Interreg Sudoe

EUROPEAN UNION

Transnational plans for the management of forest risks

PLURIFOR

European Regional Development Fund

Conservation biological control for the management of exotic forest pests

Hervé Jactel

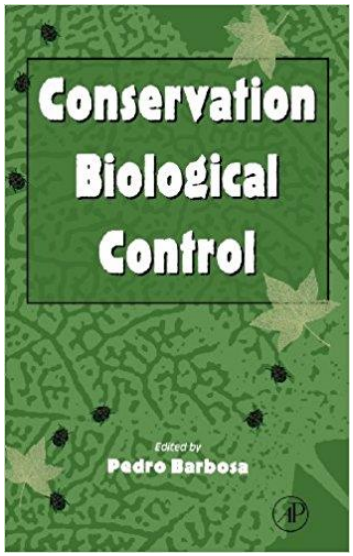
INRA SCIENCE & IMPACT

Conservation Biological Control: Definition

Pests can be biologically controlled by two ways.

First, by importing **exotic natural enemies** that destroy pests = **classical** biological control

Second, by conserving the **native natural enemies** of the pests that are already there or are readily available = **conservation** biological control



Conservation Biological Control: Concept

Habitat manipulation to enhance native natural enemies
So that they are sufficiently abundant and locally present to effectively control new pests

By providing:

- **Alternate feeding resources**: other prey (predators) or hosts (parasitoids)
- **Complementary feeding resources**: pollen, nectar, honeydew (for adult parasitoids)
- **Shelter** for protection against adverse weather conditions, super predators (spiders), hyper parasitoids, for egg-laying, overwintering

Conservation Biological Control: Concept

The key condition:
Native natural enemies need to be **generalists** enough to be able to shift onto the new (exotic) host or prey

More likely to occur when the new host or prey belongs to same family or feeding guild as the native hosts or prey

Conservation Biological Control: in agriculture

Flower strips

Beetles bank

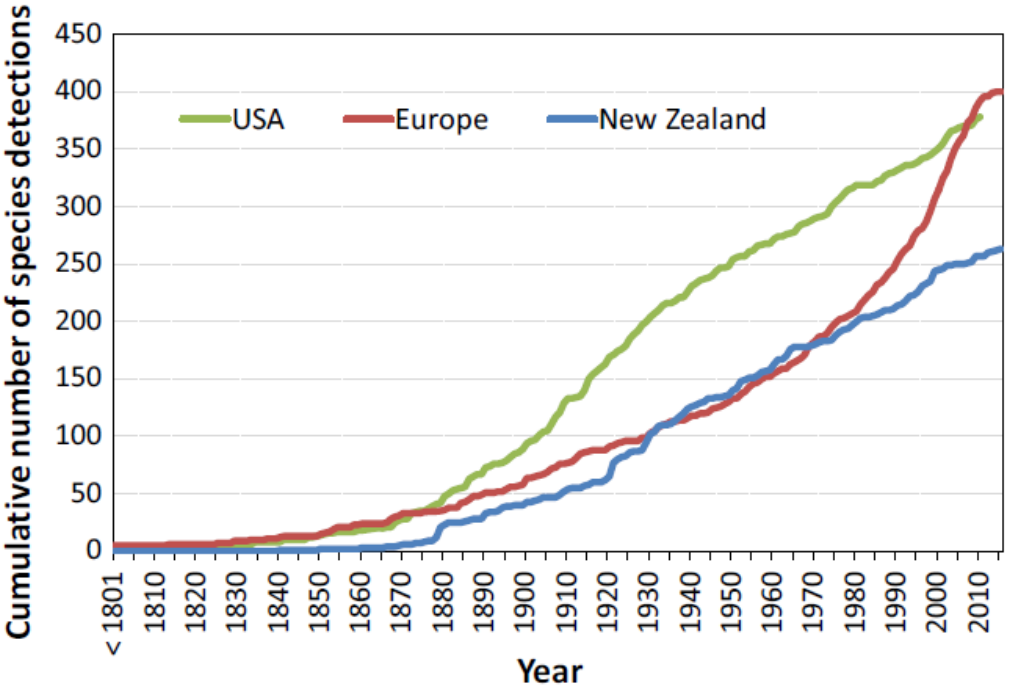
Intercropping

Hedgerows

Conservation Biological Control: in forest ?

Ecology of forest insect invasions

E. G. Brockerhoff · A. M. Liebhold

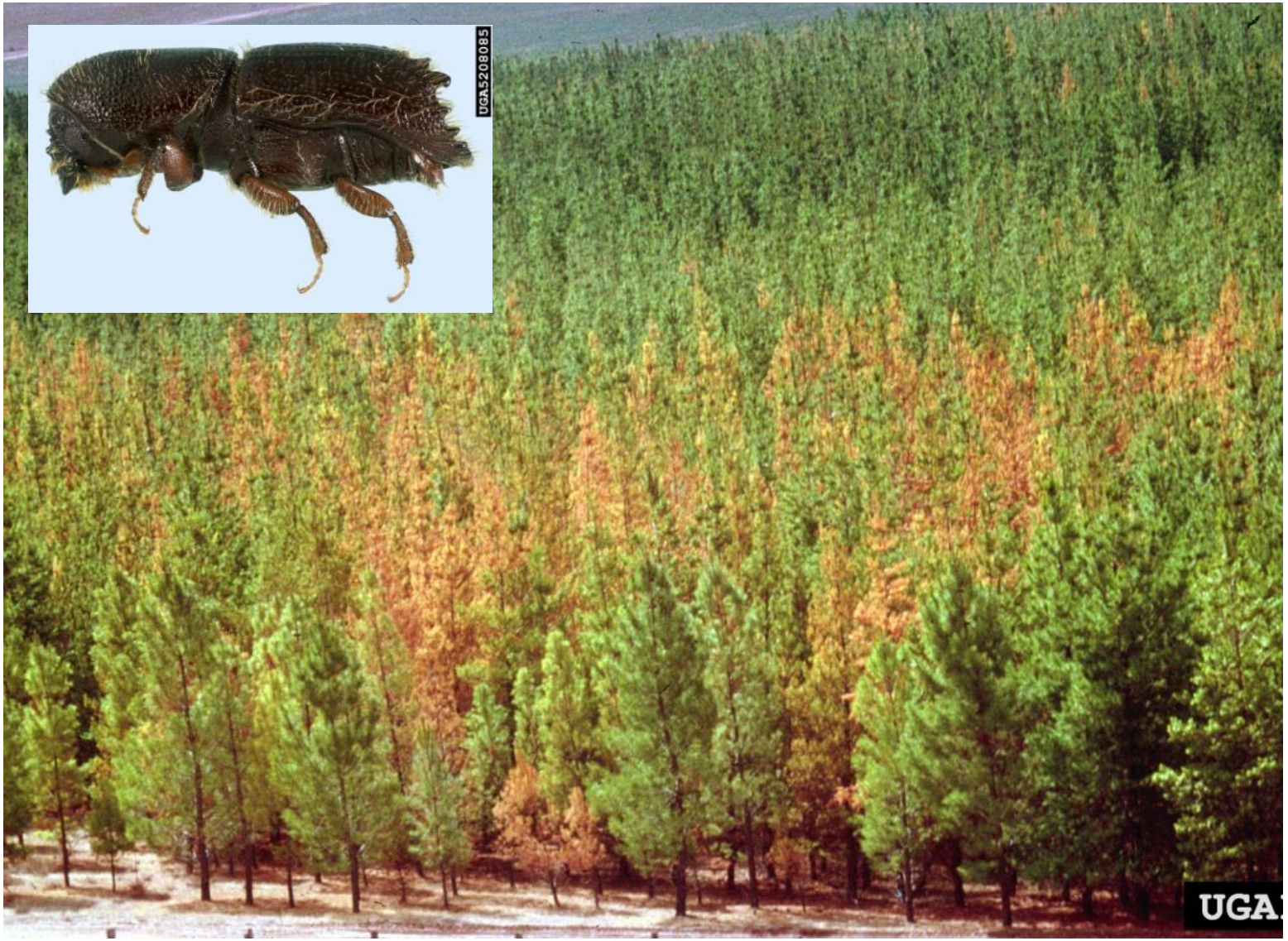


Web of Science

« conservation biological control » **= 632 references**

« conservation biological control » AND « forest pest» **= 1 reference**

Monocultures more invasible than mixed forests?



***Ips grandicollis* outbreak on *Pinus radiata* in Australia**

Does tree diversity drive resistance to invasive forest insects?

=

Conservation Biological Control in forest ?

Diversity drives resistance to (native) forest pests

Ecology Letters, (2007) **10**: 835–848 doi: 10.1111/j.1461-0248.2007.01073.x

LETTER

Tree diversity reduces herbivory by forest insects

Hervé Jactel[1]* and Eckehard G. Brockerhoff[2]

50 YEARS WITH IMPACT Journal of Applied Ecology 1913 2013 British Ecological Society CELEBRATING 100 YEARS

Journal of Applied Ecology 2014, **51**, 134–141 doi: 10.1111/1365-2664.12175

Effects of plant phylogenetic diversity on herbivory depend on herbivore specialization

Bastien Castagneyrol[1,2,3]*, Hervé Jactel[1,2], Corinne Vacher[1,2], Eckehard G. Brockerhoff[4] and Julia Koricheva[3]

Tree Diversity Drives Forest Stand Resistance to Natural Disturbances

Hervé Jactel[1] · Jürgen Bauhus[2] · Johanna Boberg[3] · Damien Bonal[4] · Bastien Castagneyrol[1] · Barry Gardiner[5] · Jose Ramon Gonzalez-Olabarria[6] · Julia Koricheva[7] · Nicolas Meurisse[8] · Eckehard G. Brockerhoff[9]

CURRENT FORESTRY REPORTS 2017

… but little evidence of resistance against non-native pests

Mechanisms?

How does biodiversity confer associational resistance?

1. Diversity reduced abundance of host trees

2. Diversity reduces physical or chemical detectability of host

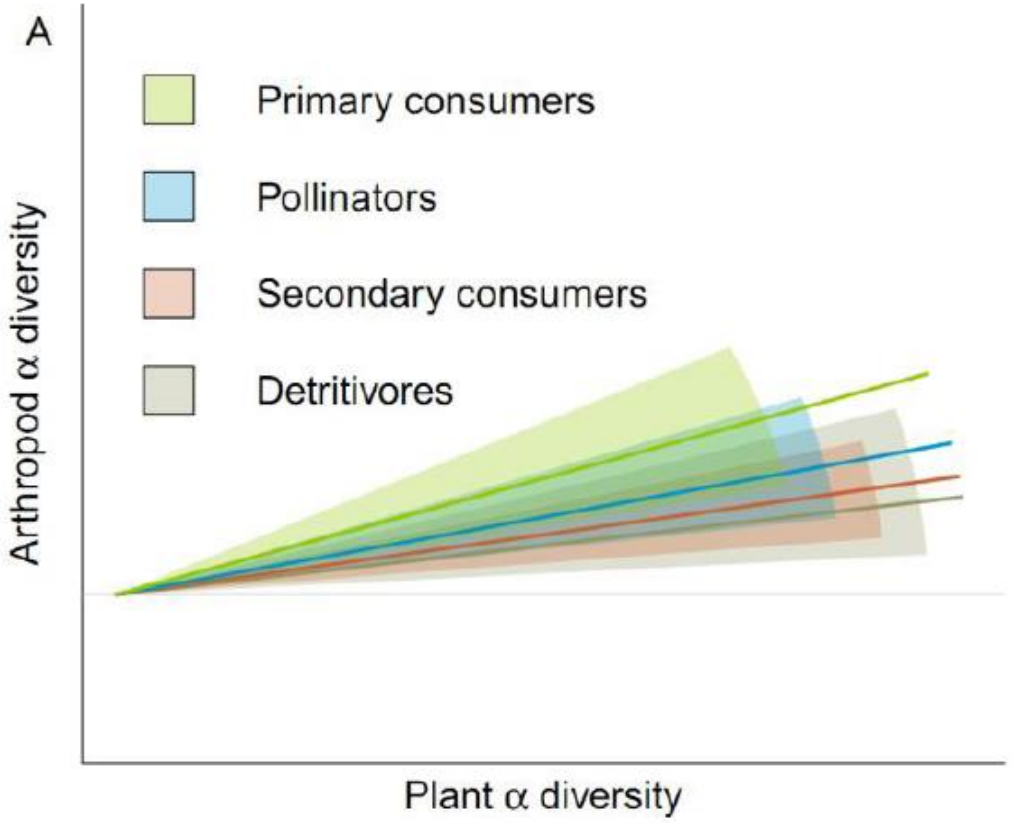
3. Diversity enhances *activity of natural enemies* of pests
   - more insect predators, parasitoids, insectivorous birds

   = conservation biological control mechanisms

Ecology, 93(9), 2012, pp. 2115–2124

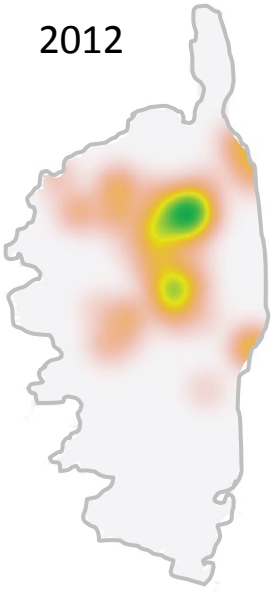
Unraveling plant–animal diversity relationships: a meta-regression analysis

Bastien Castagneyrol[1] and Hervé Jactel

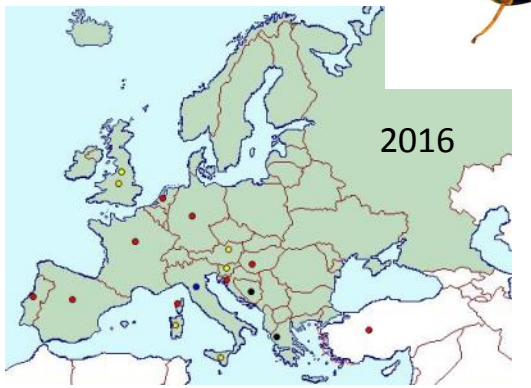


Two well studied invasive forest pests in Europe

Maritime pine bast scale
Matsucoccus feytaudi



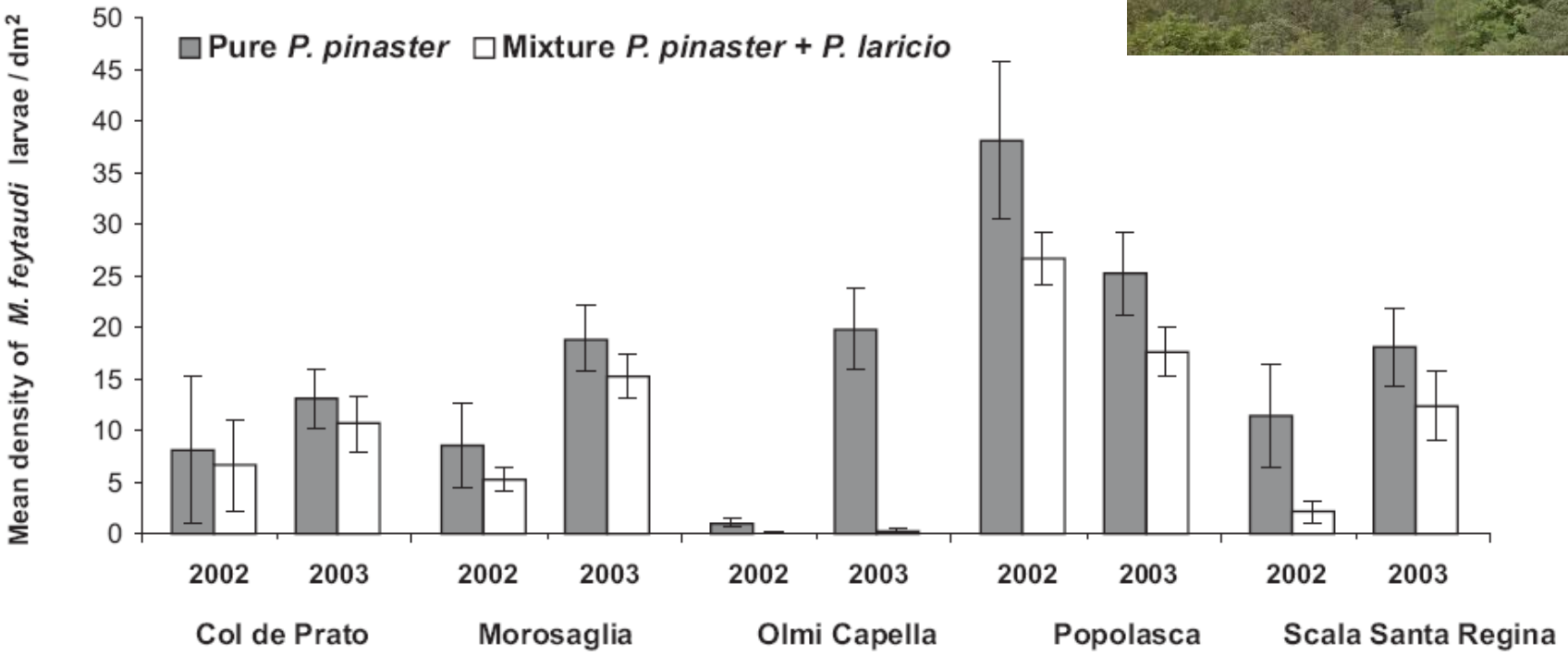
Asian chestnut gall wasp
Dryocosmus kuriphilus



CABI

Tree species diversity reduces the invasibility of maritime pine stands by the bast scale, *Matsucoccus feytaudi* (Homoptera: Margarodidae)[1]

H. Jactel, P. Menassieu, F. Vetillard, A. Gaulier, J.C. Samalens, and E.G. Brockerhoff



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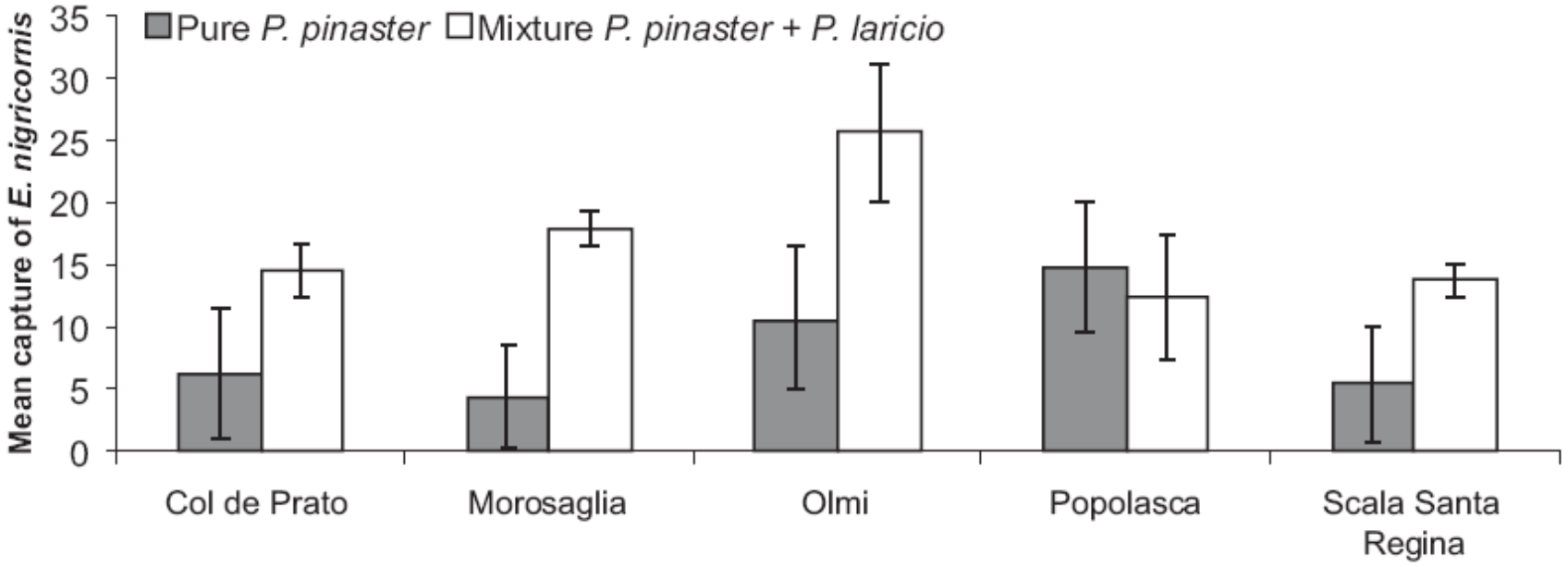

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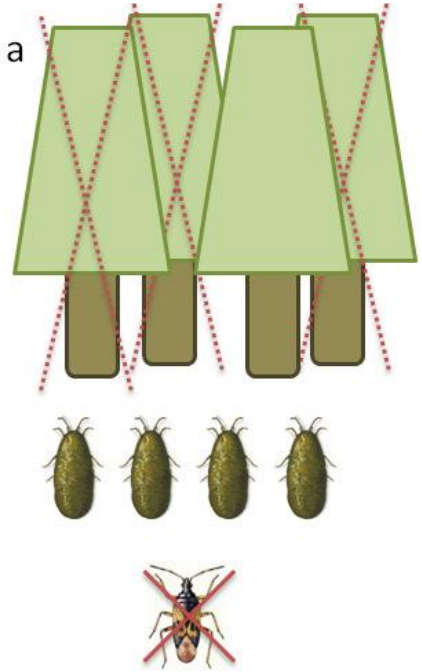
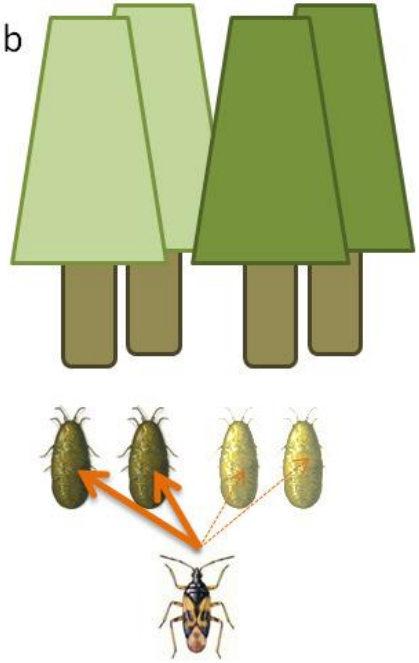
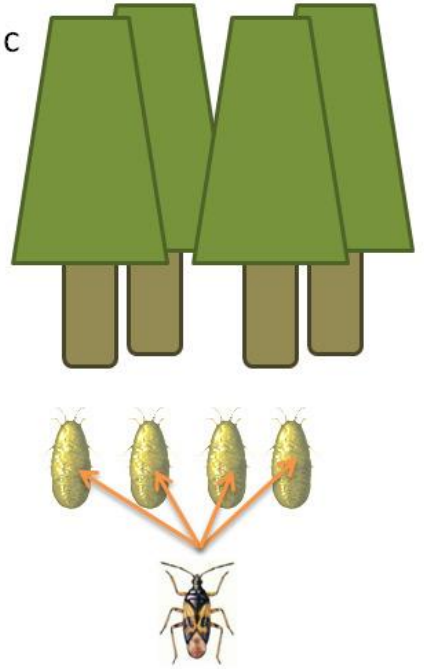
Pure maritime pine stand



Mixed stand of pines



Pure black pine stand



Matsucoccus feytaudi *Matsucoccus pini* *Elatophilus nigricornis*

Tree Diversity Limits the Impact of an Invasive Forest Pest

Virginie Guyot[1,4]*, Bastien Castagneyrol[3,4], Aude Vialatte[1,2], Marc Deconchat[1], Federico Selvi[5], Filippo Bussotti[5], Hervé Jactel[3,4]

Biol Invasions
https://doi.org/10.1007/s10530-017-1637-4

ORIGINAL PAPER

Plant neighbour identity and invasive pathogen infection affect associational resistance to an invasive gall wasp

Pilar Fernandez-Conradi · Nicolas Borowiec · Xavier Capdevielle · Bastien Castagneyrol · Alberto Maltoni · Cécile Robin · Federico Selvi · Inge Van Halder · Fabrice Vétillard · Hervé Jactel

Chestnut Asian gall wasp
Dryocosmus kuriphilus

Perspectives in Plant Ecology, Evolution and Systematics 15 (2013) 281–291

Contents lists available at ScienceDirect

Perspectives in Plant Ecology, Evolution and Systematics

journal homepage: www.elsevier.com/locate/ppees

Forum

A novel comparative research platform designed to determine the functional significance of tree species diversity in European forests

FunDiv EUROPE

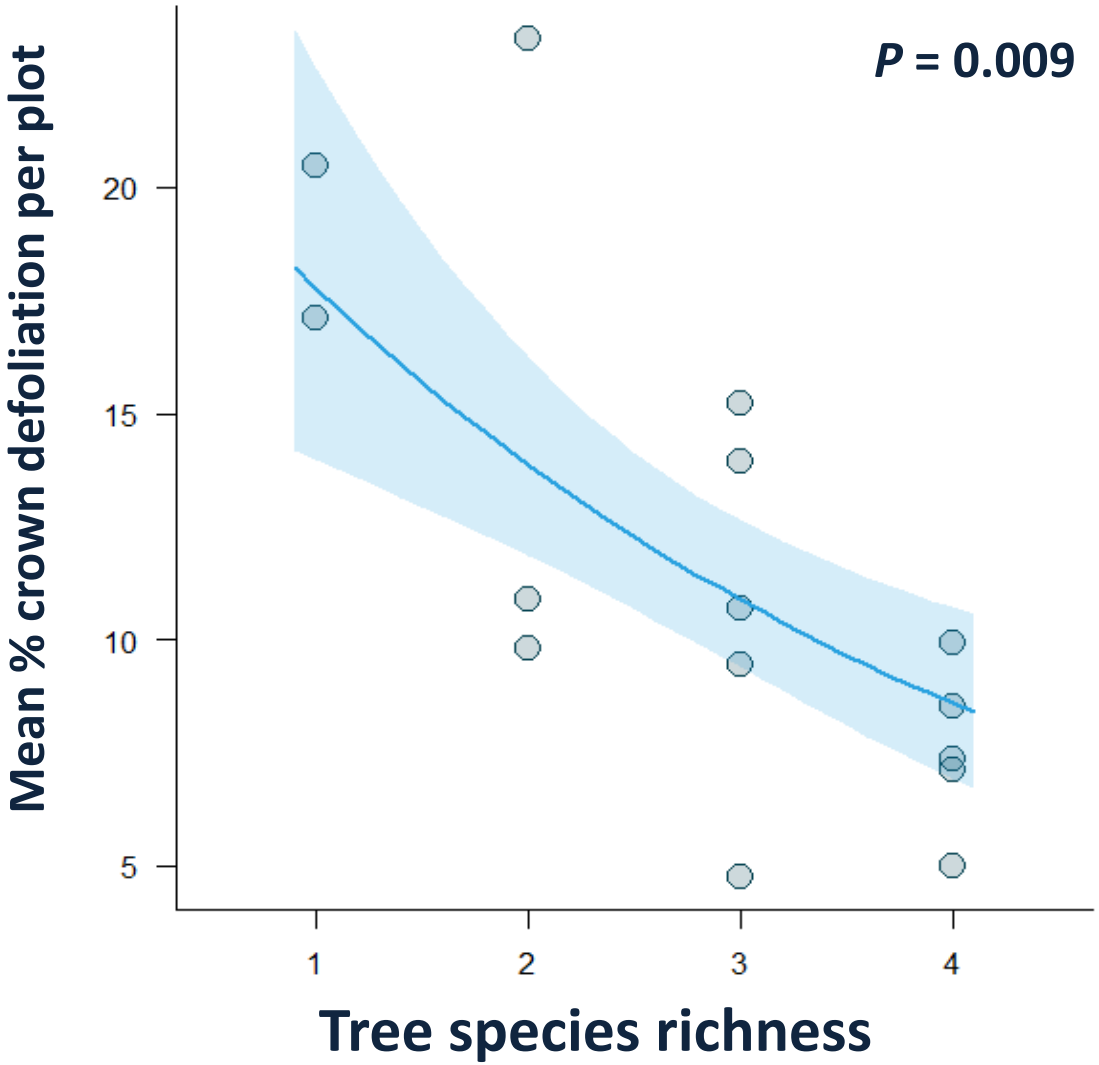
Crown damage assessment = % foliar loss

Explanatory variables

- tree species richness
- proportion of chestnut trees / plot

Results at the plot scale

100% of sampled chestnut trees attacked by *D. kuriphilus*.
Foliar loss = 13 ± 8 % (0.8% - 31.1%)



Natural chestnut stands (Italy)

- Monospecific CS
- chestnut-oak CS-QC
- chestnut-pine CS-PP
- chestnut-ash CS-FO

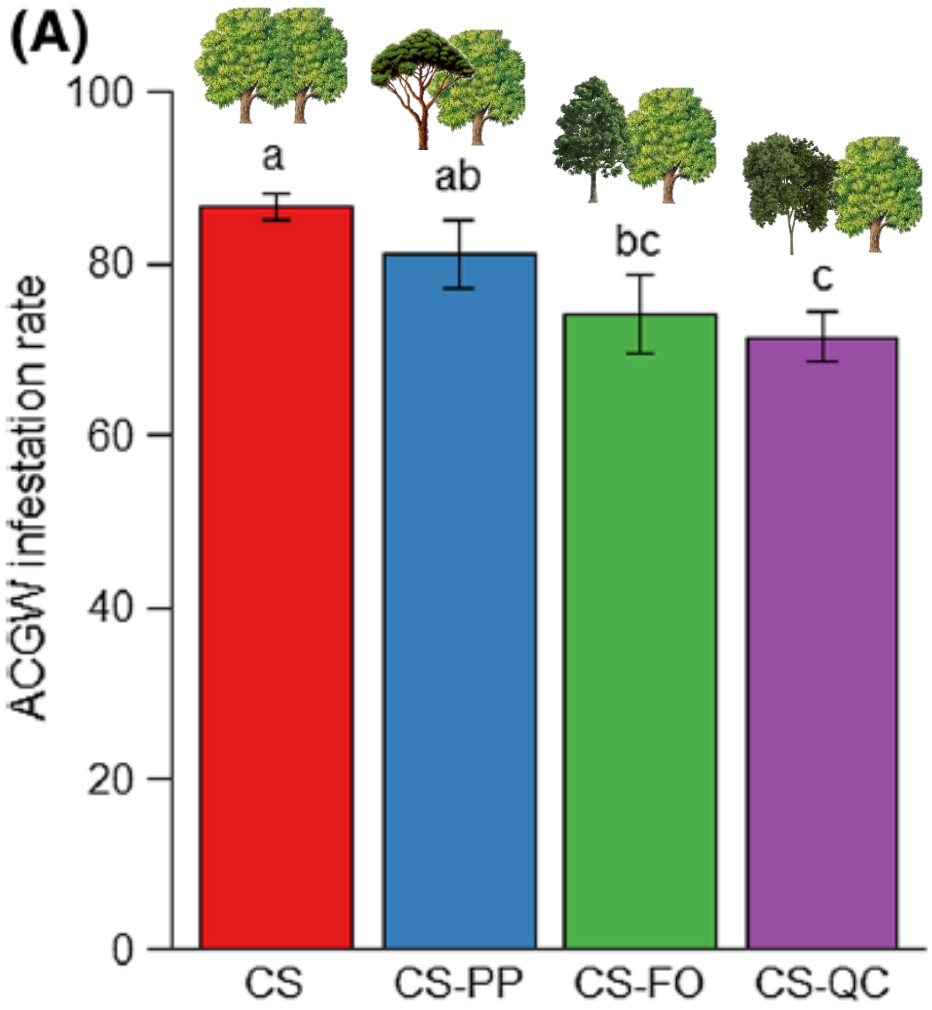
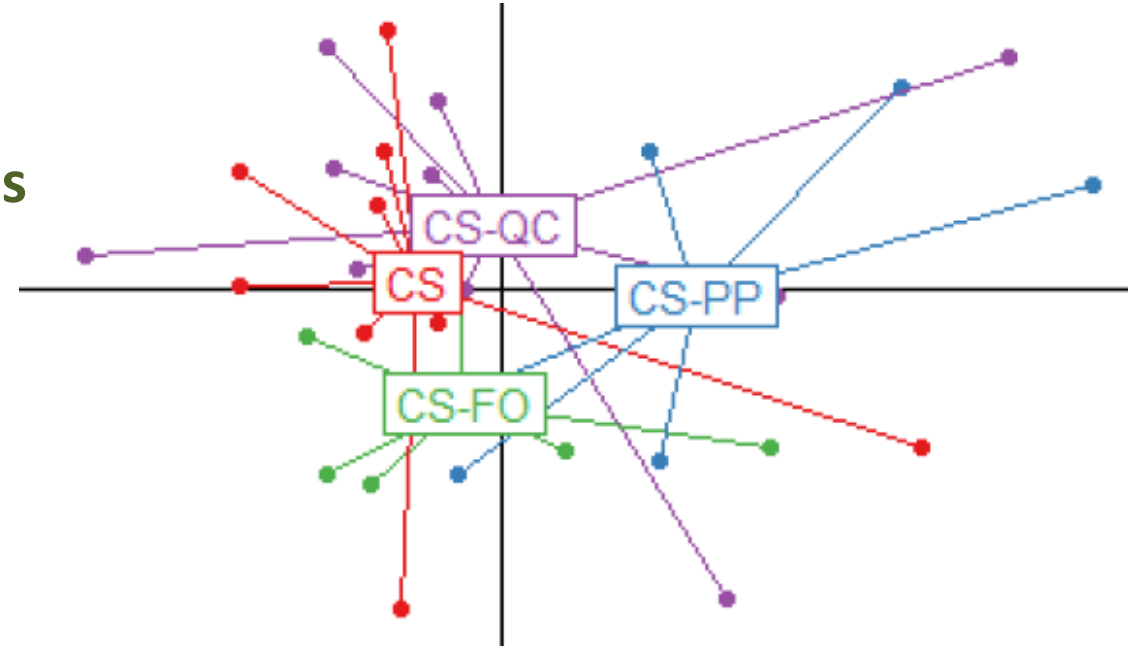


Fig. 1 Mean ACGW infestation rate per chestnut tree as a function of, **a** tree species composition and **b** chestnut frequency

9 600 galls spring → 809 parasitoids (mean: 8 per 100 galls)

22 native parasitoid species

Torymus flavipes / oak galls



CONCLUSIONS

1. Promising results for conservation biological control of invasive forest pests with increased tree diversity

2. But we were lucky: similar hosts (two scale insects of the same genus, two gall makers of broadleaved trees) AND presence of generalist enemies able to shift onto new prey (predatory bug) or new host (parasitoid wasp)

3. More difficult cases = ex. Box tree moth (no native chewers)?

4. We need more research!

Thank you
for your attention

Inge van Halder ®