France’s experience in tackling transboundary plant pests
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context
biological invasions have been much more frequent in recent years

Number of insect species introduced in France per year, with agronomical consequences

- 1950-1999: 1,58 (79)
- 2000-2005: 7,45 (41)
- 2005-2014: 6,78 (61)
origin of arthropods that are invasive in Europe

Roque et al. 2009
organization for plant protection

regional context

• EPPO: regional organization
  - protocols for identification of pests
  - identification of emerging threats
  - recommendations and guidelines

• EFSA: European agency for food safety
  - risk analysis
  - categorization of pests
  - methodology for risk assessment

national context

• ministry of agriculture:
  - public policy
  - regulations
  - risks and crisis management

• Anses: agency for food safety

• Inra: research and expertise
France’s experience in tackling transboundary plant pests

a return on experience
**Xylella fastidiosa**

**a complex biological system**

- 5 sub-species; many lineages
- >200 potential host species (Fr)
- >50 potential insect vectors (Fr)

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Transboundary plant pests

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response to the sanitary crisis

first detection in France (Corsica): July 2015

- activation of eradication procedures (UE guidelines)
- surveillance, sampling, identification (EPPO guidelines)
- setting up of a research task-force for short-term response (18 months)
improved tools for direct typing of *Xf* from plant material

following EPPO standards for test development

proposition of new tests and procedures to EPPO (PM 7/24, May 2018)
determination of $X_f$ host range for strains present in France

**Indicator species (Cv.) used as positive controls**

- *Olea europaea*
- *Nerium oleander*
- *Coffea arabica*
- *P. myrtifolia*
- *Vitis vinifera*

**Plants of interest for the Loire Valley**

- *M. domestica (2 cv)*
- *P. communis (2 cv)*
- *Vitis vinifera (3 cv)*

**Plants of interest for the Mediterranean area**

- *C. europaea (3 cv)*
- *V. vinifera (3 cv)*
- *C. clementina (2 cv)*
- *C. x paradisi (1 cv)*

pathogenicity/susceptibility tests

partnership with producers, associations, botanical conservatory

- S3 chambers
- 8 - 18 months
new detection tools for insect vectors

high performance molecular tools for identification of vectors + Xf strains + ... plants they fed on

→ screening hundreds of vectors without dissection for presence of Xf (10 €/unit)
→ preliminary identification of strains carried (25€/unit for 7 loci)
→ will be used on sample insect bulks to quickly assess the local presence of Xf strains
building reference databases for identification

DNA sequences of vectors and host plants

European vectors

40 species
BLAST tool

Corsican plant database

collaborative local network (sampling)
- olive producers (AFIDOL)
- National Botanical Conservatory Corsica

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12
adaptation of standard epidemic models

- postulation of introduction date in 80's (modeling + phylogeny)
- postulation of hidden reservoir of disease in Corsica
results: short-term response (18 months)

- improved tools for detection: bacteria in plants
  bacteria in insects
  → transfer to state agency (Anses) and EPPO

- postulation of introduction date (phylogeny + modeling)
- postulation of hidden reservoir of disease in Corsica
  → from eradication to containment strategy
  → first recommendations for prophylaxis
long term: deciphering ecological network

network of interaction between plants, vectors and bacteria using high-throughput molecular tools → developing prophylactic strategies for disease management
general context

- available data
- basic knowledge
- *ex-ante* risk analysis

EPPO / EFSA general guidelines

local context

- local host plants
- local vectors
- local conditions
- strain introduced

specific ecology

need of

- local data
- efficient tools for detection
- local expertise

→ identification of competences
→ funding for short-term project

transboundary plant pests
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anticipating the next crisis
improving risk assessment

a case-study on the pinewood nematode, a vector-borne pathogen causing pine wilt disease

*Bursaphelenchus xylophilus*

present in Europe but not in France; introduction is feared; surveillance is intense

a study by Marie Grosdidier, Marine Marjou & Lucie Michel (PF ESV)
improving risk assessment

from random sampling to risk-based approach: targeting high-risk areas for improving the surveillance strategy

\[ W_i = R_{0i} \times P_i \]

- \( W_i \): estimated risk at site \( i \)
- \( R_{0i} \): expected epidemic severity at site \( i \)
- \( P_i \): introduction probability at site \( i \)

based on Parnell et al., 2014
estimating potential epidemic size

\[ R_{0i} = \text{expected epidemic severity in quadrant } i, \text{ based on host density} \]

3 models tested:

a) \[ R_{0i} = 1 - \exp(a \times \text{host density}) \]

b) \[ R_{0i} = \text{prob}((\text{host density})^3) \]

c) \[ R_{0i} = \frac{1}{1 + \exp(a \times \text{host density} + b)} \]
estimating introduction probability

\[ P_i = \text{introduction probability at site } i \],
based on the number of sensitive neighbor sites

\[ P_i = \frac{SS_i}{\text{max} (SS)}, \text{ with } SS = \text{number (or weight) of sensitive sites} \]

sensitive sites: wood industry and activities
is sampling effort optimal with regards to risk?

risk = expected epidemic size \times introduction probability

Samplings: wood material + insect vector 2013-2018

- red: insufficient sampling
- blue: excessive sampling
proposition of optimal sampling design

- targeting both sensitive and low-risk areas
- for 300 insect traps
- based on estimated risk
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conclusions
need of data sets
need of precision

general data (available) → potential risks
specific data (not available) → local risk

• better surveillance
• adapted strategies

anticipation is crucial (eradication is difficult)

• identification of competences → task force
• fast data processing and analysis → risk analysis, containment strategies
• funding for short-term projects

long term: new tools can be used for research on prophylaxis, breeding, ecology, ...
Plateform for Plant Health Surveillance (PF ESV)
French cooperation at international level

Efficient action against transboundary pests requires international cooperation

**Euphresco**: A network of organisations funding coordinated research projects

Initiated as an EU funded ERA-NET in 2006 → now 70 organizations (>50 countries)

**Bilateral cooperation**

- **Joint linkage calls**: e.g. Inra - CSIRO call
  → Genomic tools for risk assessment of invasive fall armyworm *Spodoptera frugiperda*

- **Joint labs**: e.g. Inra-BFU Joint laboratory on Invasive Forest Pests in Eurasia

**Research Article**

*Planting Sentinel European Trees in Eastern Asia as a Novel Method to Identify Potential Insect Pest Invaders*

Alain Roques¹, Jian-ting Fan², Béatrice Courtil¹, Yan-zhuo Zhang³, Annie Yart¹, Marie-Anne Auger-Rozenberg¹, Olivier Denum¹, Marc Kenis⁴, Richard Baker⁵, Jiang-hua Sun⁶
thank you for your attention