Summary report of the Pine Wilt Disease Conference

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co-organized by the IUFRO and the REPHRAME Project

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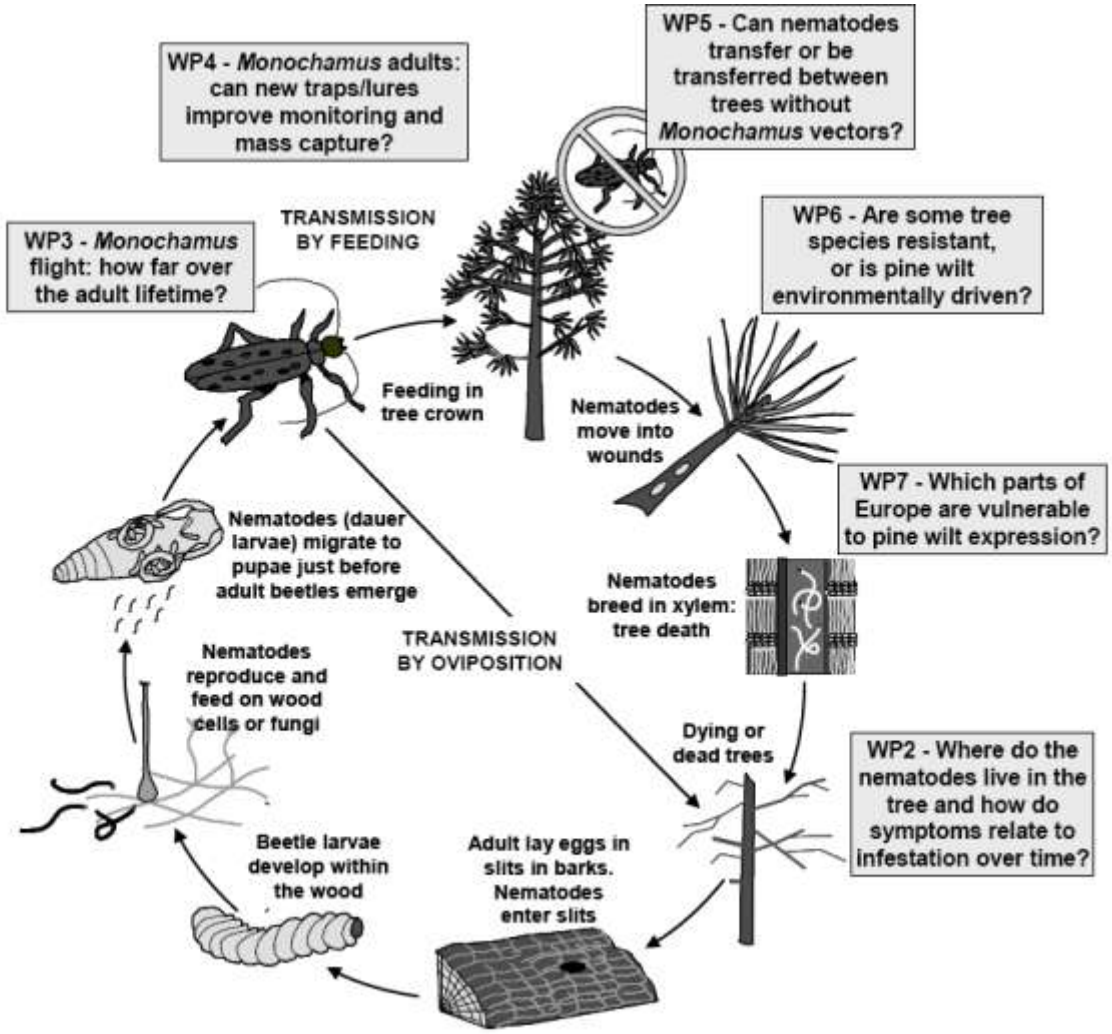
Biological cycle



Outline

What we have learnt recently about

1. *Monochamus galloprovincialis*, the insect vector
2. *Bursaphelenchus xylophilus*, the pine wood nematode
3. Pine Wilt Disease management

1. *Monochamus galloprovincialis,* insect vector of the PWN

Dispersal capacities

Flight mill:

- daily: median 2 km, max 9 km
- entire lifespan of adults: median 12km, max 63 km
- no effect of sex, of mating, of nematode load
- positive effects of age and weight at emergence

Mark – release – recapture :

- flight distance of 1 – 10 km
- no recapture of immature beetles before 2 – 3 weeks
- but physiological and flight mill studies confirm they can fly

1. *Monochamus galloprovincialis,* insect vector of the PWN

Detection and monitoring

Pheromone traps:

- very effective pheromone lure (Galloprotect Pack)
- very effective interception trap design
- attraction radius = 100m

Mark – release – recapture :

- max 30% of recapture in dense grid of pheromone traps
- questioning the mass trapping

Detection :

- combination of pheromone trapping = regional
- and sampling of cutting residues (logs, branches) = local

1. *Monochamus galloprovincialis,* insect vector of the PWN

Predicting the spread

Genetic data:

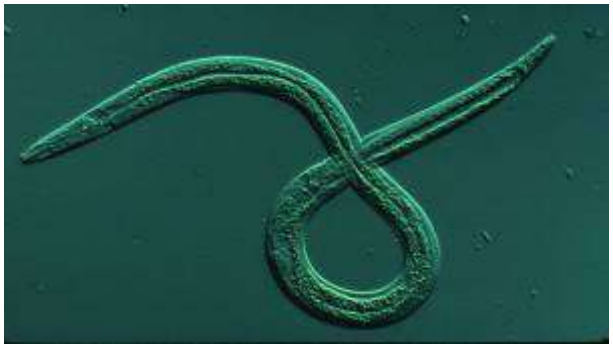
- topographic barriers
- invasion routes through low elevation
- connectivity of the pine forest

Modeling the spread :

- improved spread model based on refined parameters in the European context
- prediction of spread across the landscape, 3 - 20 km
- prediction of inoculation and PWD expression based on climate

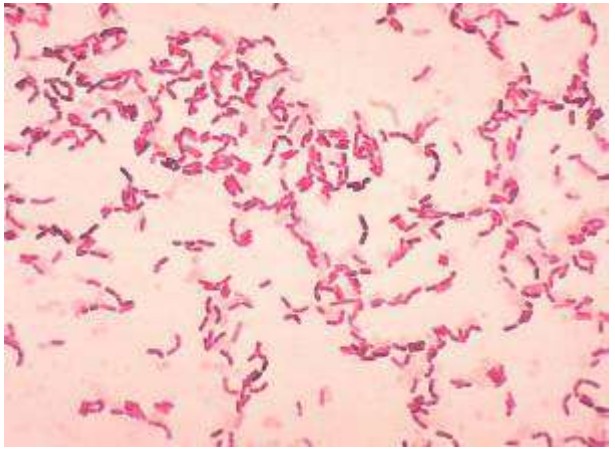
2. *Bursaphelenchus xylophilus,* agent of the PWD

Systematic and diagnostic



- 6 new species of found in the *B. xylophilus* clade in Europe
- morphological traits not accurate enough to allow good diagnostic
- improved methods of DNA identification: real time PCR
- towards a European standard
- new, more rapid methods:
    - High resolution Melting Analysis : PCR-HRM
    - SSU rDNA
    - reverse transcription loop-mediated isothermal amplification (RT-LAMP) based on mRNA

2. *Bursaphelenchus xylophilus,* agent of the PWD



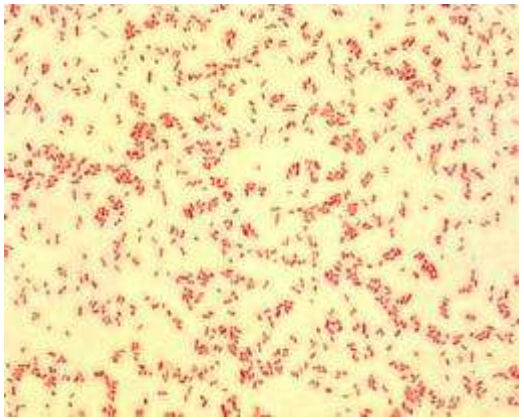
Interaction with bacteria

Hypothesis that not pine wood nematode itself,
but its accompanying bacteria were responsible for the PWD

- Japan: bacteria isolated from PWN are not pathogenic
  but aseptic PWN still are
- China: inoculation of PWN with vs. without bacteria had the same
  effect on pine seedlings
- China: inoculation of aseptic PWN vs. aseptic *Bacillus firmus*
  (isolated from PWN): more severe and rapid symptoms with bacteria

2. *Bursaphelenchus xylophilus,* agent of the PWD

Interaction with bacteria



Portugal: metagenomic approach
- main bacteria isolated from PWN are *Serratia* sp.
- they are particularly resistant to oxidative stresses
- the level of virulence of the PWN would depend on stress resistance
- bacteria would therefore help the PWN to better resist tree defenses
- however not the same composition of bacteria communities in different populations of PWN (functional redundancy?)
- presence of bacteria in the insect vector
- some bacteria are nematicide

3. Management of the Pine Wilt Disease

Targeting the insect vector

- Clear Cut Zones, not effective, counter productive
  - do not prevent the flight dispersal: *M. galloprovincialis* can fly across open areas, at longer distance than radius of CCZ
  - CCZ may force immature beetles to fly whereas they naturally prefer feeding on pine shoots
  - CCZ produce lots of logging residues that can be human transported over long distances

- Pheromone mass-trapping not effective enough
- Biological control with mass reared parasitoids in China but not specific

3. Management of the Pine Wilt Disease

Targeting the nematode in living trees

- selection of resistant provenances
  of *Pinus massoniana* in China
- screening of resistant maritime trees in Portugal
- breeding for resistant varieties

- injection of nematicide (Emamectin Benzoate) in trunk of living trees can prevent PWN infection for 3 years (but limited to valuable trees)

3. Management of the Pine Wilt Disease

Targeting the nematode in wood products

- effective hot steam treatment of wood products (logs, bark)
- fumigation with sulfuryl fluoride (SF) to replace methyl bromide
- kiln drying (<20% humidity) effective only if properly applied (56°C for 30 min)
- Impregnated nets with insecticide (alpha-cypermethrin) to cover logging trucks

Concluding remarks

- **Still lots of knowledge gaps**
  - **dispersal and colonization behavior of the insect vector (tree selection)**
  - **inoculation of PWN by *M. galloprovincialis* (behavior, dose)**
  - **variability of PWN strains and virulence**
  - **resistance / tolerance of Pinus pinaster trees, varieties, provenances**
  - **effect of climate change on PWD, climate adaptation of PWN**

- **Need to work more on *B. mucronatus* in other parts of Europe**

- **Need to upscale studies**
  - **from nematode – insect – tree relationships to population dynamics**
  - **epidemiology at stand and landscape levels**
  - **role of genetic, specific and functional forest diversity on invasibility by Monochamus and resistance to PWN**

Thank you for your attention !

Photo: E. Segura