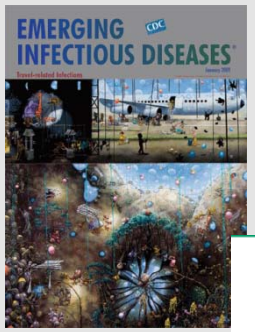
Emerging Risks in Plant Health: from plant pest interactions to global change

efsa
European Food Safety Authority

What makes for an emerging invasive species?

Marie-Laure Desprez-Loustau,
INRA UMR BIOGECO, Bordeaux

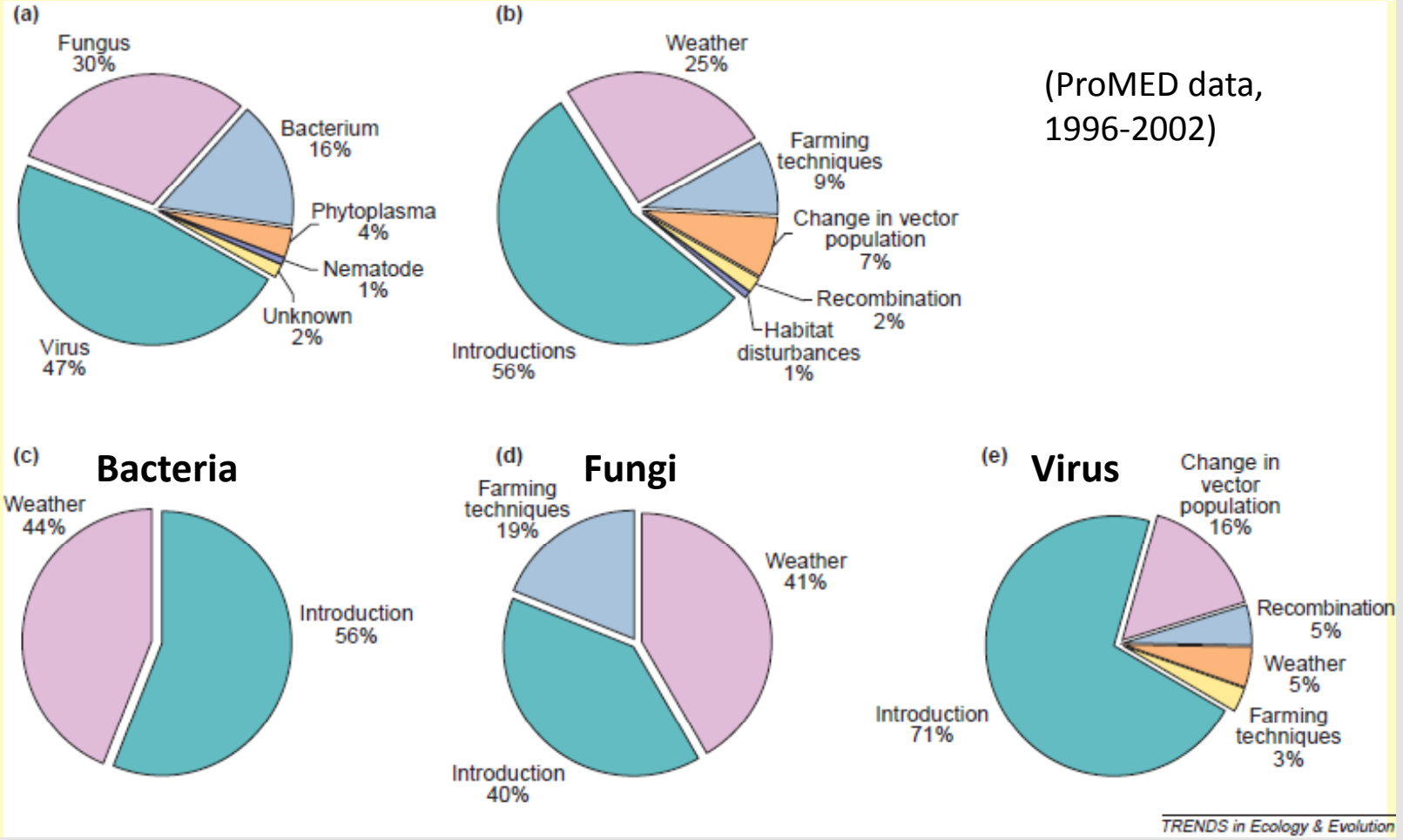


Introductions of pathogens account for a majority of plant emerging diseases

Review TRENDS in Ecology and Evolution Vol.19 No.10 October 2004 539

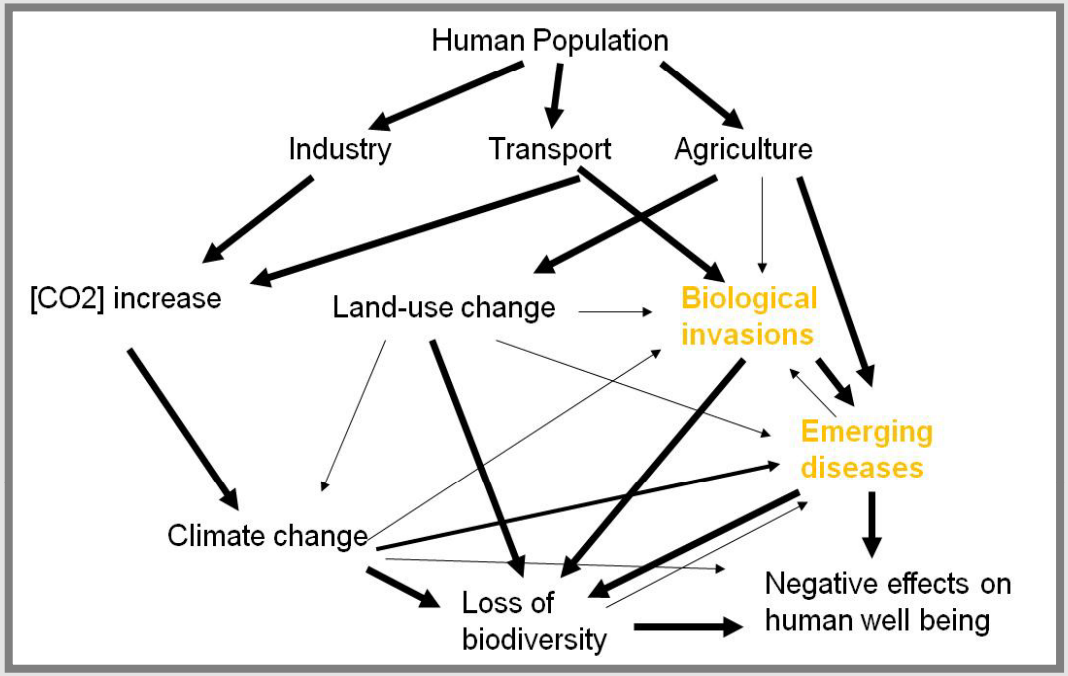
Pamela K. Anderson[1], Andrew A. Cunningham[2], Nikkita G. Patel[3], Francisco J. Morales[4], Paul R. Epstein[5] and Peter Daszak[3]

Box 1. Characteristics of the pathogens and drivers of emerging infectious diseases of plants

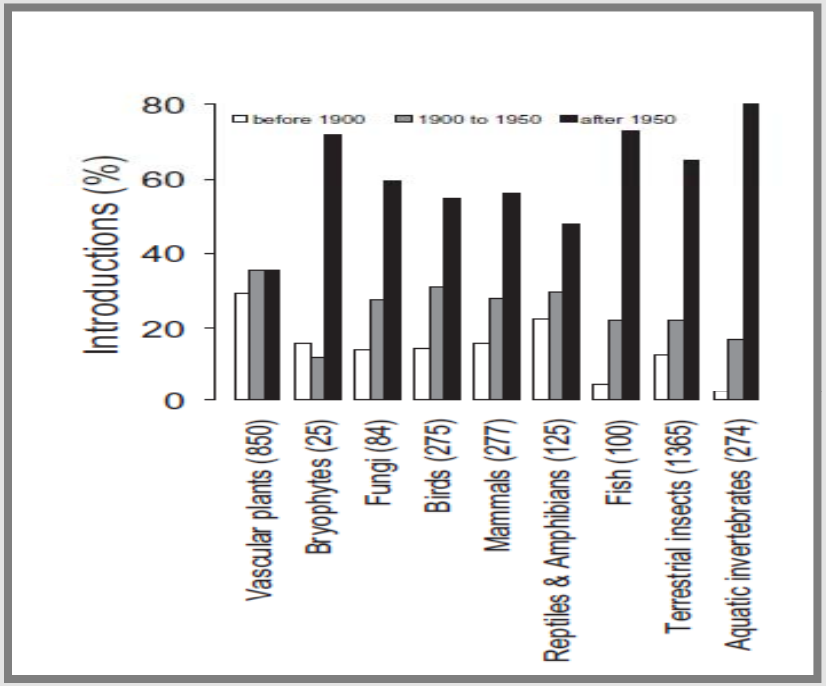


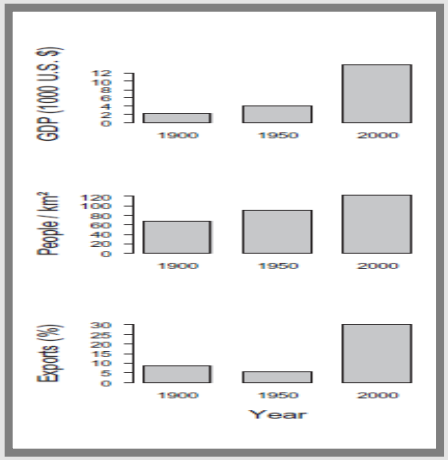
(ProMED data, 1996-2002)

The rising issue of biological invasions



(from Vitousek, Ecology 1994)





(Pysek et al, PNAS 2010 - Essl et al , PNAS 2011)

Seeking patterns and generality in order to predict : the « Holy Grail » of invasion ecology

Diversity and Distributions, (Diversity Distrib.) (2009) **15**, 22–40

BIODIVERSITY REVIEW

Reducing redundancy in invasion ecology by integrating hypotheses into a single theoretical framework

Jane A. Catford[1]*, Roland Jansson[2] and Christer Nilsson[2]

Perspectives in Plant Ecology, Evolution and Systematics 13 (2011) 89–100

Contents lists available at ScienceDirect

Perspectives in Plant Ecology, Evolution and Systematics

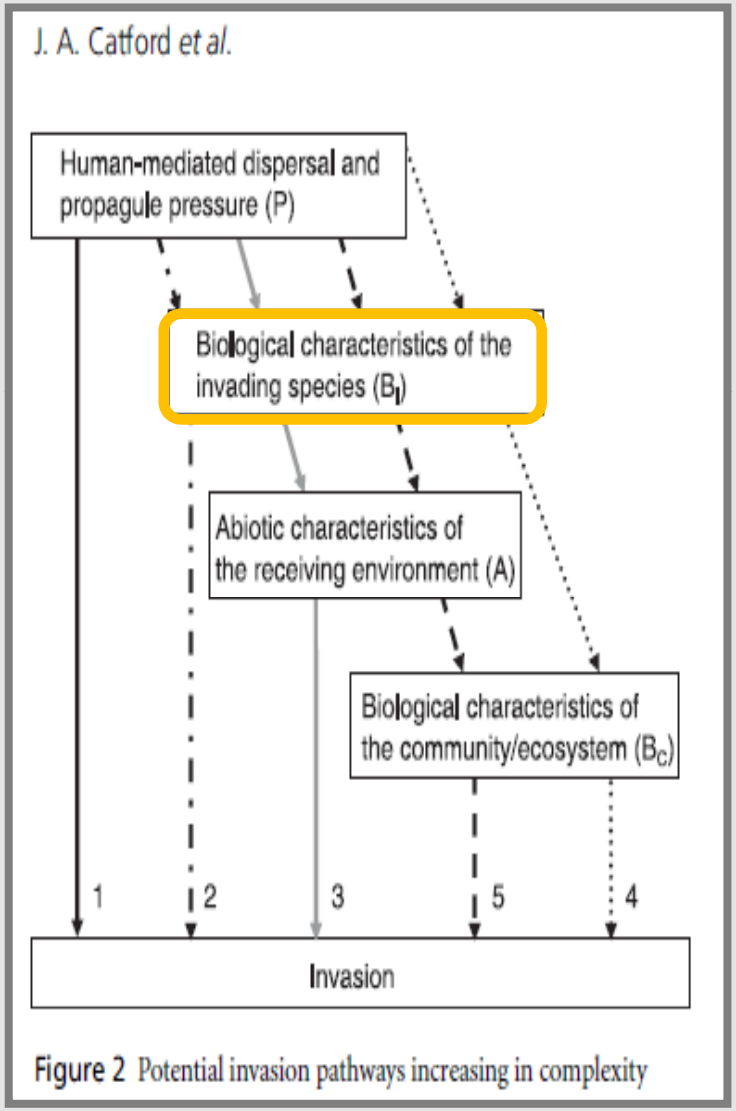
journal homepage: www.elsevier.de/ppees

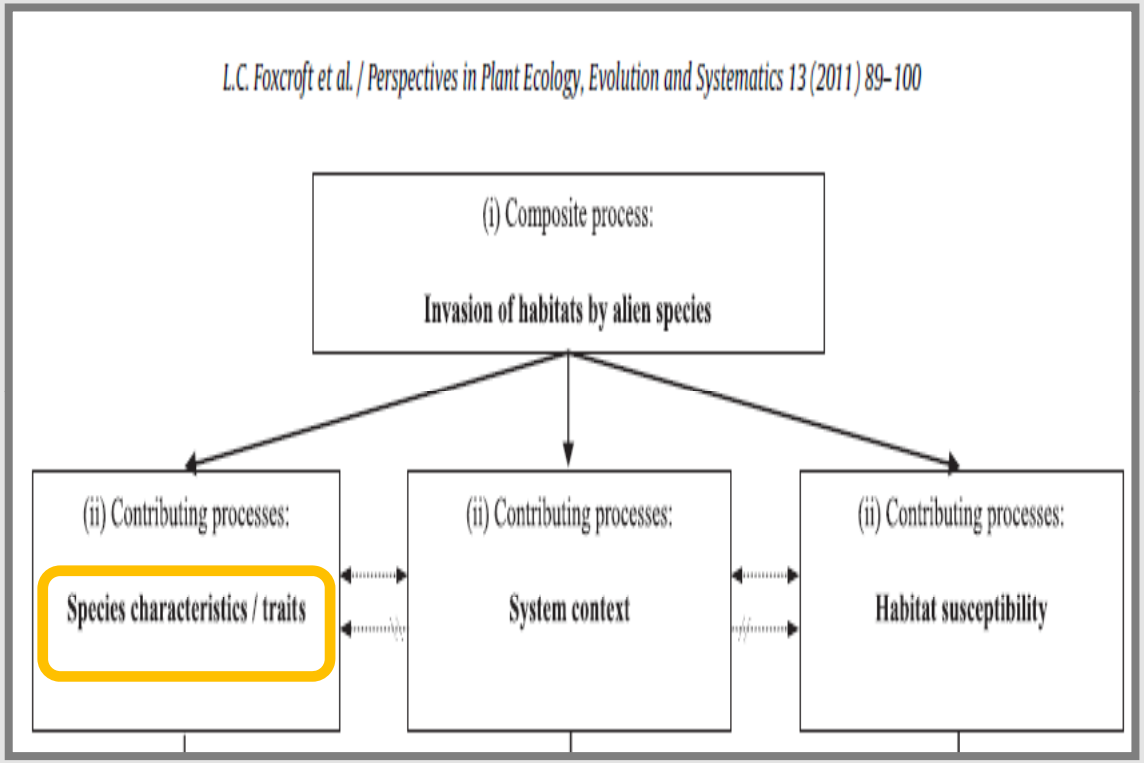
Review

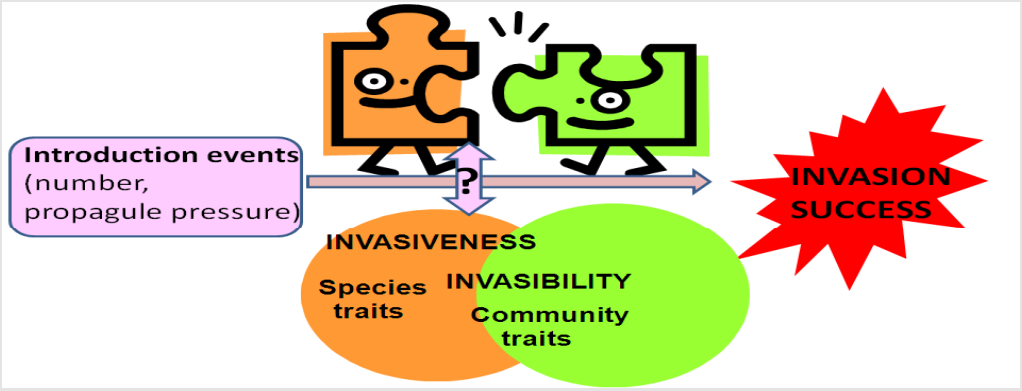
Expanding the conceptual frameworks of plant invasion ecology

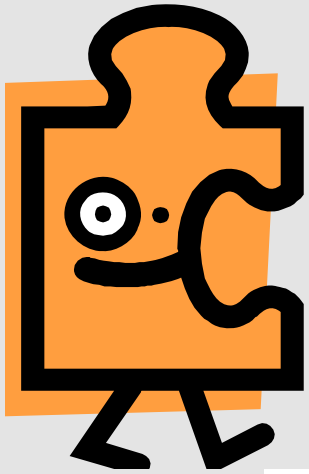
Llewellyn C. Foxcroft[a,b,*], Steward T.A. Pickett[c], Mary L. Cadenasso[d]

Seeking patterns and generality: characteristics of invasive species









A long-lasting question: Making the portrait of the ideal invader…

Biological Invasions: a Global Perspective
Edited by J. A. Drake *et al.*

CHAPTER 12

Attributes of Invaders and the Invading Process: Terrestrial and Vascular Plants

IAN R. NOBLE

Biol Invasions (2008) 10:483–506
DOI 10.1007/s10530-007-9146-5

ORIGINAL PAPER

Are there any consistent predictors of invasion success?

Keith R. Hayes · Simon C. Barry

ECOLOGY LETTERS

Ecology Letters, (2010) **13**: 947–958 doi: 10.1111/j.1461-0248.2010.01503.x

IDEA AND PERSPECTIVE

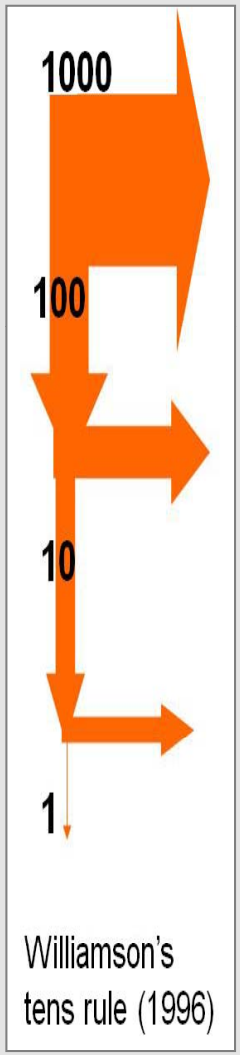
Are invaders different? A conceptual framework of comparative approaches for assessing determinants of invasiveness

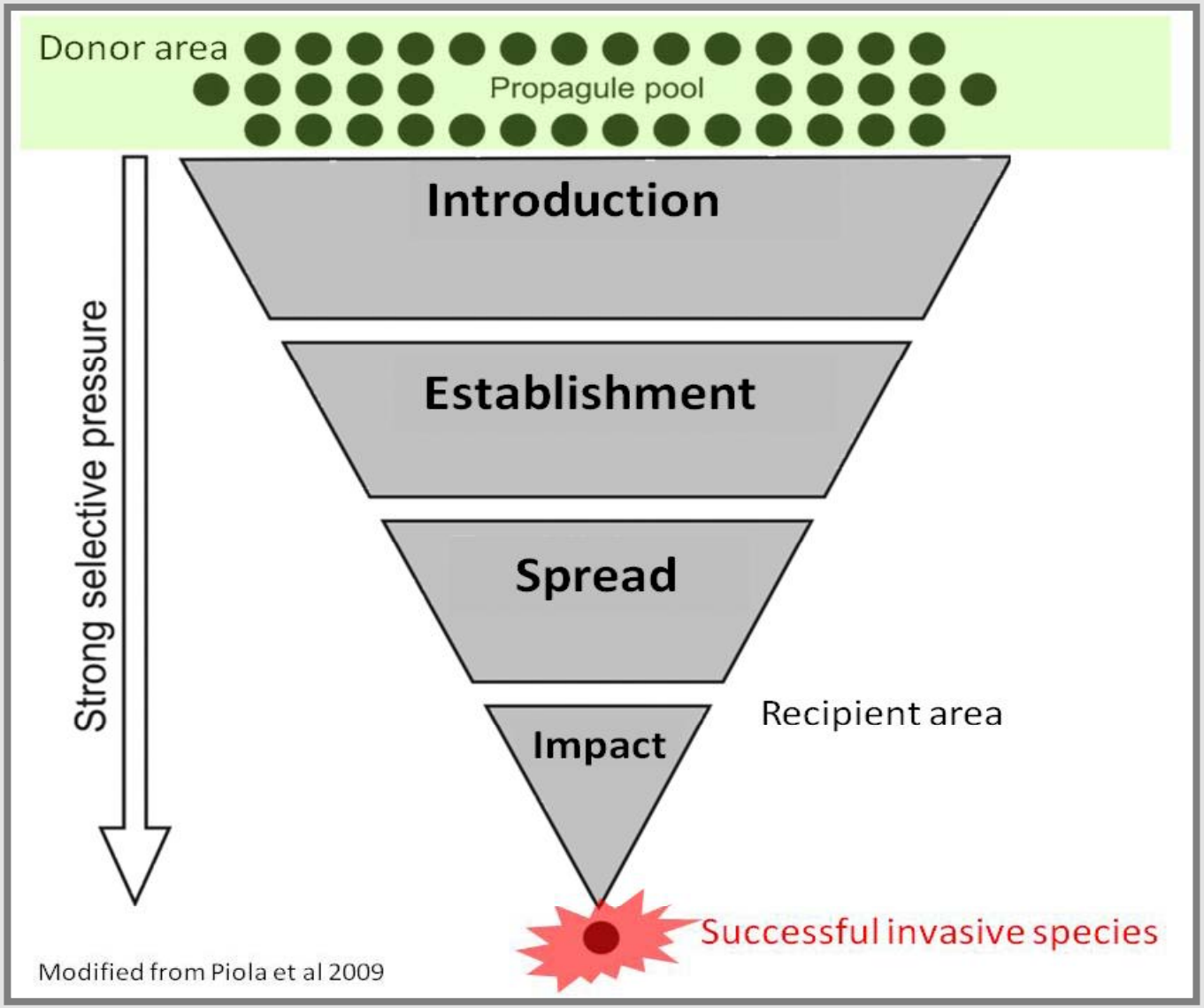
Mark van Kleunen,[1]* Wayne Dawson,[1] Daniel Schlaepfer,[1,2] Jonathan M. Jeschke[3,4] and Markus Fischer[1]

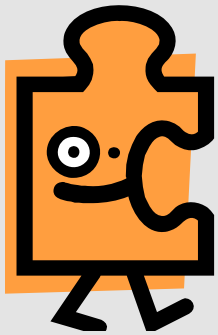
Abstract

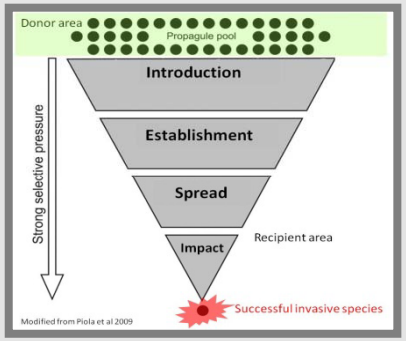
What determines invasiveness of alien organisms is among the most interesting and urgent questions in ecology. In attempts to answer this question, researchers compare invasive alien species either to native species or to non-invasive alien species, and this is done in either the introduced or native ranges. However, inferences that can be drawn

Invasive species have characteristics which allow them to go successfully through a highly selective process…

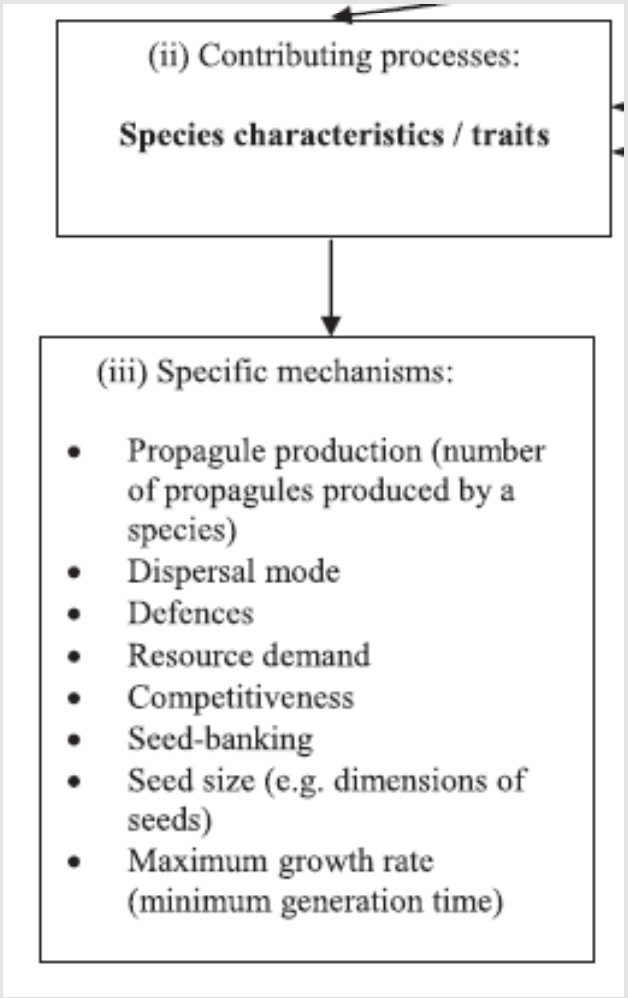








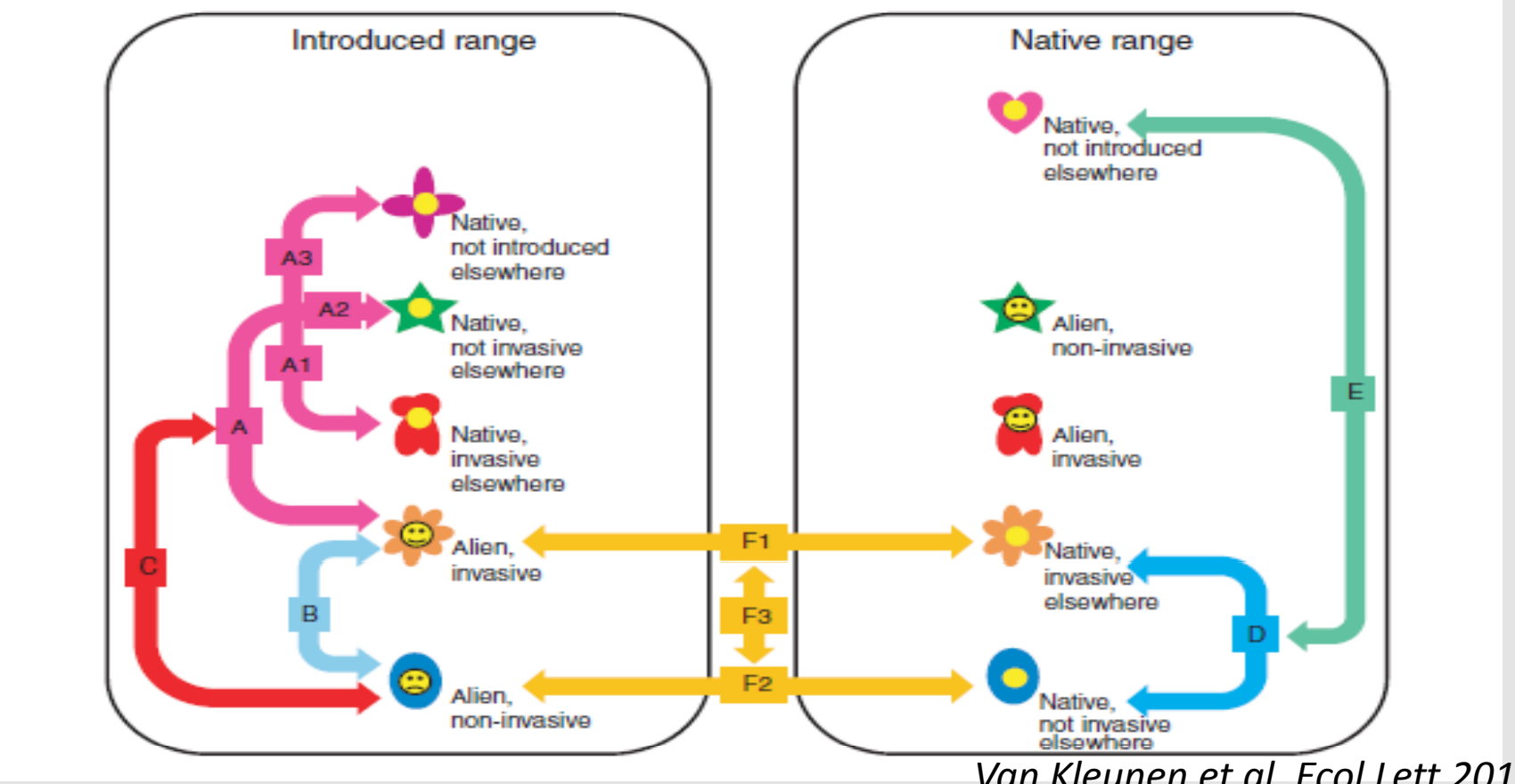
Which traits?



EPPO PRA

Question	Rating + uncertainty	Explanatory text of rating and uncertainty
1.25. How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment?		
1.26 How likely are relatively small populations to become established?		
1. 27 How adaptable is the pest?		

Testing determinants of invasiveness: the comparative approach



Van Kleunen et al, Ecol Lett 2010

Many studies for plants and animals but very few for plant pests:

- lack of data,
- unknown origin (non deliberate introductions),
- native-alien comparisons less relevant (inter-trophic interactions >> competition)

DAISIE 2005-2008: First all-taxa inventory of alien species at continental scale (Europe)

DAISIE

http://www.europe-aliens.org/

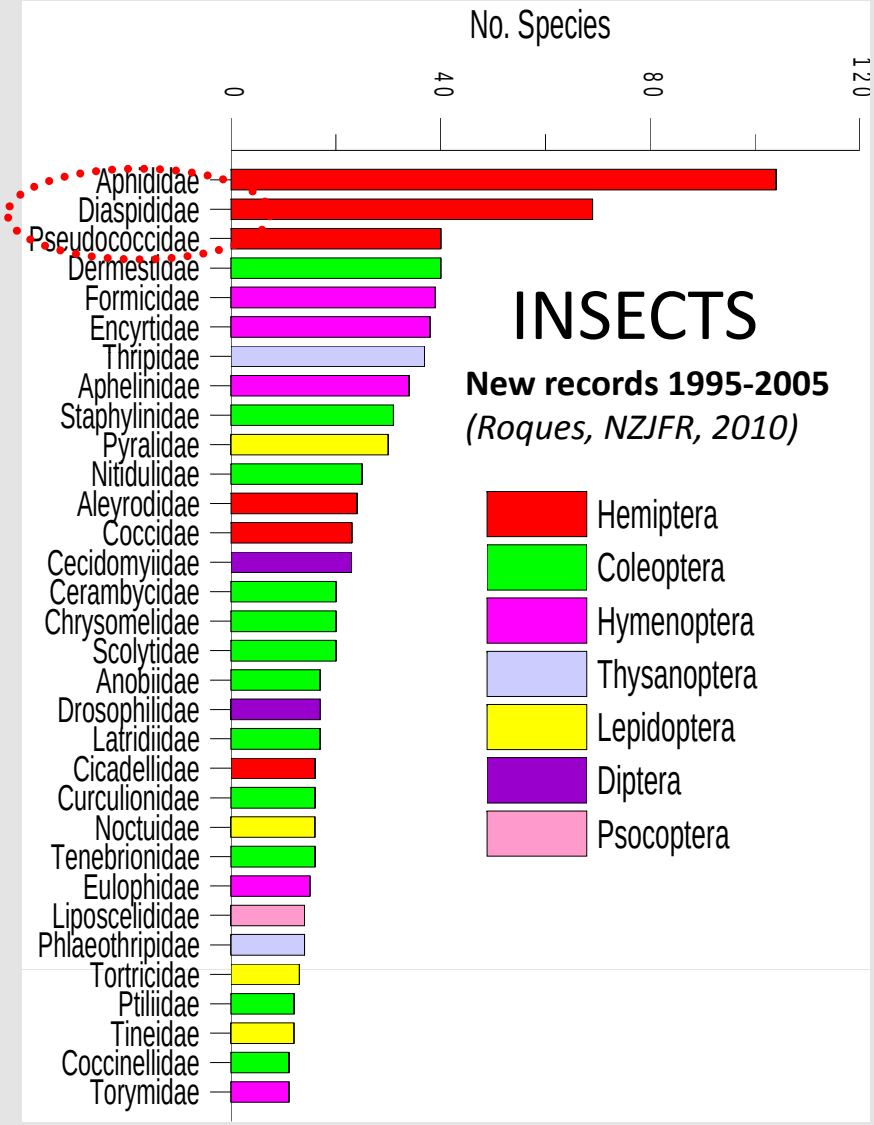
- 10 711 alien species
- 45 211 introduction events

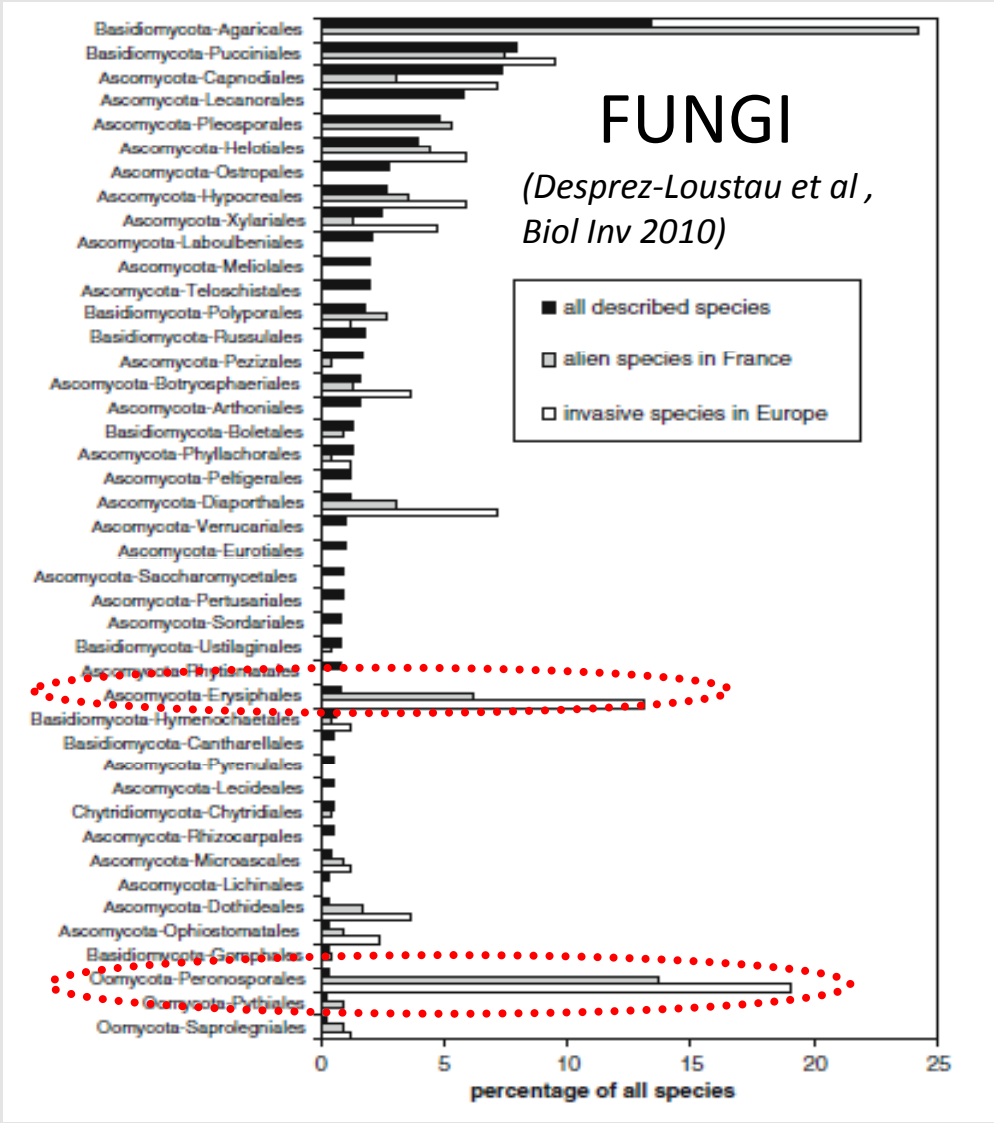
Desprez-Loustau, Fungi –
Roques, Terrestrial invertebrates

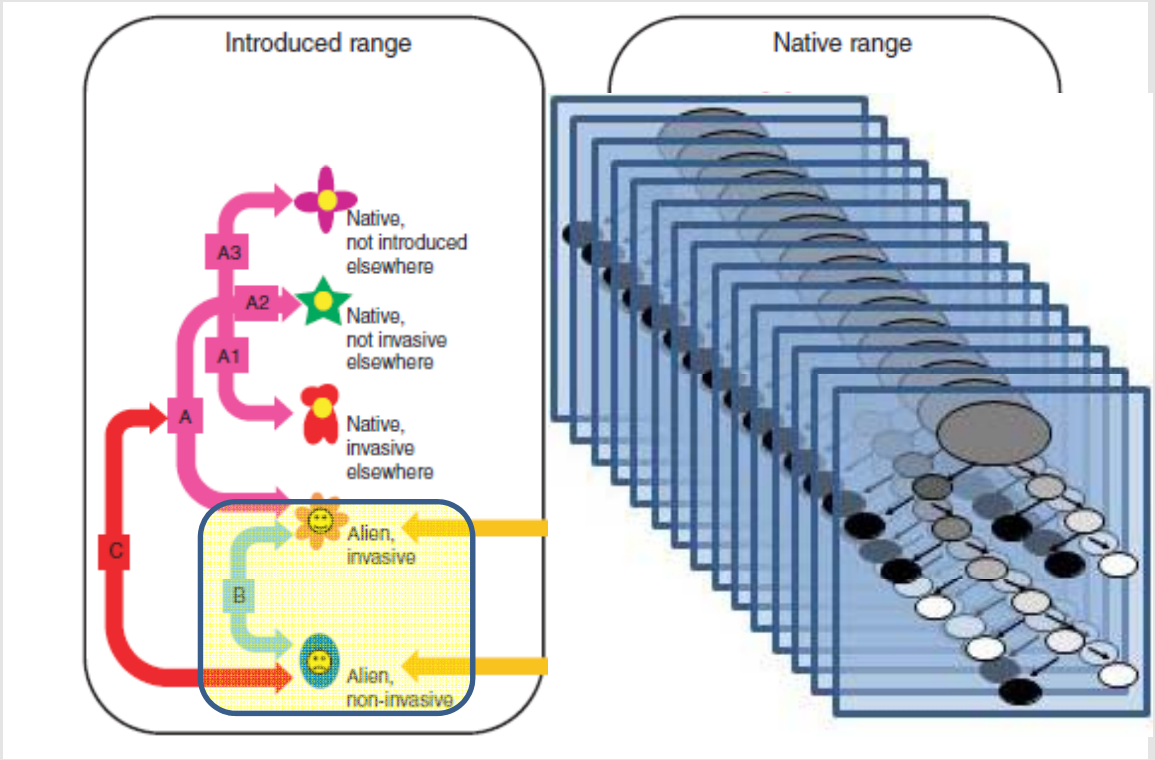
- **688 alien fungi (227 en France)- 84 forest pathogenic fungi**
- **1517 alien terrestrial invertebrates**

(Desprez-Loustau et al, 2010 Biol Inv)

Some taxonomic groups are over-represented in introduced aliens







- 47 species of **forest pathogenic fungi** + ***Phytophthora*** spp
- invasion history, distribution and impact in Europe
- 19 traits + residence time, potential habitat
- Random Forest

What is the predictive value of traits for invasive success/ disease emergence?

= which traits, if any, best classify invasive species ?

Philibert et al , JAE in press

Models including traits have better predictive value than « null » models

⇒ Prediction of invasive success at ~78 % with cross-validation
⇒ The most important traits* related to invasive species are:

- Spore characteristics (shape, size)
- Mode of long distance dispersal

DISPERSAL

- Sexual reproduction
- Host range
- Biotrophy

PARASITIC STRATEGY, EVOLVABILITY

- Optimal temperature for growth

CLIMATE MATCHING

* Accounting for residence time – No effect of phylogeny

Philibert et al , JAE in press

ECOLOGY LETTERS

Ecology Letters, (2010) **13**: 506–515 doi: 10.1111/j.1461-0248.2010.01445.x

LETTER

Novel insect-tree associations resulting from accidental and intentional biological 'invasions': a meta-analysis of effects on insect fitness

Coralie Bertheau,[1] Eckehard G. Brockerhoff,[2] Géraldine Roux-Morabito,[1] François Lieutier[1] and Hervé Jactel[3]*

Abstract

The translocation of species beyond their native range is a major threat to biodiversity. Invasions by tree-feeding insects attacking native trees and the colonization of introduced trees by native insects result in new insect–tree relationships. To date there is uncertainty about the key factors that influence the outcome of these novel interactions.

Table 1 Effect of forest insect host specificity on Hedges' effect size

Class variable	Sample size	Hedges' effect size §	Bias corrected bootstrap CI
All tree species $n = 346$, $P = 0.0001$			
Monophagous insects	121	**−1.25**	−1.58 to −0.94
Oligophagous insects	74	**−0.48**	−0.89 to −0.13
Polyphagous insects	151	+0.01	−0.41 to +0.42

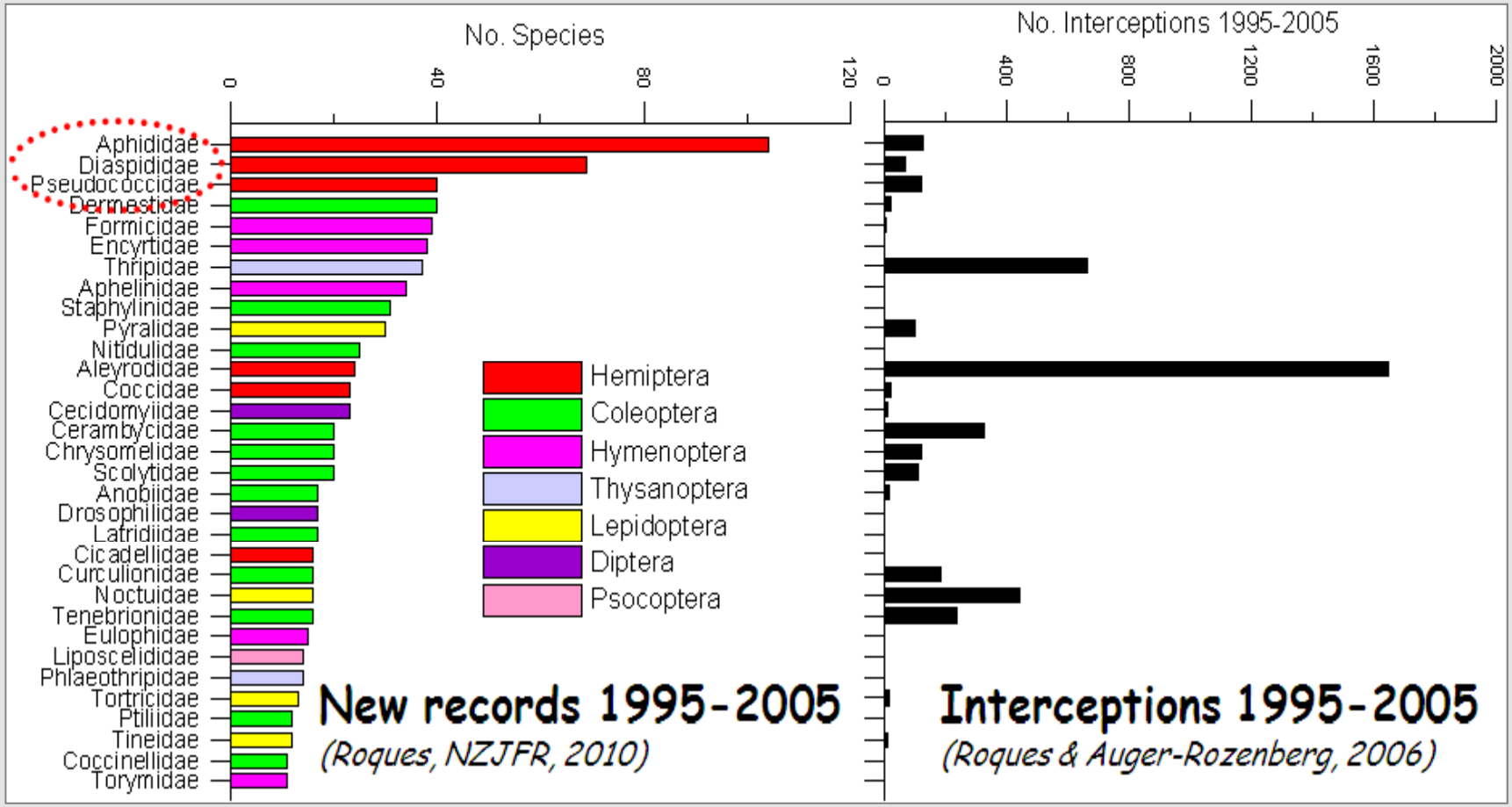
Insect specialization

…but some spectacular and damaging invasions are caused by specialized species, mostly occuring on congeneric species of their native host

Species traits and invasiveness : some thoughts about implications for plant health, gaps and open questions…

1. Quarantine measures and the species level:

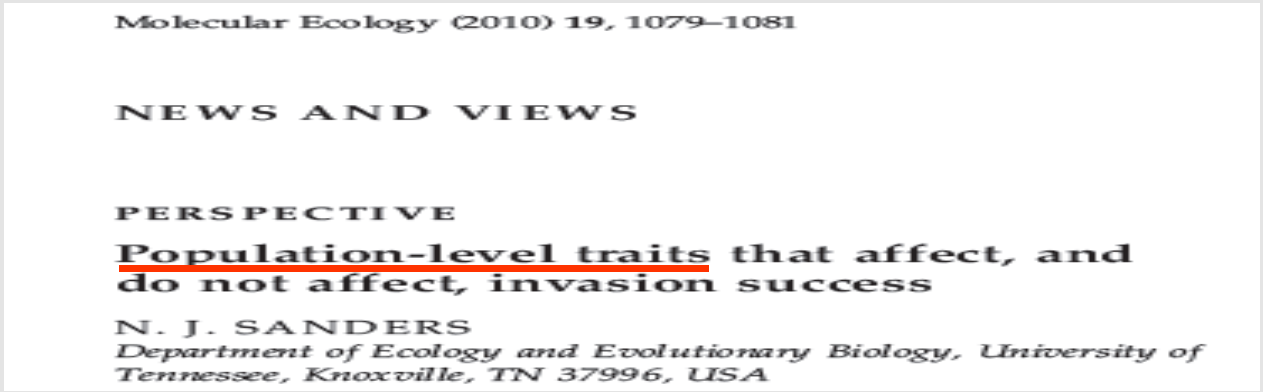
- Too narrow?



Some thoughts… (2)

1. Quarantine measures and the species level:

➢ Too wide?



Molecular Ecology (2010) 19, 1079–1081

NEWS AND VIEWS

PERSPECTIVE

Population-level traits that affect, and do not affect, invasion success

N. J. SANDERS
Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, TN 37996, USA

Genetic diversity
Population density

Invasive ≠ Invading

Multiple introductions

Some thoughts… (3)

2. Species traits are useful

- Merits of an interdisciplinary approach (Ecology & Epidemiology)
- Support to PRA approaches

From checklists to strategies and functional groups

theoretical framework, machine-learning methods

Biological Invasions: a Global Perspective
Edited by J. A. Drake *et al.*

CHAPTER 12

Attributes of Invaders and the Invading Process: Terrestrial and Vascular Plants

IAN R. NOBLE

12.2 THE IDEAL INVADER

The best known description of invasive plants is Baker's (1965) description of the 'ideal weed'. In summary, an ideal weed is a plastic perennial which will germinate in a wide range of physical conditions, grow quickly, flower early, is self-compatible, produces many seeds which disperse widely, reproduces vegetatively and is a good competitor. However, as Baker points out, no one species is likely to possess all these characters; nor does a species need all these features to be a successful invader. Conversely, the possession of a single, or indeed several, characters from the list does not mean the species will be a successful invader.

Some thoughts… (4)

2. Species traits are useful but …
(What about bacteria and viruses?)

- Lack of datasets

- Knowledge gaps in processes and mechanisms:
  - population dynamics and dispersal: within/between seasons; from the field to the landscape (modelling)

  - host shift

ZOOLOGIA 27 (2): 151–162, April, 2010
doi: 10.1590/S1984-46702010000200001

INVITED REVIEW

How specialists can be generalists: resolving the "parasite paradox" and implications for emerging infectious disease

Salvatore J. Agosta[1, 3]; Niklas Janz[2] & Daniel R. Brooks[1]

Some thoughts… (5)

3. Plant health risks

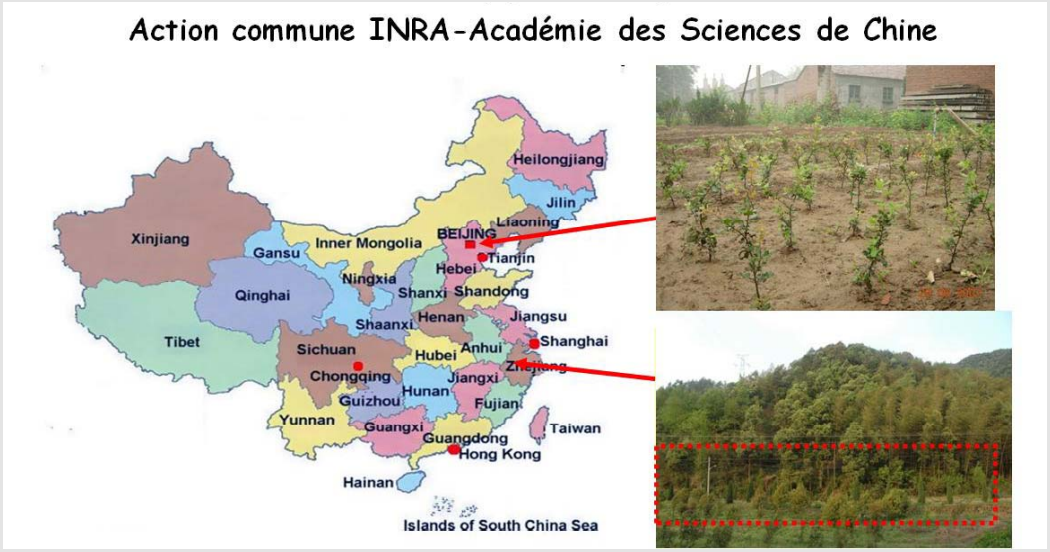
- Plant health = crops + « wild » plants (indigenous forest trees)

ecological impacts in addition to economic impacts

less globalized distribution of pathogens => more uncertainty?

Unknown species + host shifts,

Sentinel trees : a new predictive approach

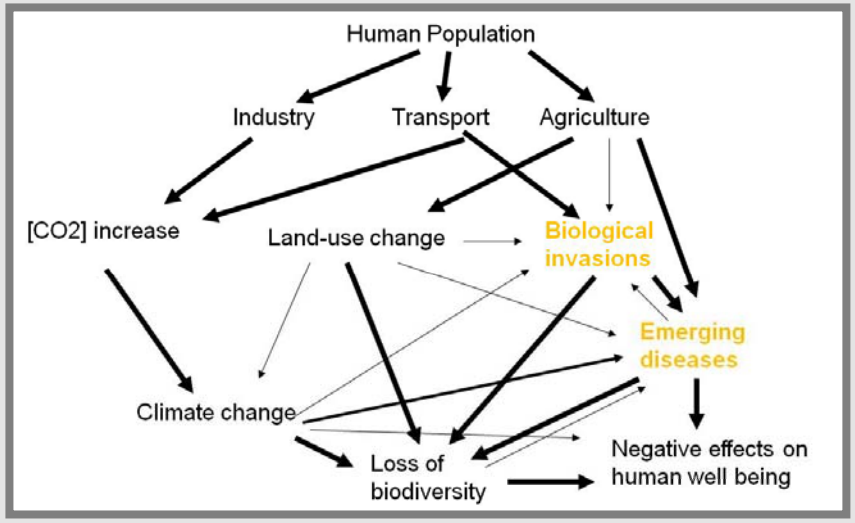


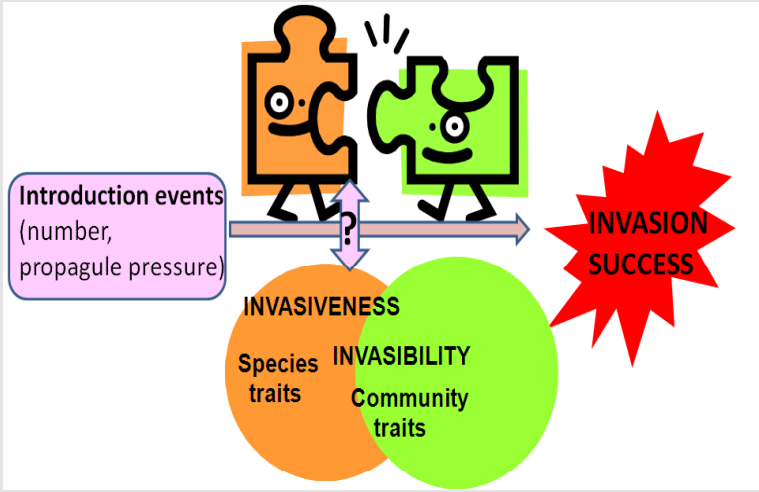
(Roques)

Some thoughts… (5)

3. Plant health risks

- Tracking the « ideal invader » or emerging pest will not solve the problem: the negative effects of introductions of exotic pests are amplified by <u>interactions with other components of global and local change</u> :
  climate, management practices (diversity and invasibility)





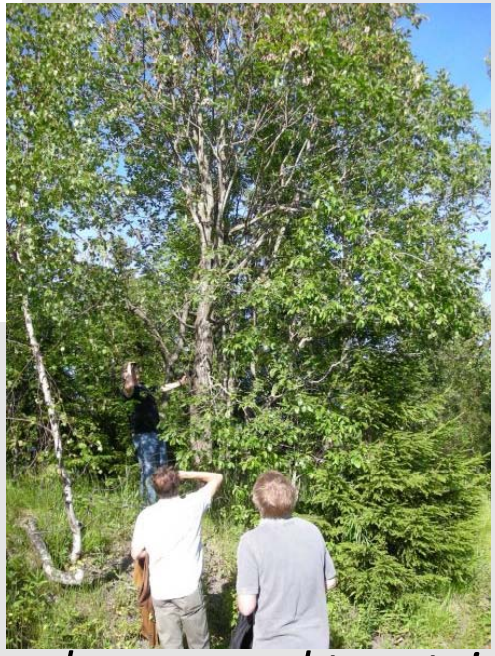
Plant Pathology (2011) 60, 31–43 Doi: 10.1111/j.1365-3059.2010.02407.x

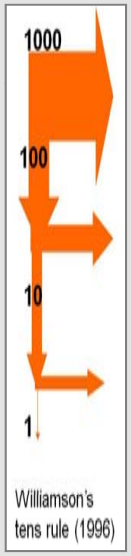
REVIEW

Geographic distribution of plant pathogens in response to climate change

M. W. Shaw[a*] and T. M. Osborne[b]

EPPO meeting, Chalara fraxinae





« *What can be said is that [climate] change will bring, above all,* ***surprises****.* »

"the ***uncertainty*** *in predictions of change is so great that the important adaptive response is to* ***monitor*** *changes and to retain the* ***capacity to innovate****, both by access to economic capital with reasonably long-term rates of return and by retaining* ***wide scientific expertise****, including currently less fashionable specialisms"*

In a context of higher and mostly unpredictable risks, increase /create **resilience** and **adaptability** in productive systems

Aknowledgements

efsa
European Food Safety Authority

INRA

DAISIE
http://www.europe-aliens.org/

PRATIQUE

Agence Nationale de la Recherche
ANR

EMERFUNDIS

Thank you for your attention