Invasiveness of *Jacobaea vulgaris*

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Pest species

About 2% of the exotic species are becoming a pest species although they are not a pest species in their native area.

They become a pest species because of a:

- changed environment
- quick evolution
- or both

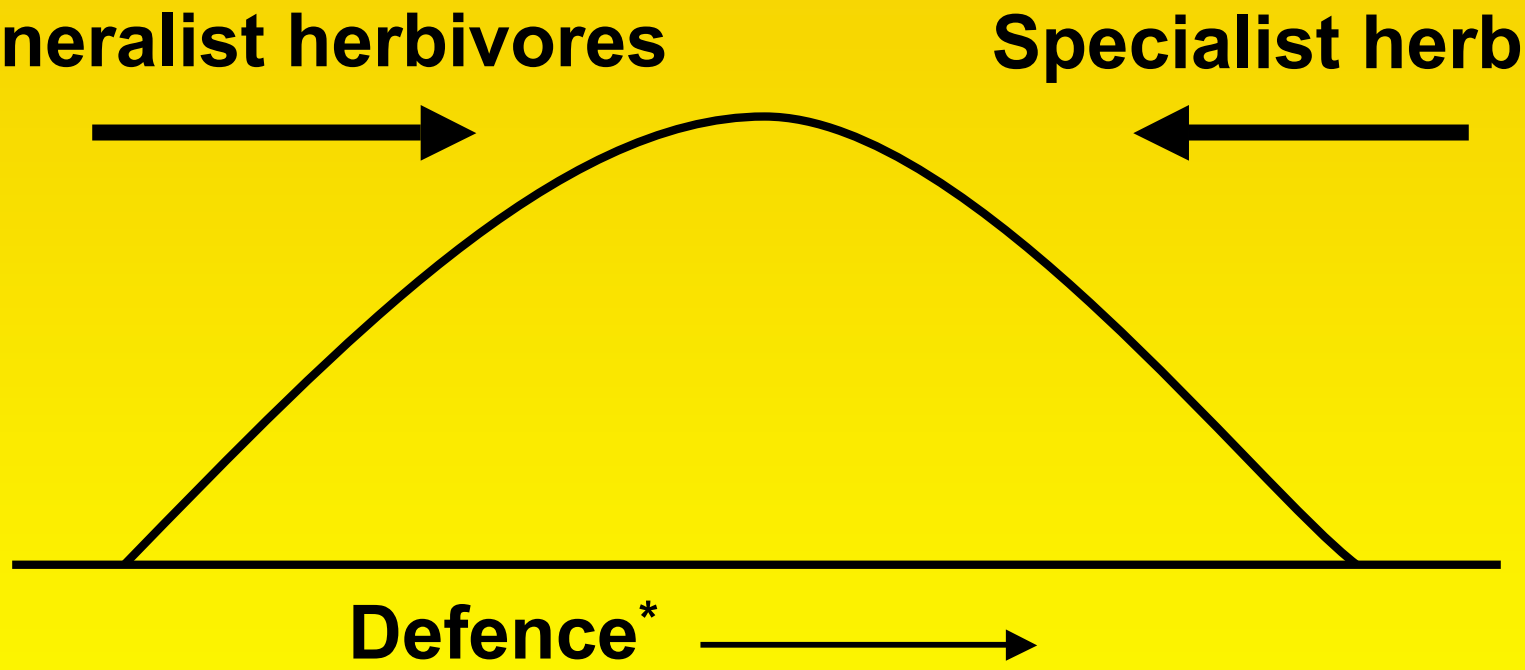
Evolution of Increased Competitive Ability (EICA) hypothesis (Blossey and Nötzold 1995)

In the exotic areas specialist herbivores are lacking. Plants would evolve to grow faster because they don't have to invest in defences against specialist herbivores.

Predictions for the invasive area

- faster growth (=more competitive)
- decreased defence

Generalist-specialist dilemma (van der Meijden ’96)



* Qualitative defences such as glucosinolates, alkaloids, cyanogenic glycosides, etc

Shifting defence hypothesis

Defence

Quantitative

Qualitative

Digestability reducers

Expensive for plant

Generalists

Specialists

•Tannins

•Thick cellwalls

Toxins

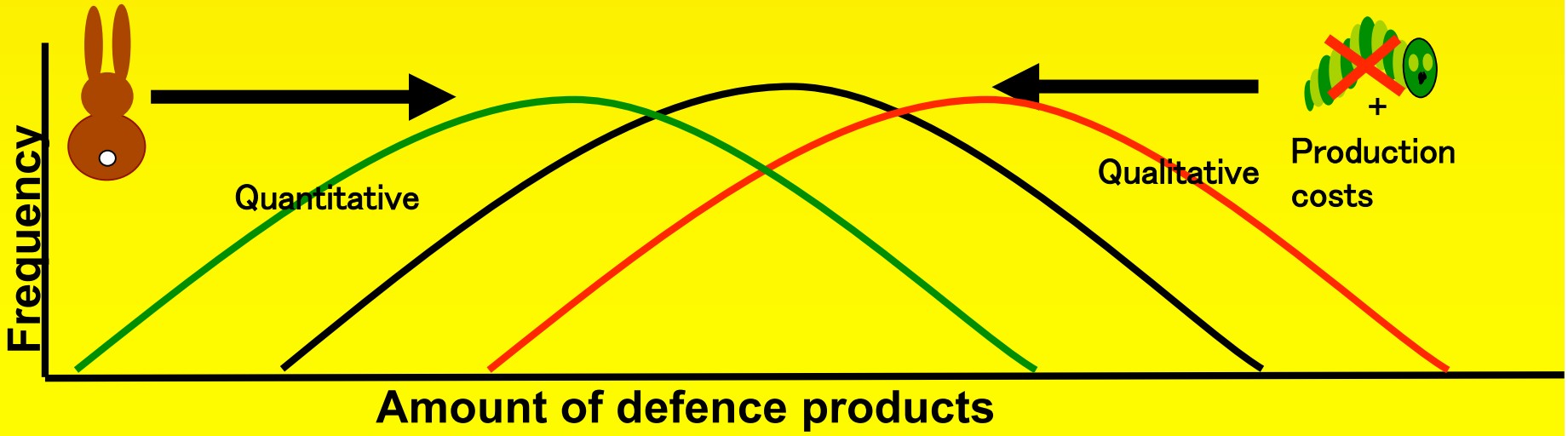
Cheap for plant

Generalists

Specialists

•Glucosinalates

•Pyrrolizidine alkaloids



Senecio jacobaea

(Asteraceae)

- **Facultative biennial, short-lived perennial**
- **Contains pyrrolizidine alkaloids**
- **Native in Eurasia,**
- **Where specialised and generalist herbivores are found**
- **Prominent invasive weed in Australia, New Zealand, U.S.A & Canada.**

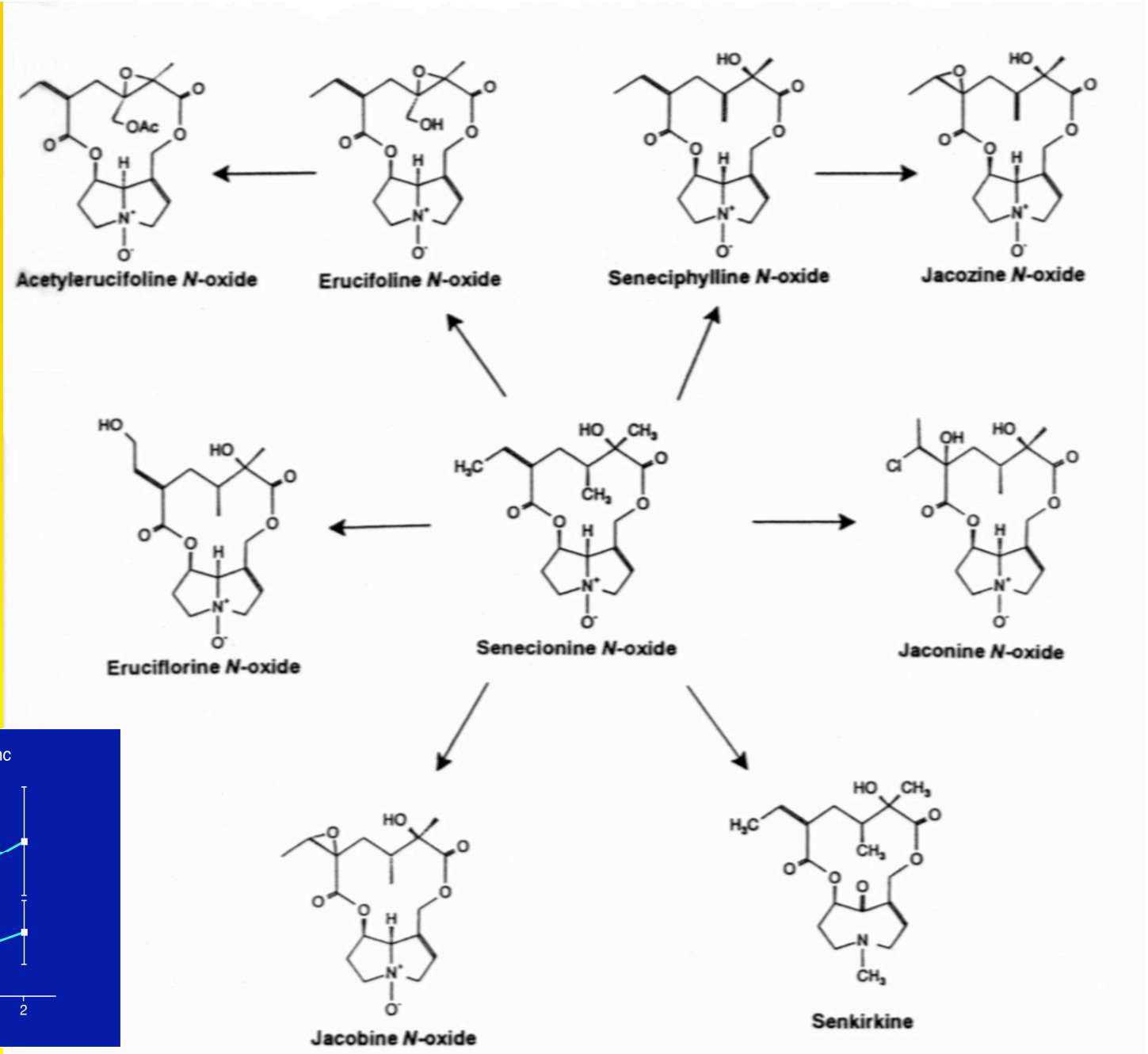
Tyria jacobaeae
Cinnabar moth

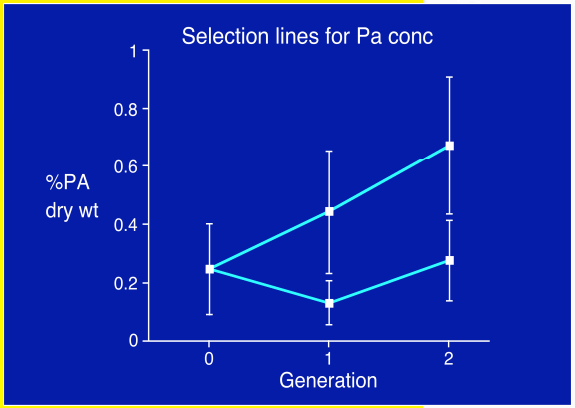
Longitarsus jacobaeae
Flea beetle

Platyptilia isodactylus
Plume moth

All these specialist herbivores are used as biocontrol agents

After: Hartmann





Narrow sense heritabilities:
0.4 - 1.0

Trade-off between PA's and growth

Several experiments showed that costs of producing and maintaining PA's are small

PA's and specialist herbivores

The cinnabar moth and the flea beetle are adapted to PA's (both sequester PA's).
Oviposition in the cinnabar moth is stimulated by PA's (Macel et al. 2004).
Oviposition is positively correlated with jacobine concentration (Cheng, unpublished)

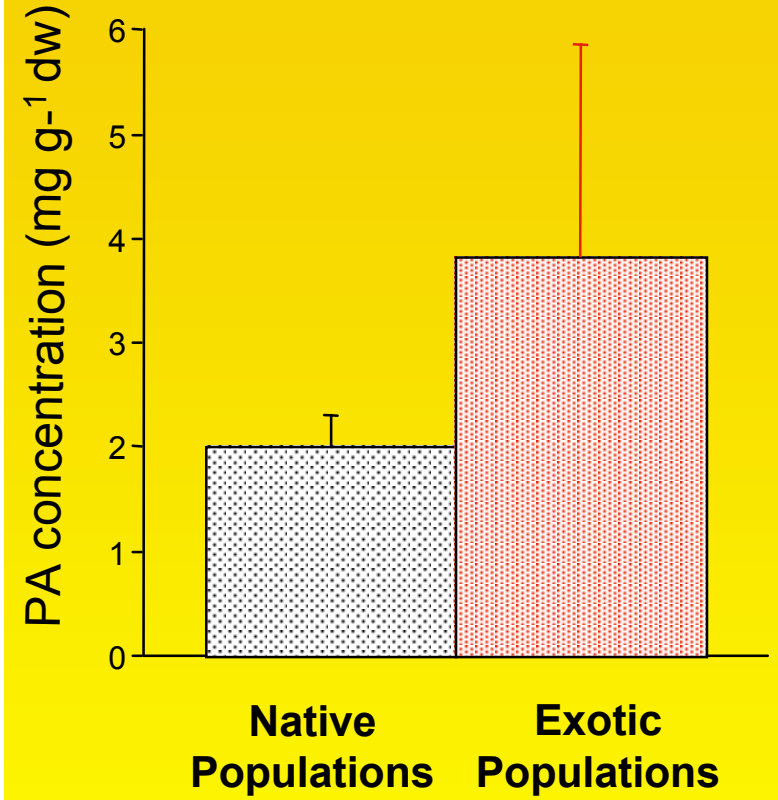

29 Populations
13 European
8 NorthAmerican
4 Australian
4 New Zealand

Experiments

The following traits were measured in native and exotic *S. jacobaea* populations in a greenhouse and/or common garden:

- PA concentration and composition
- Regrowth capacity
- Performance of a specialist herbivore
- Preference and performance of generalist herbivores
- Growth

Total PA concentration in *S. jacobaea*

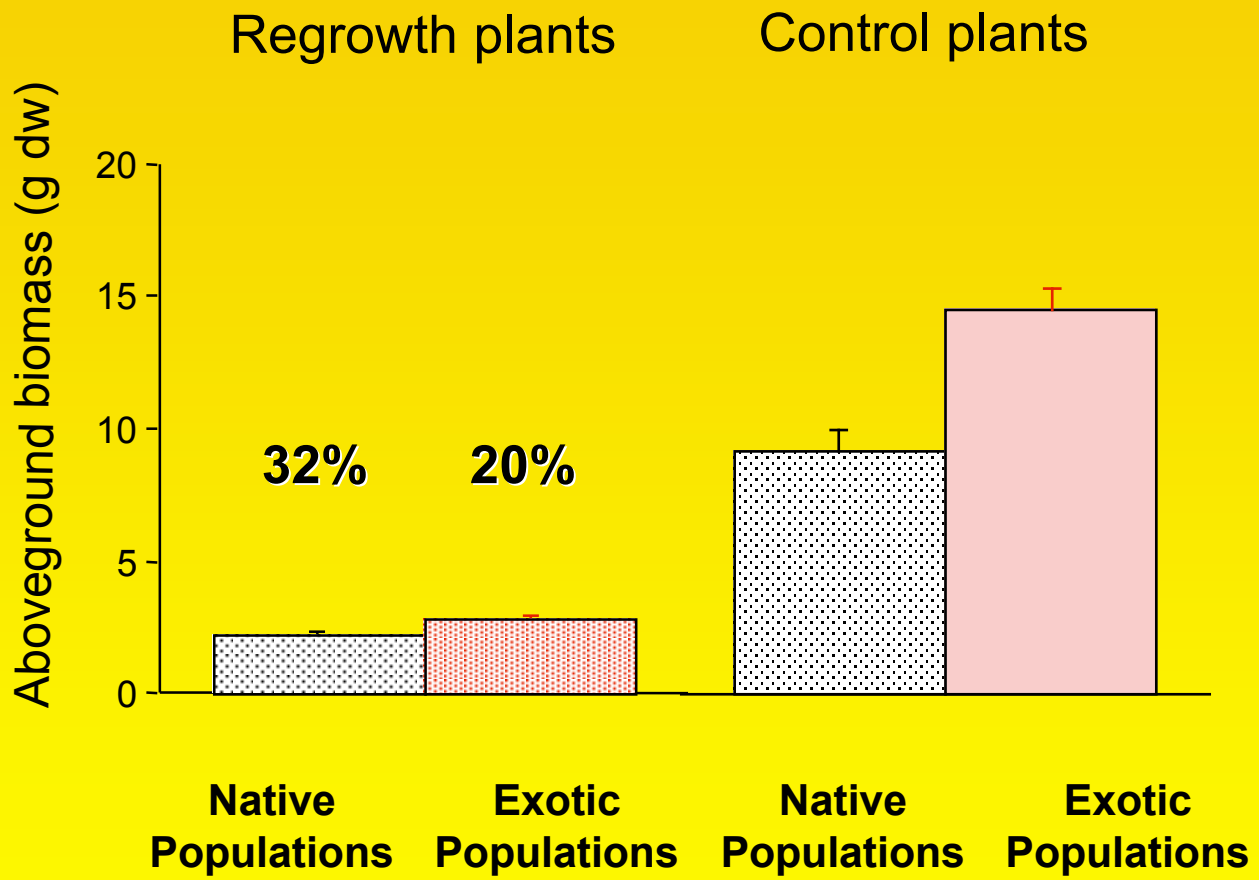


Source of variation	d.f.	MS	Variance ratio (F-value)	*P*-value
Number of leaves	**1**	**0.1818**	**1.02**	**n.s.**
Block	3	0.4026	0.7	n.s.
Introduced/native	**1**	**8.8188**	**14.88**	**< 0.001**
Region	2	0.3377	0.6	n.s.
Introduced*Block	3	0.5558	**3.13**	**< 0.05**
Population	**25**	**0.5926**	**3.34**	**< 0.001**
Residual	75	0.1773	-	
Total	110			

(Region = North America, Australia, New Zealand)

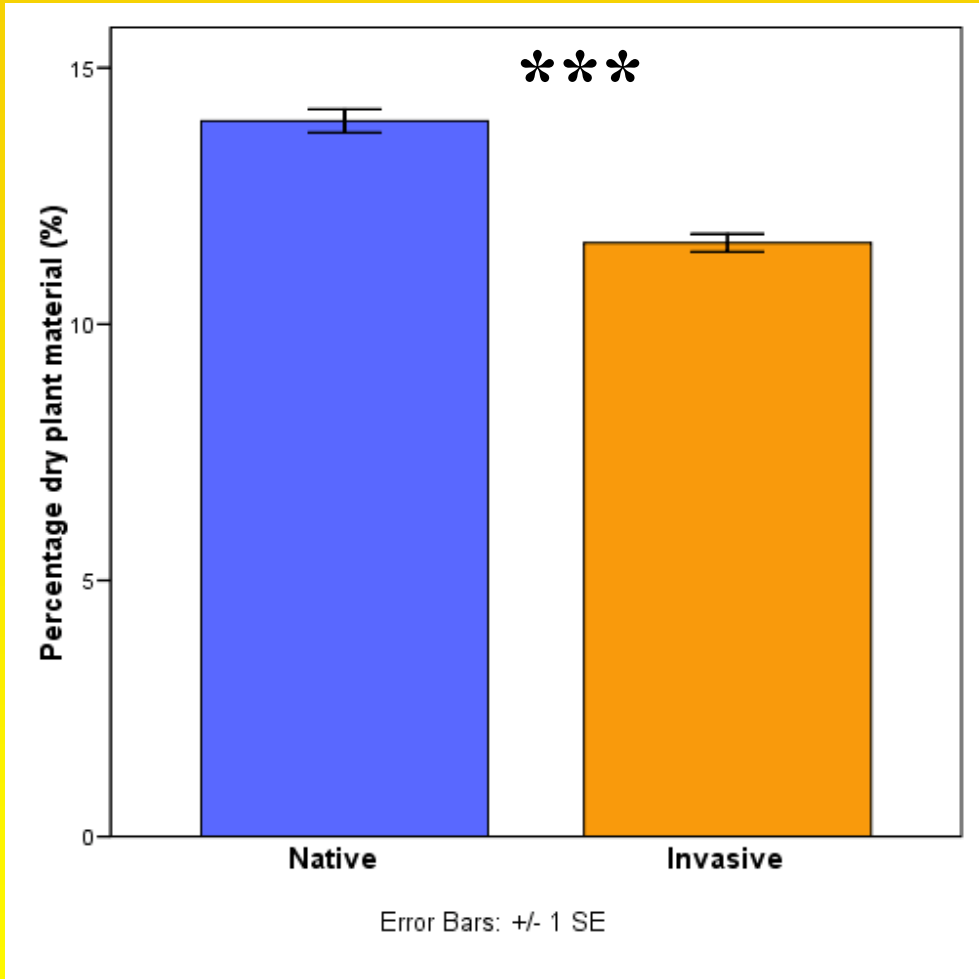
Plants in exotic areas have on average twice the amount of PA's than plants from the native area.

Regrowth experiment: Above-ground biomass



***S. jacobaea* from the native area has a better regrowth capacity after complete defoliation**

Quantitative defences



Percentage of dry plant material is an indication for the amount of quantitative defences

Tyria jacobaeae (Cinnabar moth)

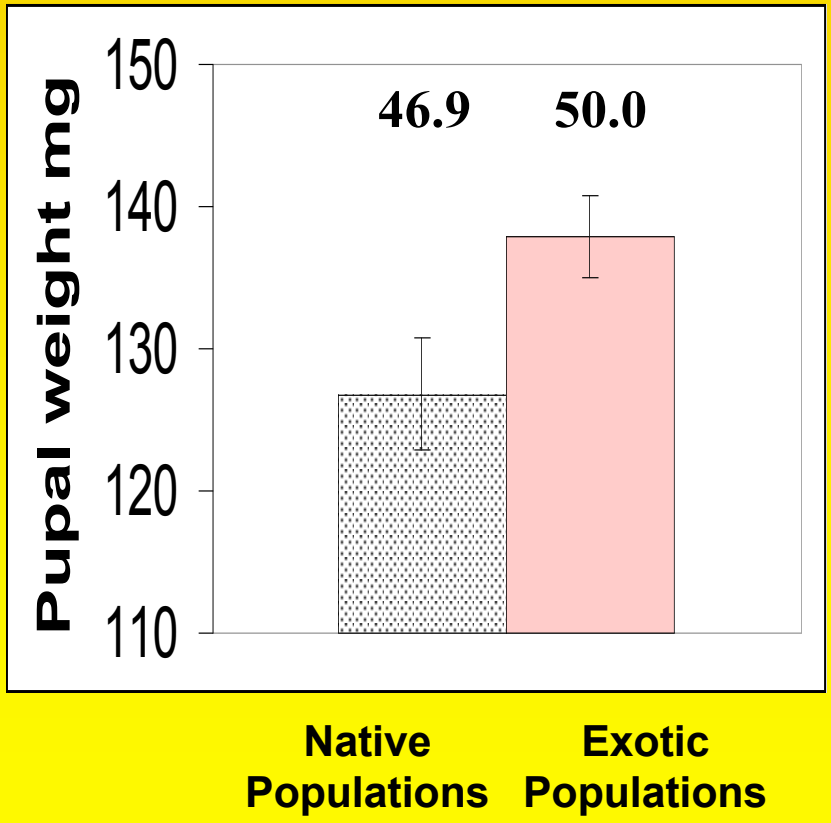
- Specialist herbivore
- Eurasian distribution
- Feeds on restricted number of *Senecio* species

- 6 first instar larvae were placed on 2-4 *S. jacobaea* plants/population. After three weeks larvae were weighed and 2 were placed back, finally pupal weight was measured.

- Larval mortality after 3 weeks
- Larval weight after 3 weeks
- Pupal weight and survival

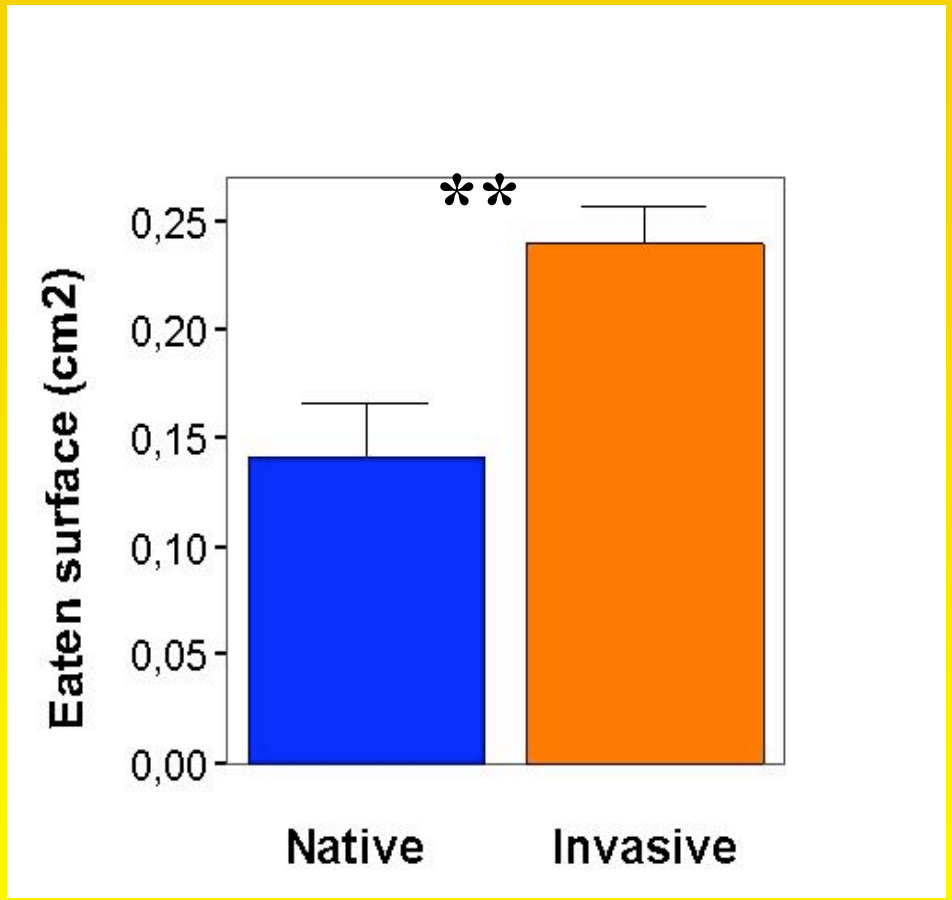
T. jacobaeae to reaches higher pupal weights on plants from exotic areas

Pupal weight



Source of variation	df	ms	F	p
Row	1	827.8	0.72486865	NS
Block	1	1142	2.8162762	NS
Native/Exotic	1	2417.7	4.16342345	<0.05
Region	2	436	0.75081798	NS
Population	23	580.7	0.68109313	NS
Plantindividual	44	852.6	2.1025894	<0.05
Residual	39	405.5		
Total	111	648.1		

(Region = North America, Australia, New Zealand)



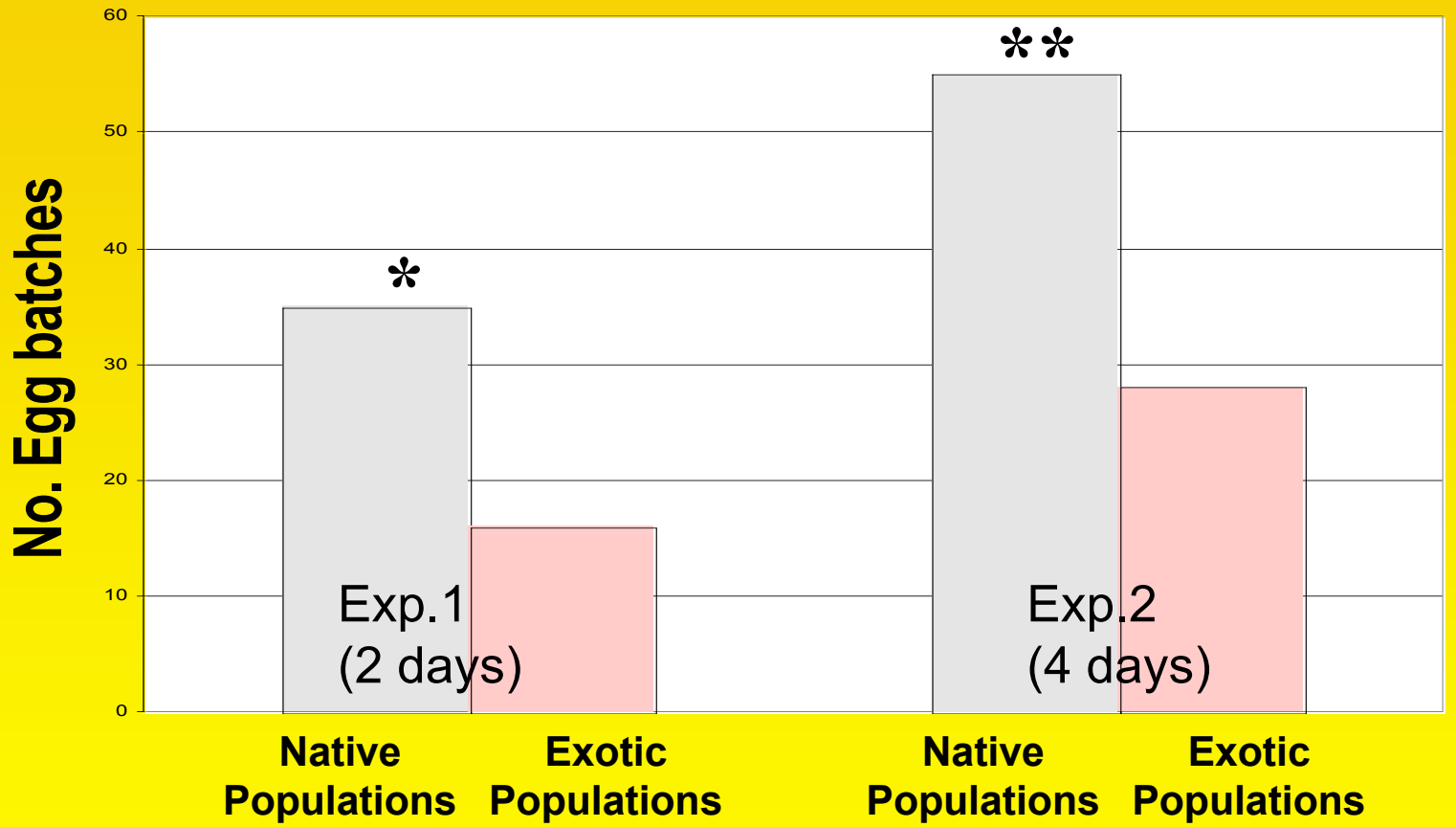
Cinnabar larvae do eat more from invasive *Senecio jacobaea* in a no-choice test

Specialist herbivores

The specialist *P. isodactylis* infested significantly more stems of plants from the invasive area (F= 4,99, Df=1,27, P=0.03)

The specialist fleabeetle *L. jacobaeae* did perform significantly better on ragwort from the invasive area in a garden in Switserland (Statsny et al. 2005)

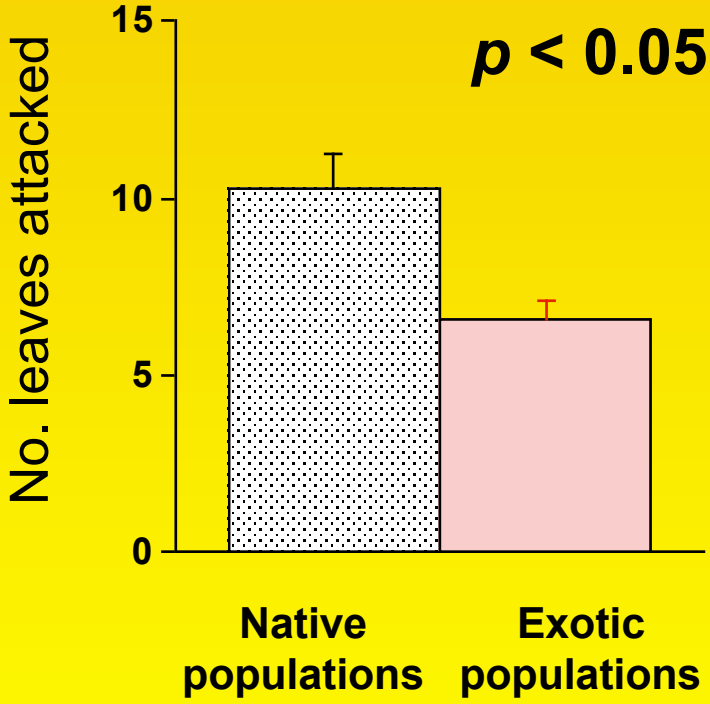
Generalist S. exigua oviposition experiment
Egg batches

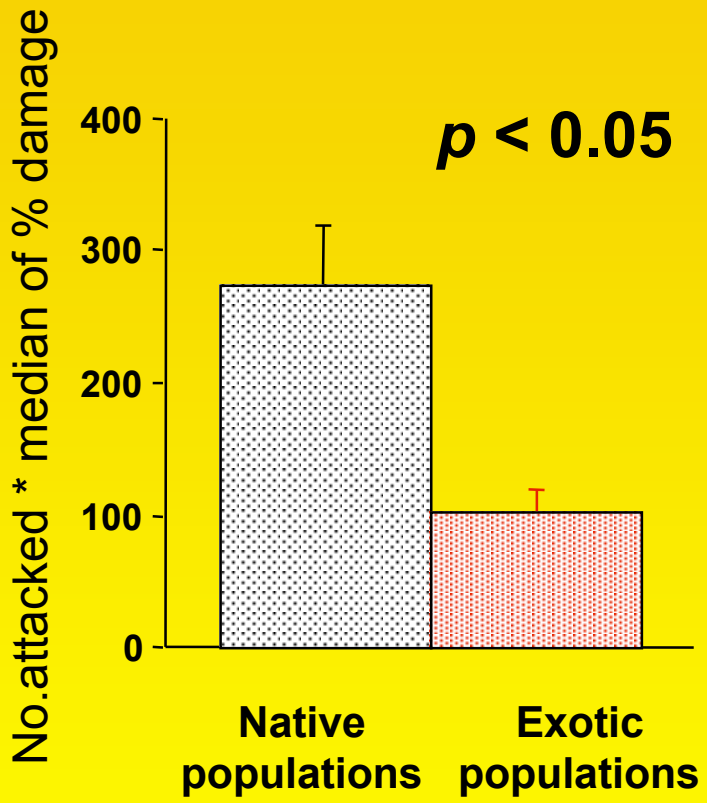


S. exigua prefers native *S. jacobaea* for oviposition in choice test

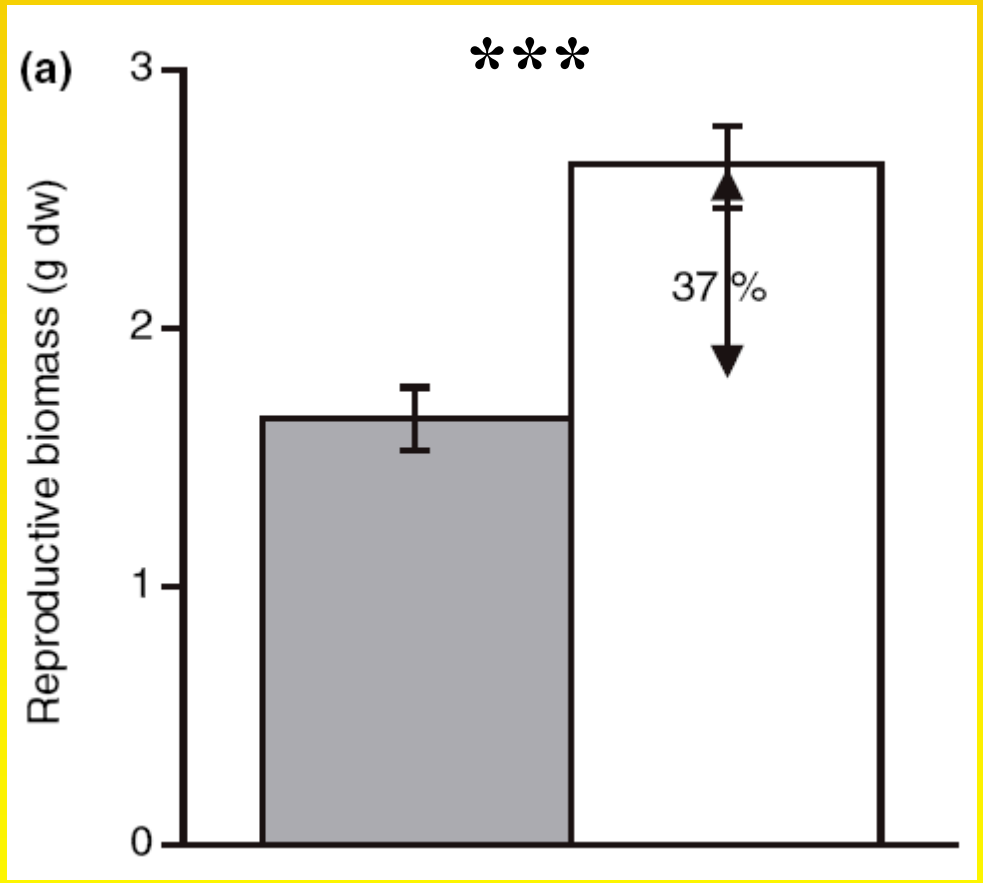
Herbivory by *Mamestra brassicae*

(after 24 days feeding on *S. jacobaea*, no choice test)





Exotic *S. jacobaea* populations are better defended than native populations



Exotic *S. jacobaea* plants produced 37% more flowerheads

General conclusions:

- **The common garden (lab) experiments indicate that *S. jacobaea,* was able to adapt quickly to its new environment by changing defence levels and growth**
- **Generalist herbivores select for higher toxin levels in exotic areas**
- **In the absence of specialist herbivores quantitative defences were decreased**
- **The EICA hypothesis should incorporate the fundamental difference between specialist and generalist herbivores**
- **The ERH can not explain the results. There is a quick adaptation (fast evolution) of plants in the new area**

Is it evolution or preadaptation?
What are the source populations?
Are there multiple introductions?

AFLP study

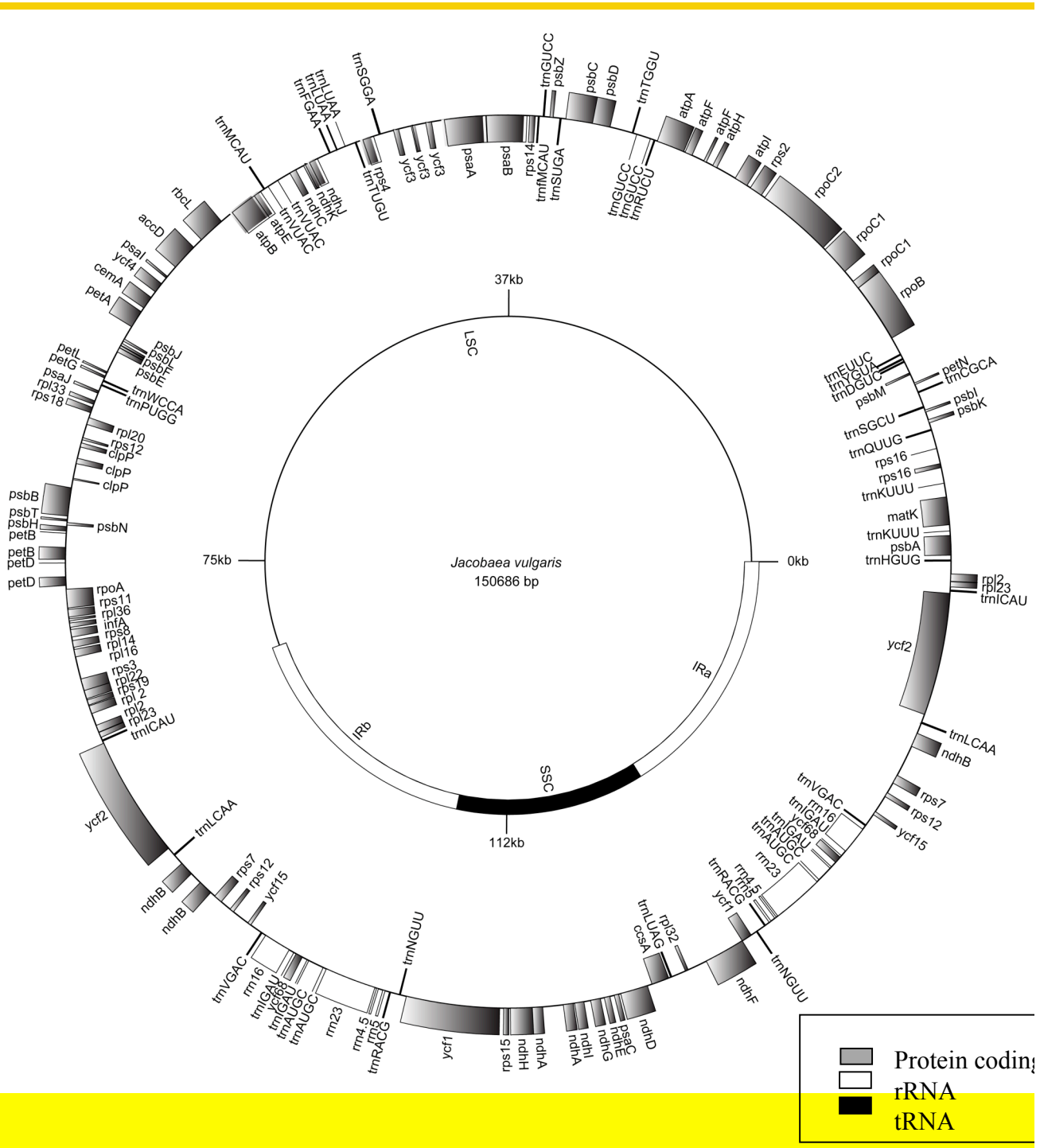
No reduced genetic variation in invasive areas

Source of variation	d.f.	Sum of squares	Percentage of variance explained
All populations combined ($n=29$)			
Native vs. invasive	1	41.14	10.55**
Among populations within native/invasive areas	27	216.66	5.21*
Within populations	49	337.25	84.24**
Total	77	595.05	
Native populations only ($n=13$)			
Among populations	12	105.63	13.26**
Within populations	21	132.17	86.74**
Total	33	237.79	
Invasive populations only ($n=16$)			
Among regions	2	17.34	1.45
Among populations	13	93.69	−0.58
Within regions			
Within populations	28	205.08	99.14
Total	43	316.11	

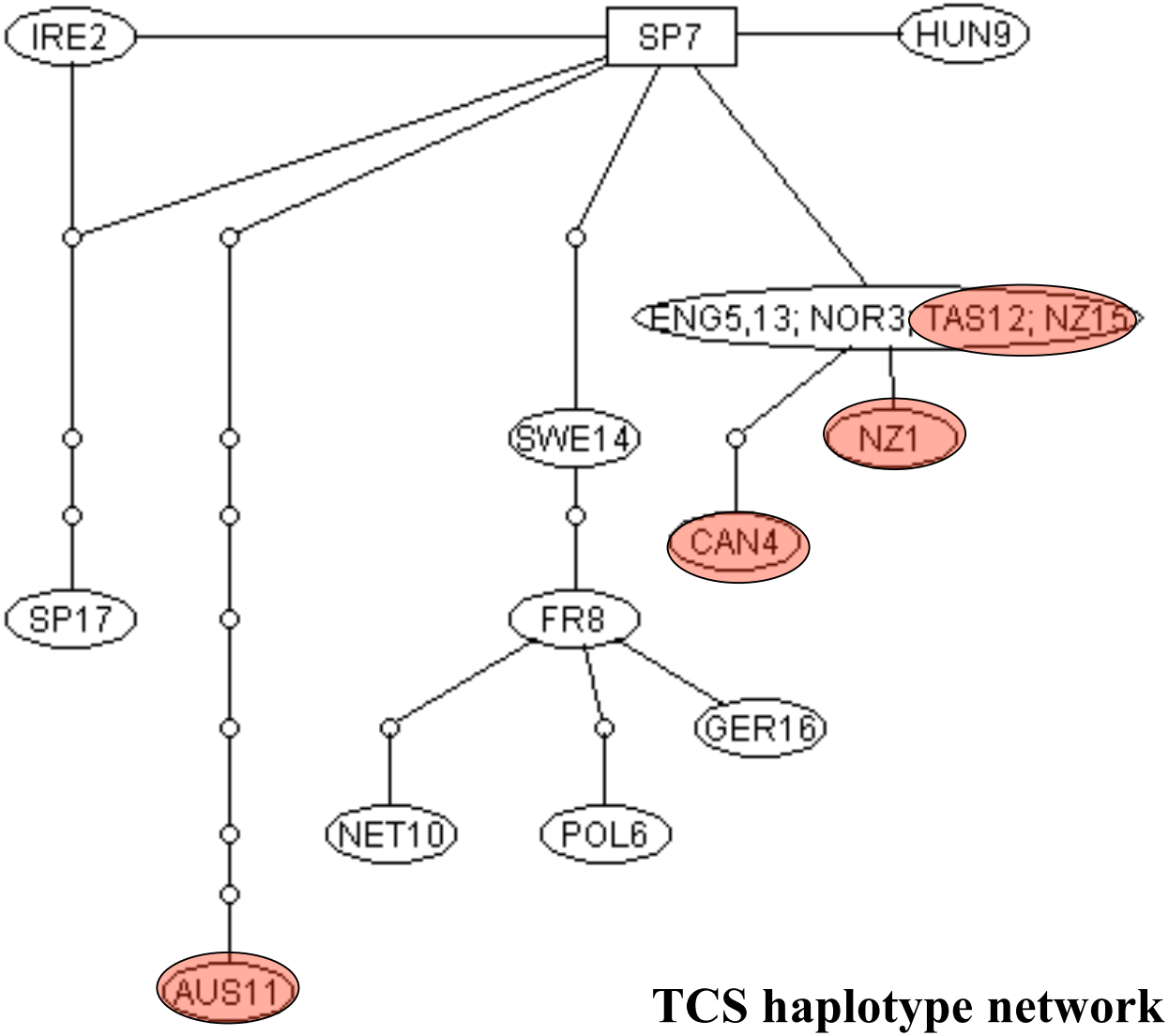
Assignment analysis suggested Baldoyle (IRL), Leiden (NL) and Wales (UK) as most likely source populations

With NGS from 17 individuals complete Cp genome sequenced.

34 SNPs detected



Haplotype netwerk indicates at least 2 introductions



TCS haplotype network

Future work on invasivness

- Look into physiological differences of invasiness

- Perform metabolomic analyses

- Make detailed genotyping with cp SNPs and cp msats

- Detailed genotyping with nuclear SNPs

- Study “reverse selection” (biocontrol agents)