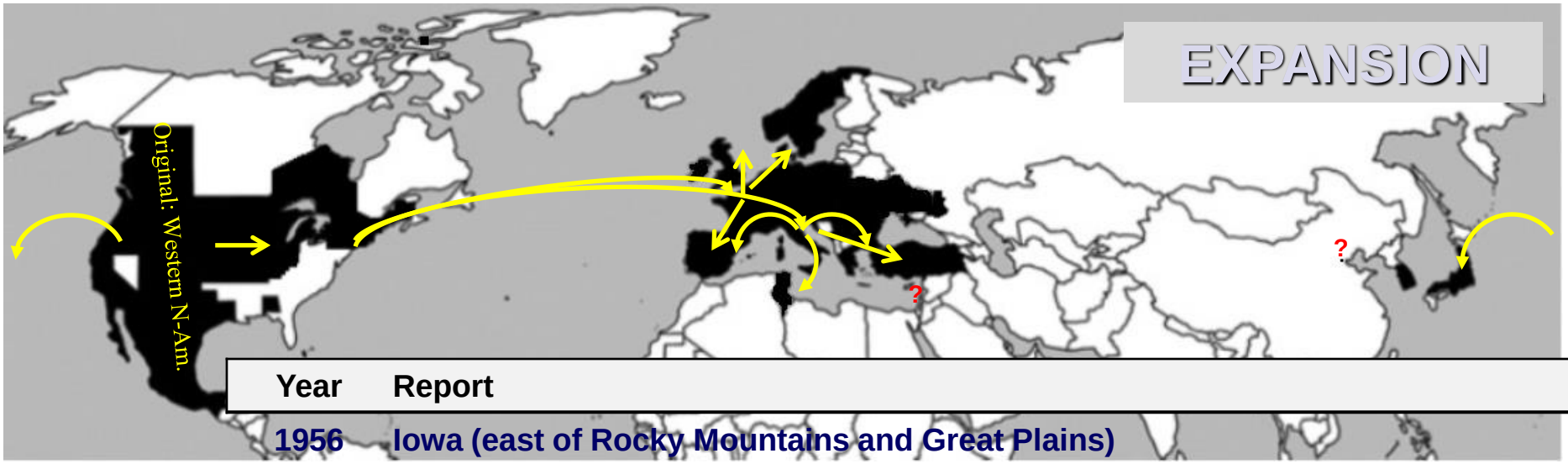
➢ Result: death of the trees


0.5 mm
1 2 3 4 5 6 7 8
mm

Management

The American Western Pine Bug *Leptoglossus occidentalis*





Year	Report
1956	Iowa (east of Rocky Mountains and Great Plains)
1985	Connecticut (East Coast)
1999	Italy
2002	Switzerland, Sicilia
2003	Spain, Slovenia
2004	Croatia, Hungary, Malta
2005	Austria, Corsica
2006	Germany, France, Serbia y Czech Republic
2007	UK, BeNeLux, Slovak Republic, Sardinia
2008	Montenegro, Poland, Bulgaria, Rumania, Moldavia, Greece,
2009	Denmark, Norway, Turkey (Eu), China (harbour quarantine office)
2010	Ireland, Portugal, Ukraine, Russia (Eu), South Korea
2011	Sweden , Tunisia
2012	Turkey (Asia)
2015	Lebanon

LIFE CYCLE

Leptoglossus occidentalis eggs on a pine needle (W. Strong)

First instar *Leptoglossus occidentalis* nymphs on conifer needle; hatched and hatching eggs on underside of needle (W. Strong)

Mating *Leptoglossus occidentalis* on spruce (W. Strong)

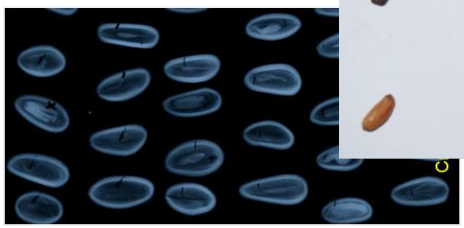
***Leptoglossus occidentalis* nymphs on Scots pine cone**


26
27
28
29

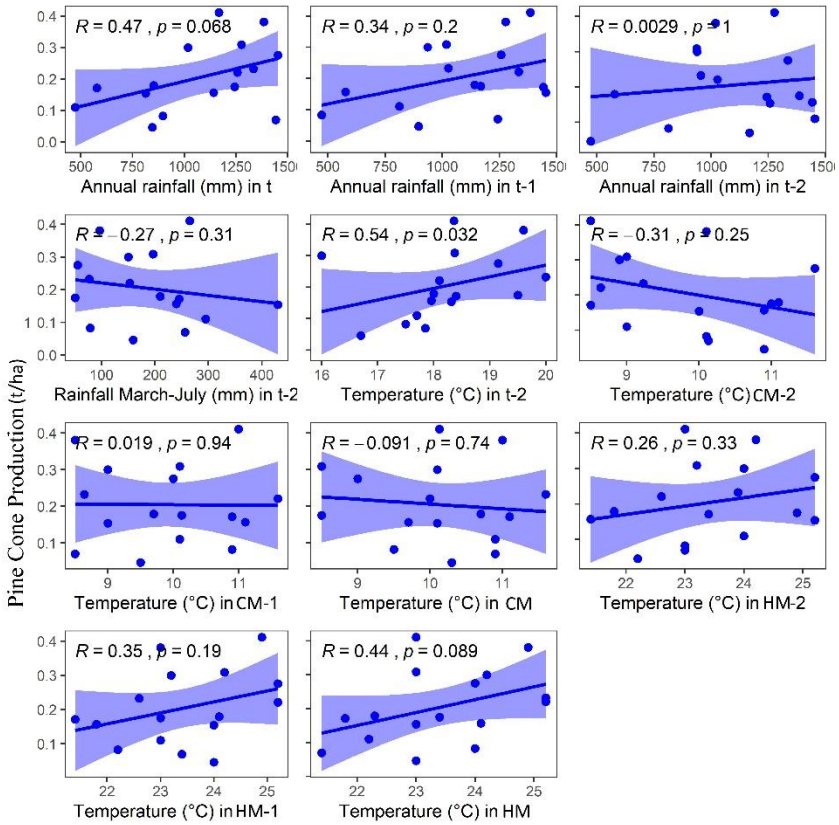

Bracalini, Terreni, Tiberi, Panzavolta & Croci 2012

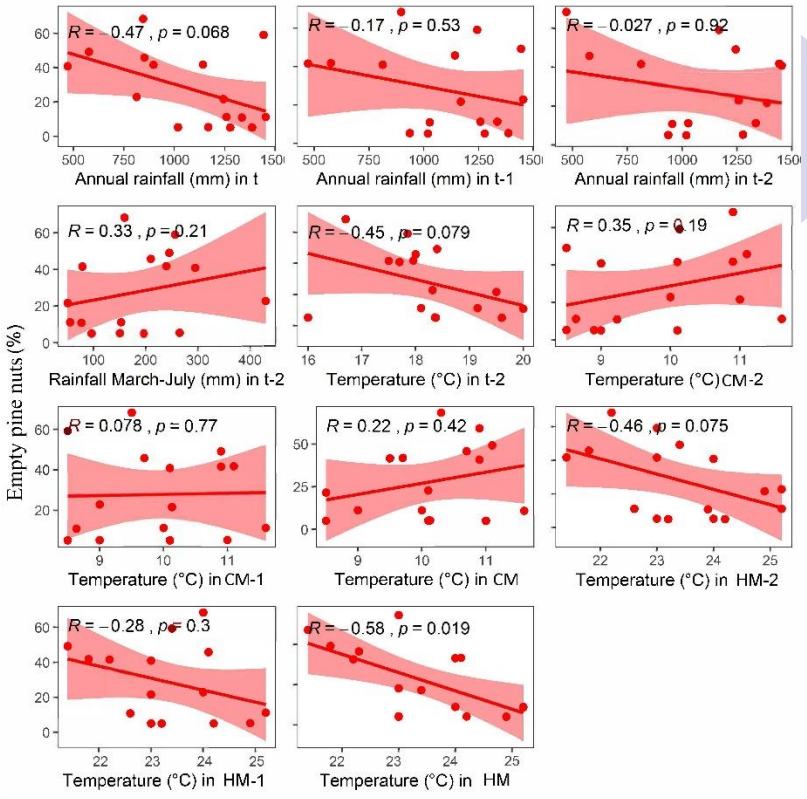

Credit: Salih Perlak

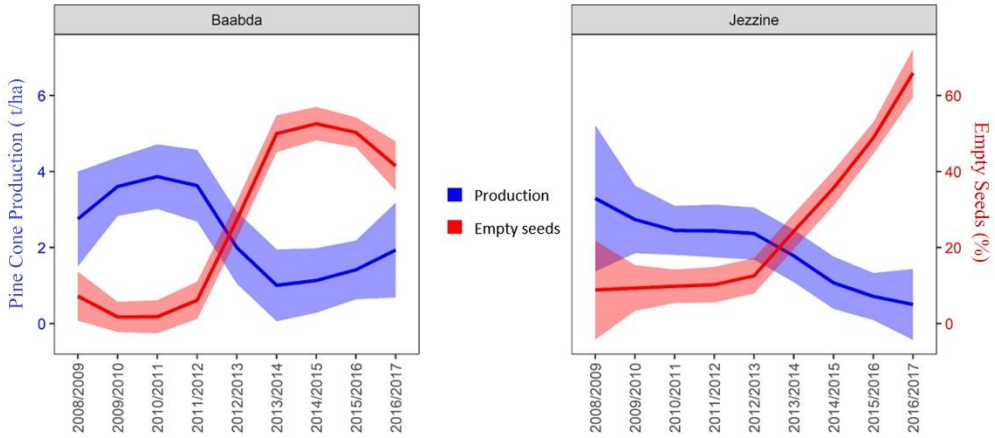

Catalina et al. 2014




Credit: Javier Gordo







forests

an Open Access Journal by MDPI

Potential Factors behind the Decline of *Pinus pinea* Nut Production in Mediterranean Pine Forests

Yara El Khoury; Elise Noujeim; Giovanni Bubici; Eustachio Tarasco; Charbel Al Khoury; Nabil Nemer

Forests **2021**, Volume 12, Issue 9, 1167

Lebanon Gypsy moth, *Lymantria dispar*

Lebanon Gypsy moth

- The Lebanese gypsy moth is more to the west and south European populations (Asian Gypsy Moth) than to the north American population (European gypsy moth) (3/5 Asian and 2/5 North America). (Using two polymorphic cytochrome oxidase I mitochondrial DNA restriction sites, the nuclear FS1 marker, and four microsatellite loci).

- Host range (mainly Oaks, *Pistachia* sp.)

- All of the damage caused by Lebanon Gypsy Moth is caused during the caterpillar stage.

Lebanon Gypsy Moth *Lymantria dispar*

- 1950

- 1998: Jabal Moussa and Tourza ~200 ha

- 1999: detected in most oak forest from the coast to the Bekaaa and to the mountains in the North and south

2019: outbreak in Ammiq; West Bekaa

2020: outbreak In Deir El Ahmar: north Bekaa

2021: small outbreaks in Kesserwan, Jbeil, Batroun

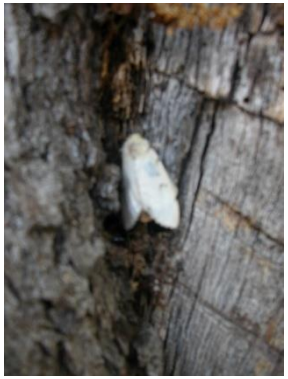
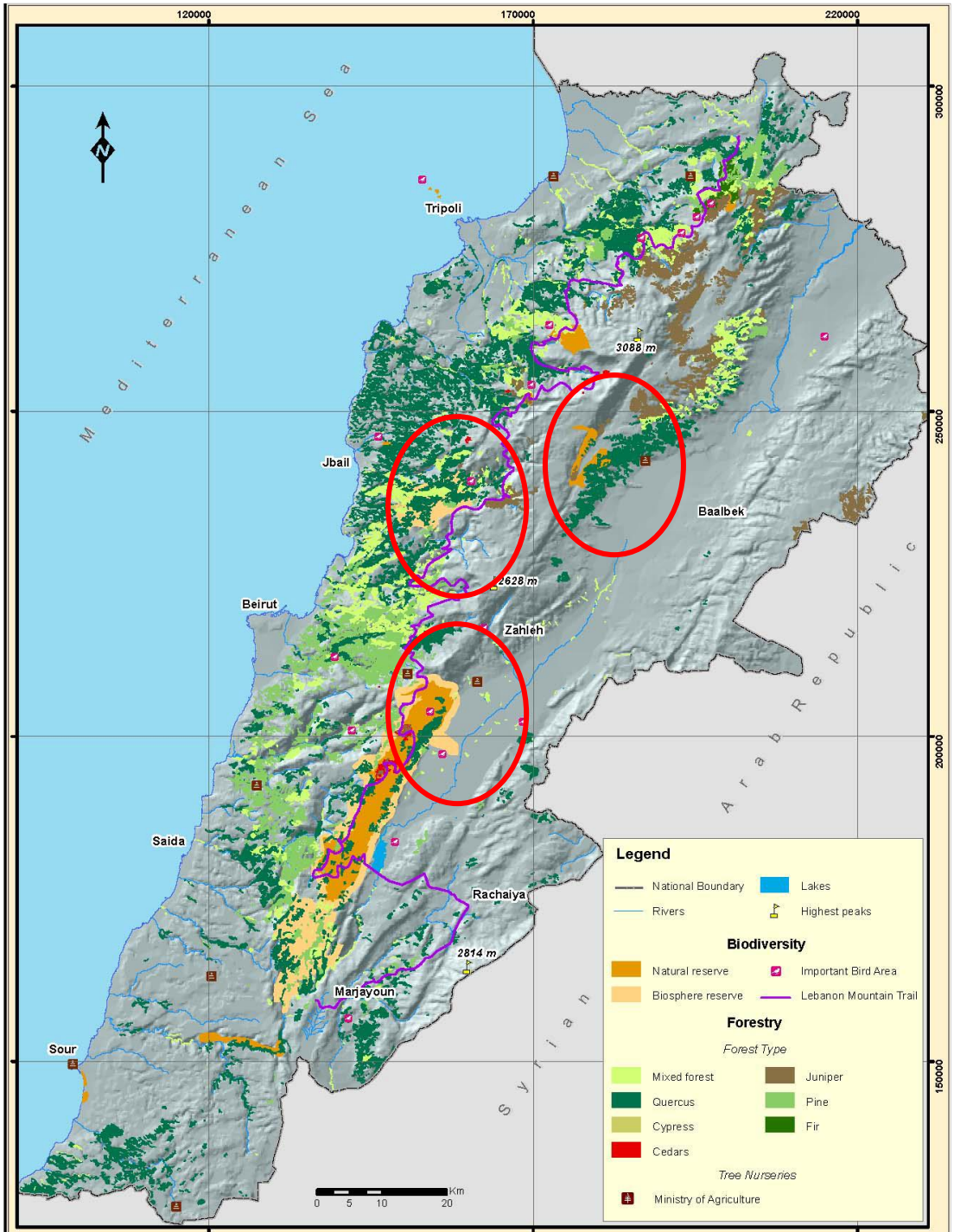
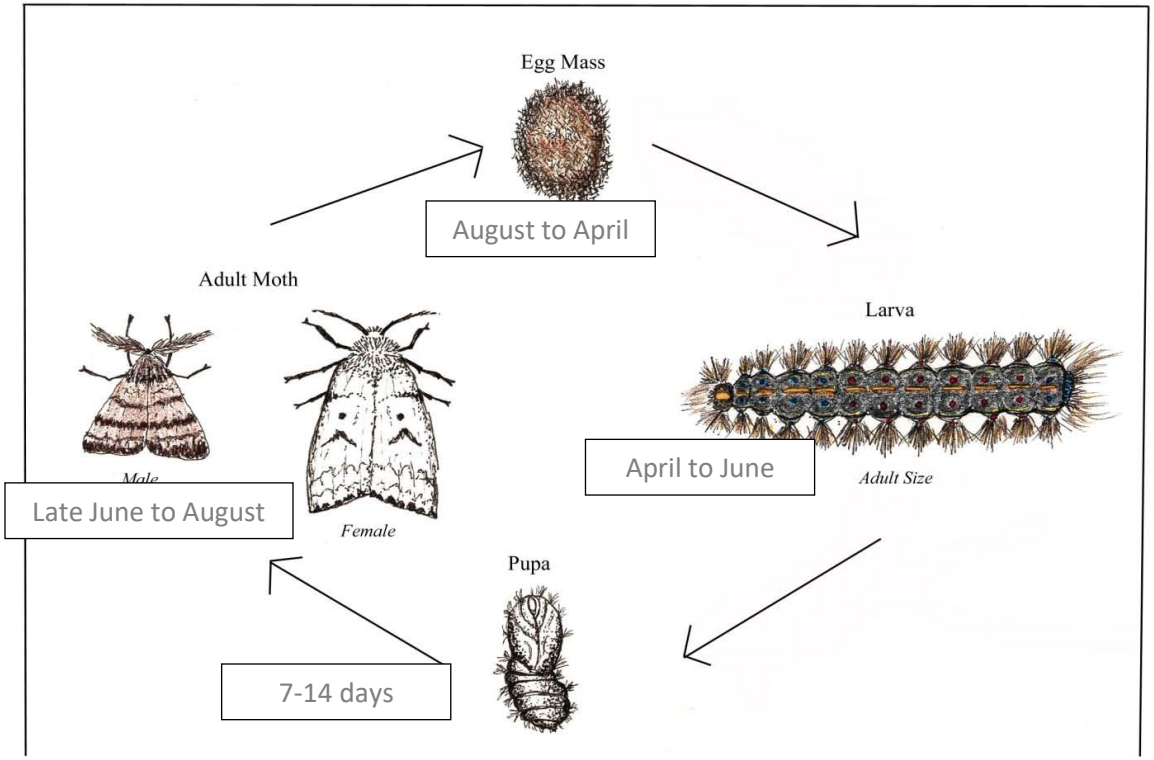


Photo N.Nemer


120000
170000
220000
300000
250000
200000
150000
Mediterranean Sea
Arab Republic
Syrian
Tripoli
Jbail
Beirut
Saida
Sour
Zahleh
Rachaiya
Marjayoun
Baalbek
3088 m
2628 m
2814 m
Km
0 5 10 20
Legend
National Boundary
Rivers
Lakes
Highest peaks
Biodiversity
Natural reserve
Biosphere reserve
Important Bird Area
Lebanon Mountain Trail
Forestry
Forest Type
Mixed forest
Quercus
Cypress
Cedars
Juniper
Pine
Fir
Tree Nurseries
Ministry of Agriculture

Life cycle Gypsy Moth



Lebanon Gypsy Moth
What does it look like?

Egg mass

Larvae

Male

Female

Photos N Nemer

Lebanon Gypsy Moth
What does the damage look like?

Photos left to right: LGM lavae fifth instar, Damage from LGM larva feeding, Defoliation from LGM larvae feedilng

Natural enemies

- *Calosoma sp. (coleoptera: Carabidae)*
- *Blepharipa sp. (Diptera: Tachnidae)*
- *Brachymeria intermedia (Hymenoptera: Chalcididae)*
- *Oencyrtus kuvanae* (Hymenoptera: Encyrtidae)

Brachymeria intermedia

Calosoma sp.

Insect outbreaks facts

- Climate important to pest population processes
- Niche model has utility, up to a point
- Food quality as important as temperature
- Climate change will act directly & indirectly
- Insects have many buffering mechanisms, behavior; not an option for plants or pathogens
- Actual predictions will require incorporation of many non-linear responses not yet understood

Final Points: Global Change & Pests

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- Niche model has utility, up to a point
- Food quality as important as temperature
- Climate change will act directly & indirectly
- Insects have many buffering mechanisms, behavior; not an option for plants or pathogens
- Actual predictions will require incorporation of many non-linear responses not yet understood

Final Points: Global Change & Pests

- While impacts of Global Climate Change on pests will require more study, much can be inferred from existing studies

- Multiple species interactions *must* be incorporated which makes problem more difficult


Thank you