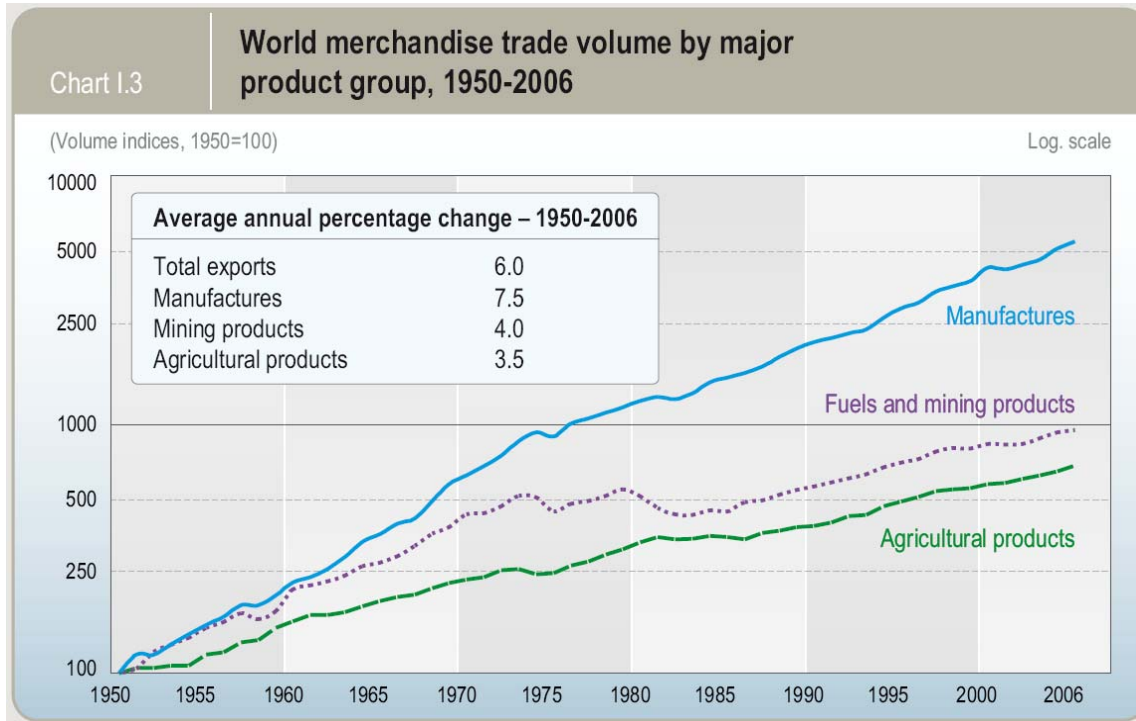


**Increasing global trade and climate change:  
co-factors increasing the international movement  
and establishment of forest pests**

Hugh Evans  
Forest Research, UK

## Increasing global trade: opportunities for pests to move internationally



Source:  
WTO International Trade  
Statistics, 2007

Volumes moving along pathways  
World seaborne trade (total goods loaded) has increased significantly since 2000, reaching a record level of 7.1 billion tons in 2005.

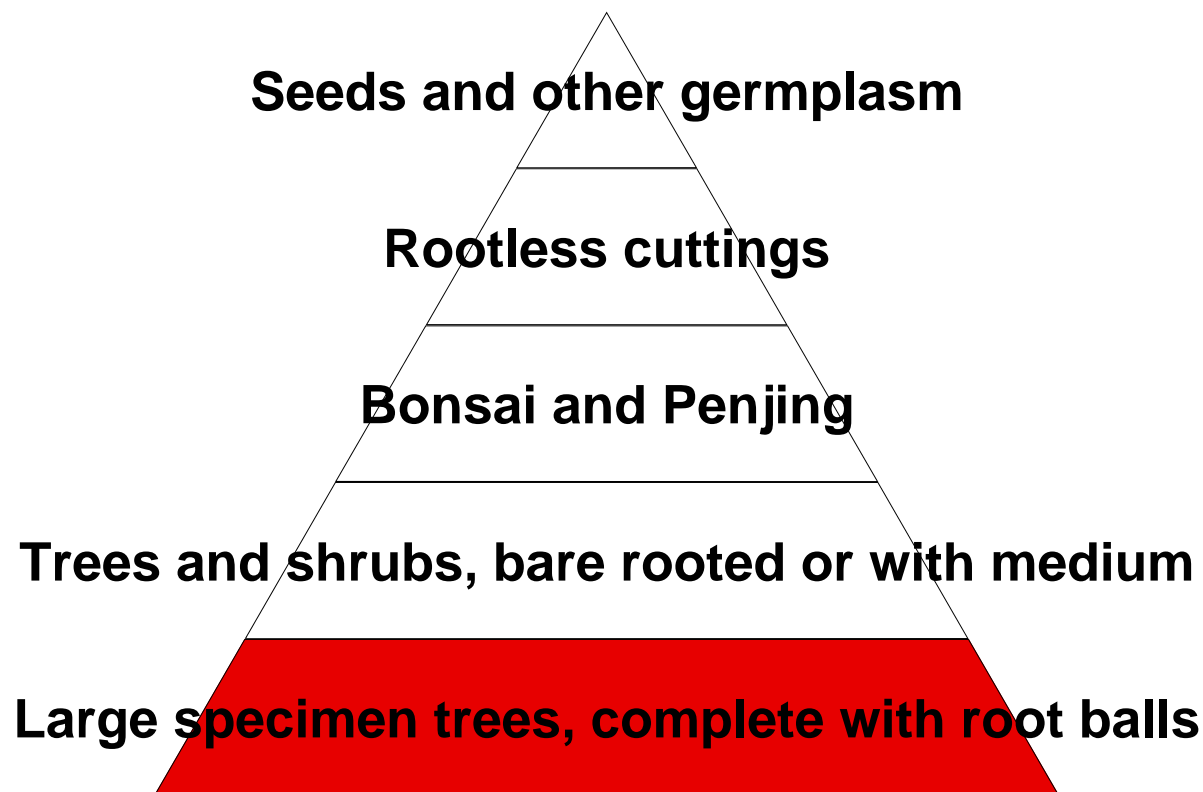


## Risk profile of untreated wood



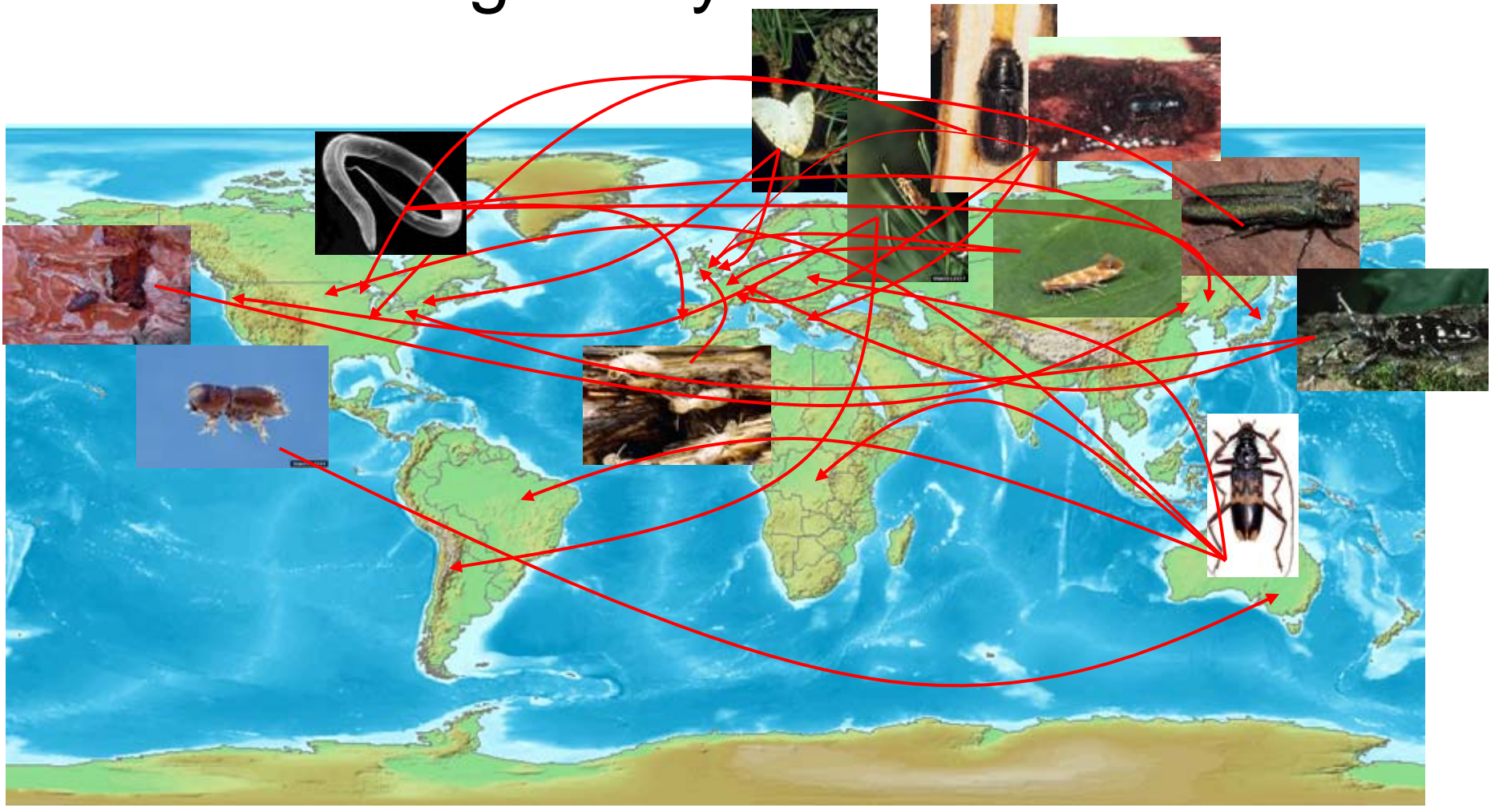
Treatments (heat, fumigation, high temperature kiln drying, etc.) remove most of the risk

## Risk profile of plants for planting



Direct treatment either not efficacious or not practical  
with increasing size of planting material

# Net result of increased trade: Pests move - globally!!!



## Eco-climatic factors affecting the likelihood of pest establishment in a new zone: a paradigm for climate change?

Suitability of ecoclimatic conditions at end of pathway

- **Climate shift** – gradual changes where the main factors are on the climate envelope boundaries. The immediate past and current scenario.
- **Climate jump** – the conditions faced when organisms arrive in new locations remote from their native ranges. A proxy for future climate scenarios?

## *IPCC predictions for climate change in the UK (Broadmeadow, et al. Forestry, 2005, 78, 145-161 )*

### By the year 2050 -

- mean summer temperatures increase by 1.2-3.7°C
- mean winter temperatures increase by 0.9-1.9°C
- less rainfall during summer, especially SE England
- up to 9% more rainfall in winter, particularly in the north & west of the country
- significant reduction in the number of frost days

## Climate Shift: a change in distribution

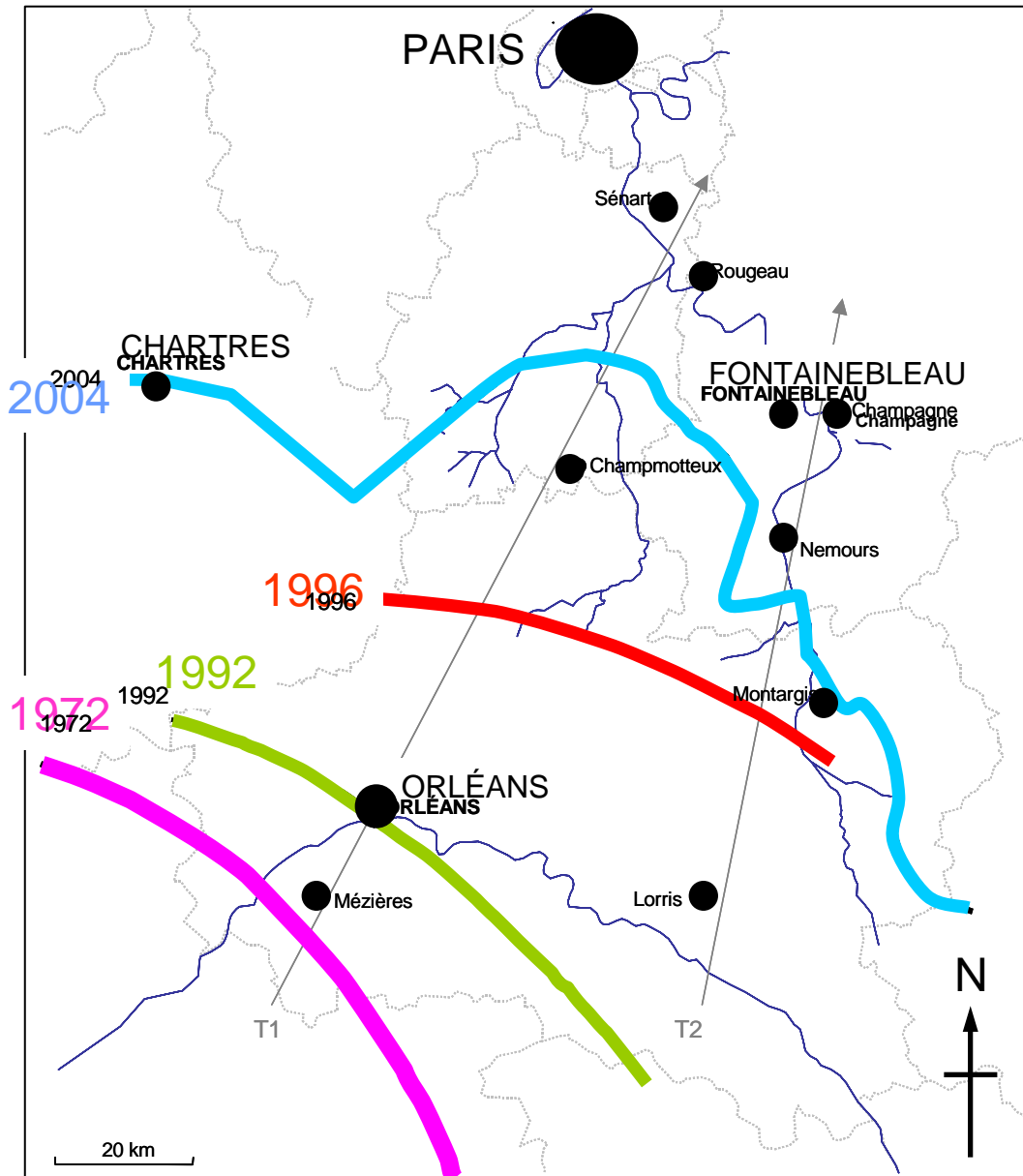
Pine processionary moth,  
*Thaumetopoea pityocampa*

Important defoliator of pines in Europe. Steadily moving north.

Defoliation leads to loss of height and volume increment. Severe damage can kill young trees.

Urticating hairs on the caterpillars cause severe skin irritation, conjunctivitis and respiratory problems.





Northward spread  
by natural means  
on a smooth  
advancing front

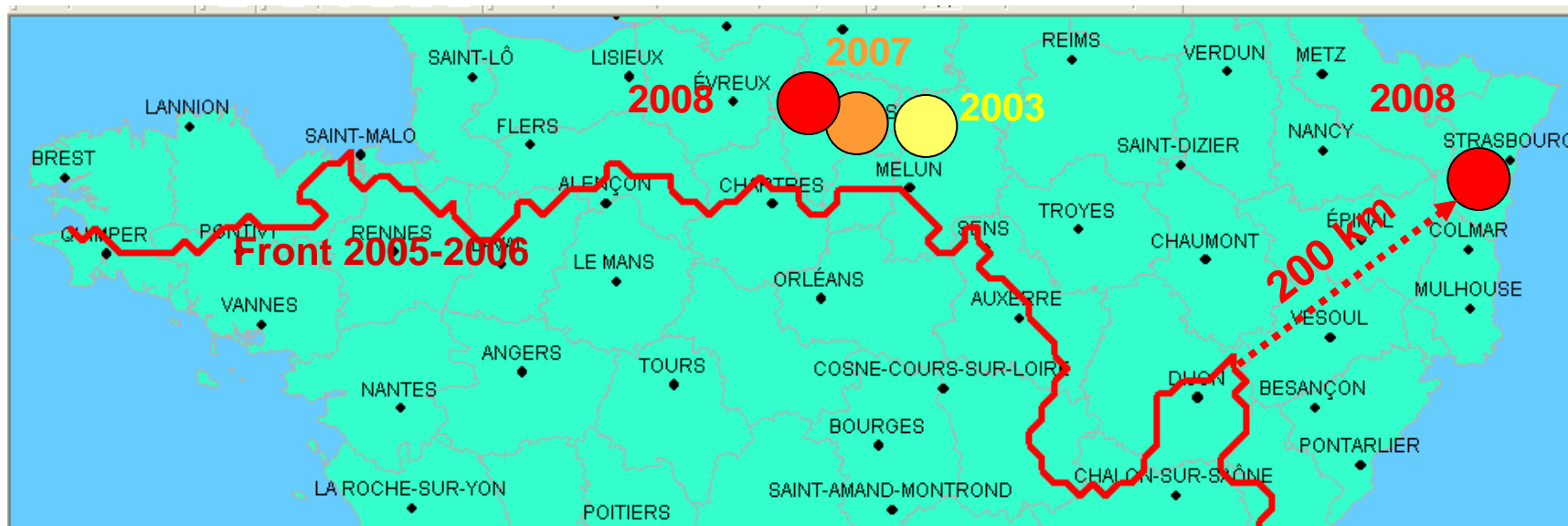
- **87 km** between 1972 and 2004
- **56 km** during the last 10 years

Minimum winter temperature:  
+ 0.9°C in Melun  
+ 1.1°C in Orléans

Critical for late winter larval survival

Information from Dr  
Alain Roques, INRA,  
France

# Pine processionary moth: range jump (from Christelle Robinet-Makdoud)

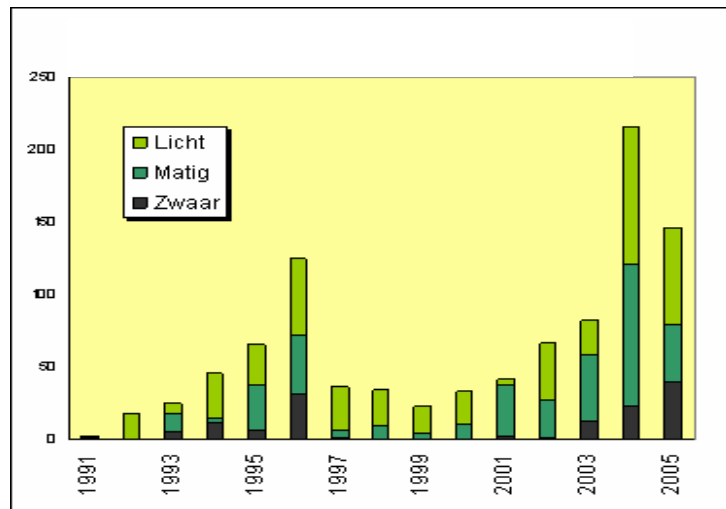


Likely long distance movement on pine plants for planting  
(large trees)

## Oak processionary moth, *Thaumetopoea processionea*

A southern & central European species that has moved north during the latter half of the 20<sup>th</sup> century.

Very damaging to oak species, with notable episodes of defoliation in the Netherlands since it arrived in early 1990s.



Breeding colonies of oak processionary were found at several sites in west London in 2006.

Large numbers of caterpillars present in May 2007.



## Global trade

Planting of large trees – a pathway for international movement of oak processionary moth and other pests





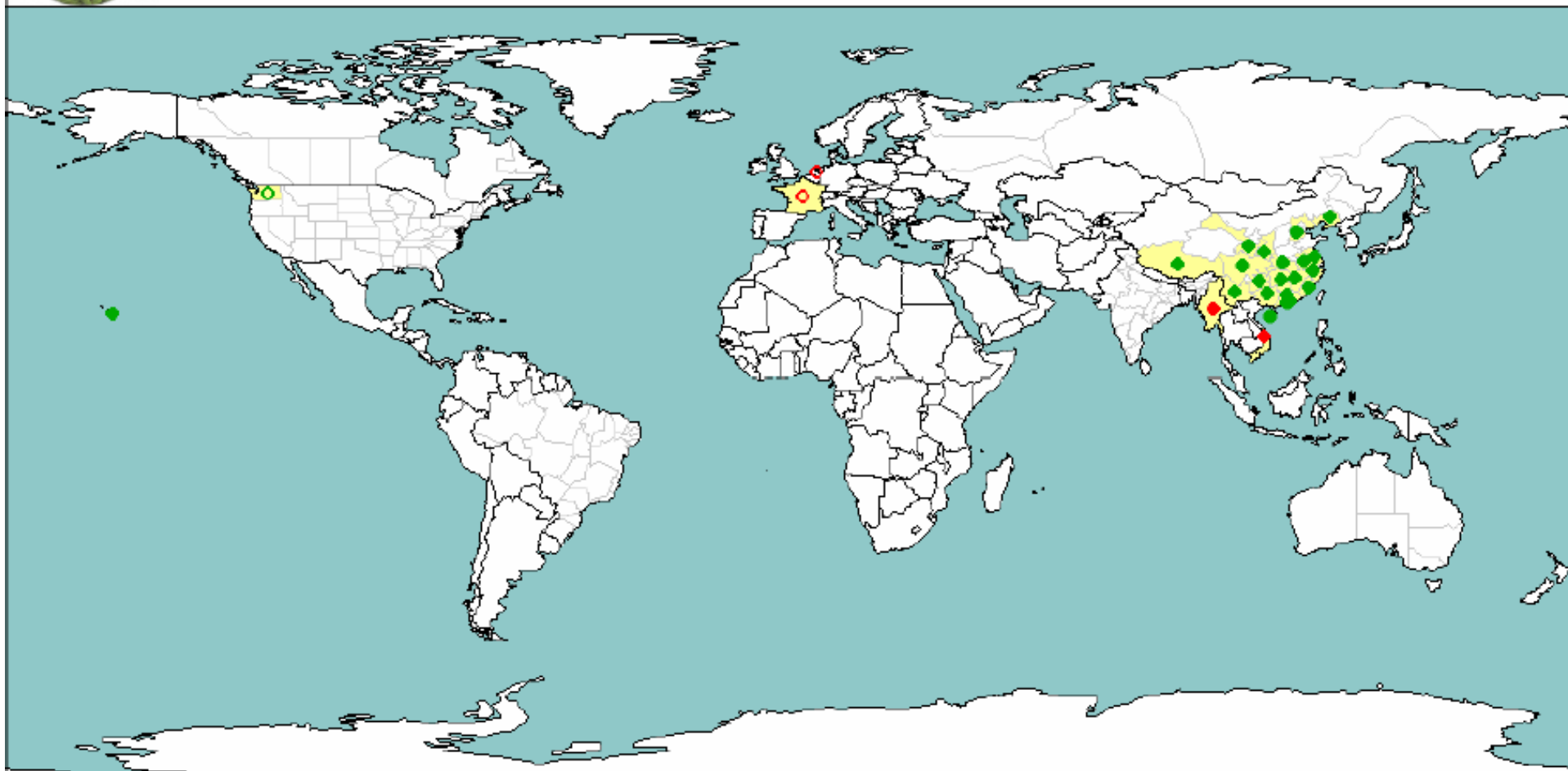
## Proposed measures to prevent further imports of oak processionary moth

- Controls on the movement of all plants of *Quercus* spp., other than seeds, intended for planting, whether or not prepared and ready for sale to the final consumer;
- All such plants to be accompanied by a plant passport;
- Authority to issue plant passports only to be given in respect of trees produced in places of production, including the immediate vicinity, which are officially known to be free from *Thaumetopoea processionea*.

- Emergency measures implemented from 31st March 2008
- The Plant Health (Forestry) (Amendment) Order 2008
- Formal request for EU 'protected zone' status sent to European Commission
- Due to be considered by Standing Committee on Plant Health on 26 - 27 May 2008
- Other member States 'at risk' may also request PZ status



# Anoplophora chinensis



National record

Subnational record



Present



Present



Present only in some areas



Present only in some areas

1 006-09-19



*Acer palmatum* recovered from private garden

(Photographs courtesy of CSL)



*A. chinensis* Feeding damage



Emergence hole

***A.chinensis* in bonsai  
*Acer palmatum***



***A.chinensis* in bonsai  
*Malus sylvestris***



One of 46,000 potted *Acer palmatum* (2m tall) at a nursery in the south of England during 2005

22 adult *A.chinensis*

16 larvae

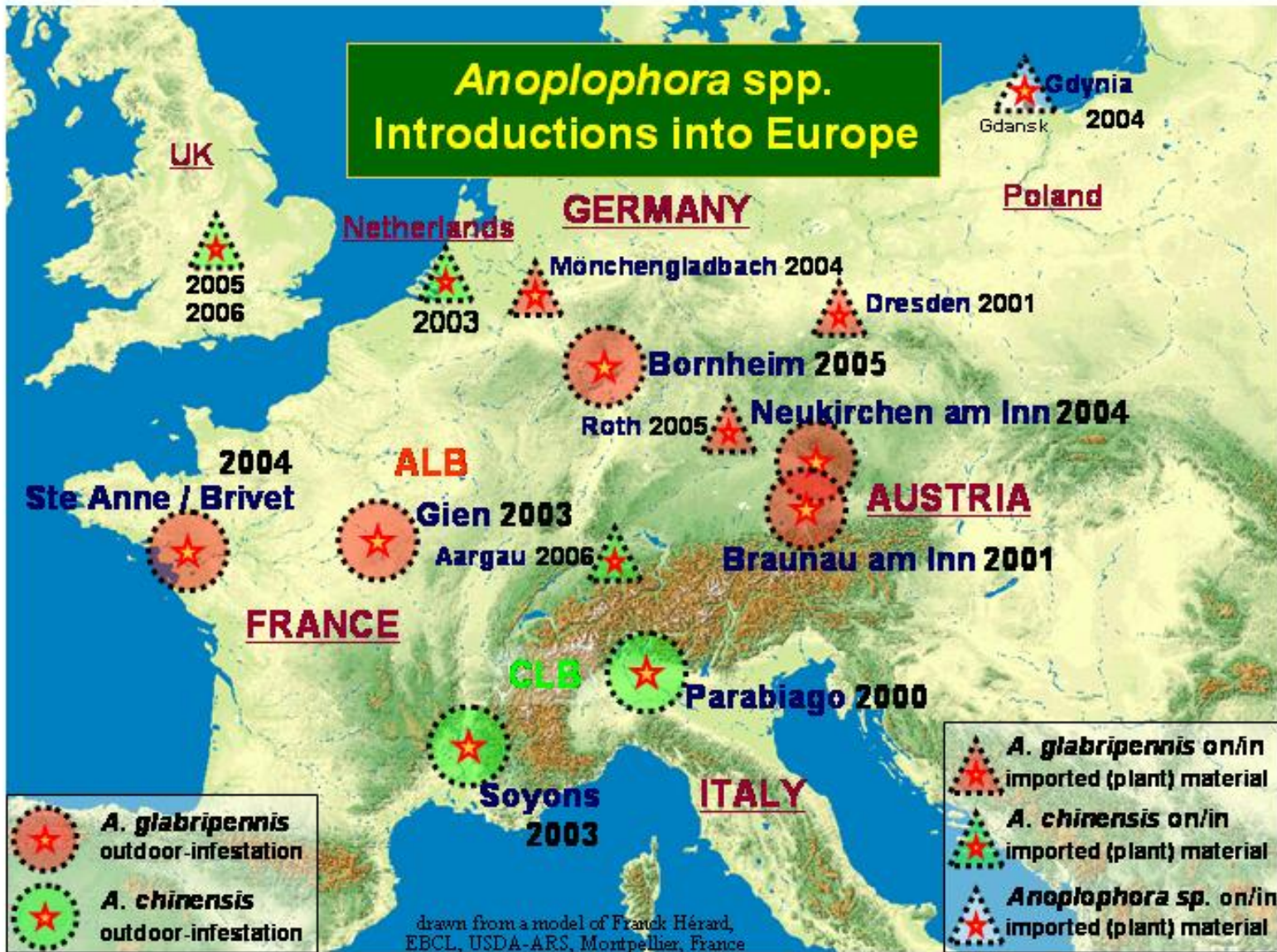
37 exit holes

All plants destroyed because of infestation and emergence of adult beetles.





change:  
st pests



Originally produced by Franck Hérard / EBCL, USDA-ARS.

Taken from publicity material by Ute Hoyer-Tomiczek et al., Federal Forest Office (BFW) – Plant Protection Service, Vienna, Austria



**Acers, Milan suburb, April 2007**







*A.chinensis*, exit holes



## The effects of climate change on both climate shift and climate jump situations

- Range shift (gradual or jump spread) presents a new opportunity for a pest
- **But:** Interaction is at the local level and determined by the spectrum of ecological factors that affect any insect-host relationship, e.g.-
  - Synchrony
  - Pest voltinism
  - Tree defences
  - Interactions with natural enemies
  - A range of climate related mortality factors – rainfall, wind, insolation, etc.

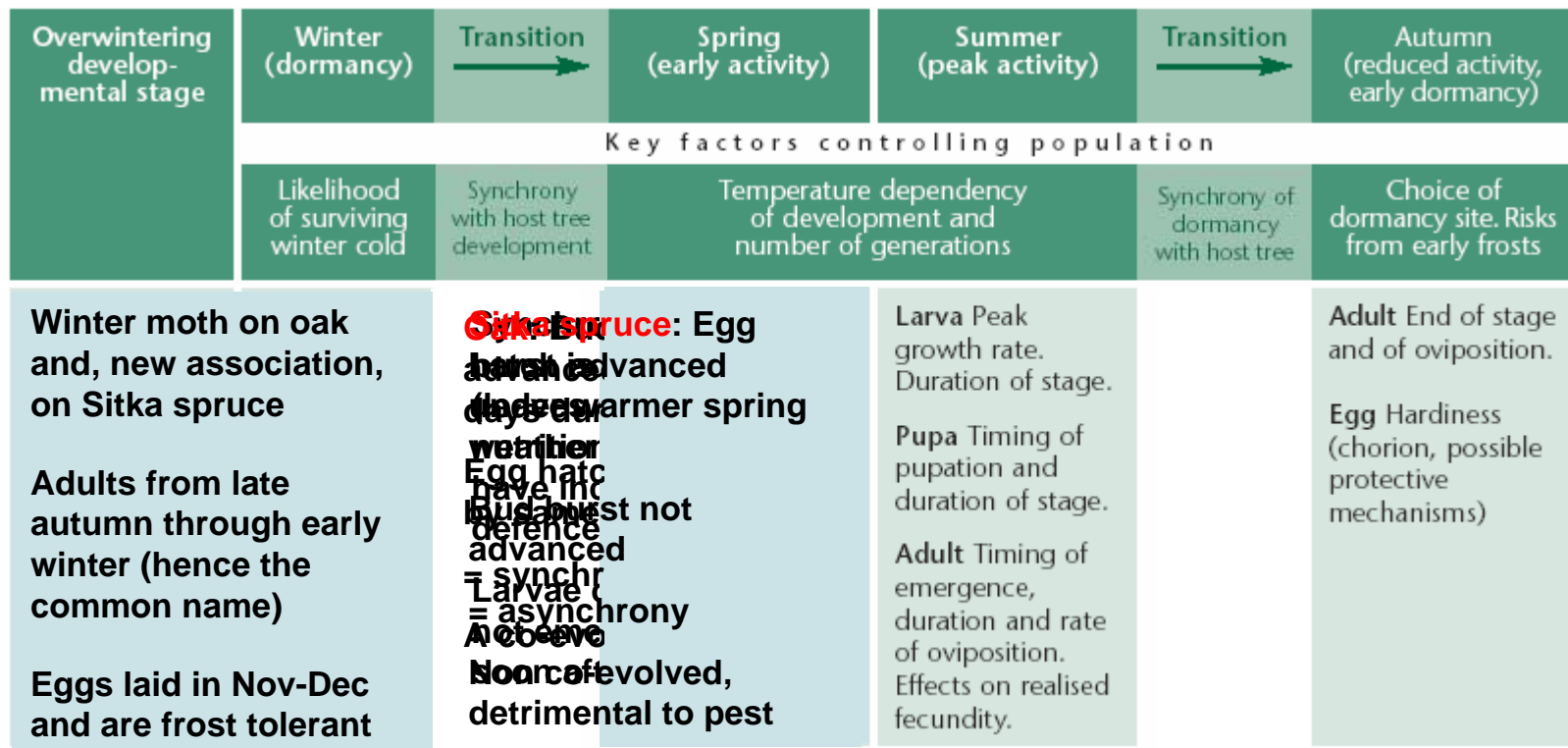
# Synchrony of pest and host development - critical survival factors in relation to climatic variables

Overwintering developmental stage	Winter (dormancy)	Transition 	Spring (early activity)	Summer (peak activity)	Transition 	Autumn (reduced activity, early dormancy)
	Key factors controlling population					
	Likelihood of surviving winter cold	Synchrony with host tree development	Temperature dependency of development and number of generations		Synchrony of dormancy with host tree	Choice of dormancy site. Risks from early frosts
<b>Egg</b>	<b>Egg</b> Frost tolerance, survival.	<i>Timing of bud burst determines suitability of oviposition and feeding sites. Strong link to nutritional and defensive status of foliage. Likelihood of mortality from late frosts</i>	<b>Egg</b> Hatch date; early survival.	<b>Larva</b> Peak growth rate. Duration of stage. <b>Pupa</b> Timing of pupation and duration of stage. <b>Adult</b> Timing of emergence, duration and rate of oviposition. Effects on realised fecundity.	<i>Leaf fall or dormancy. Links to declining nutritional suitability, loss of foliage (deciduous) and likelihood of early frosts.</i>	<b>Adult</b> End of stage and of oviposition. <b>Egg</b> Hardiness (chorion, possible protective mechanisms)

*Timing of bud burst determines suitability of oviposition and feeding sites. Strong link to nutritional status of foliage. Likelihood of mortality from late frosts*

*Leaf fall or dormancy. Links to declining nutritional suitability, loss of foliage (deciduous) and likelihood of early frosts.*

## An example commencing with the egg stage: winter moth, *Operophtera brumata*



# Conclusions

- Although climate change presents a global challenge, the influence on pest infestations is spatially and temporally constrained – exemplified by gradual climate shift effects on range and severity of pests in their native ranges
- Increased global trade, however, presents increased opportunity both for pest establishment and for learning about climate jump effects – the future happening now
- However, there are many unknowns and so we close the meeting with an appropriate quotation:

**“as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - the ones we don't know we don't know”.**

**Donald Rumsfeld**