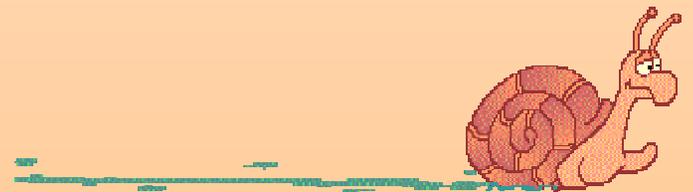


Invasion and evolution along the competition-colonisation trade-off : Of flies and snails

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DUYCK, Serge QUILICI, Philippe JARNE, Jean-
Pierre POINTIER



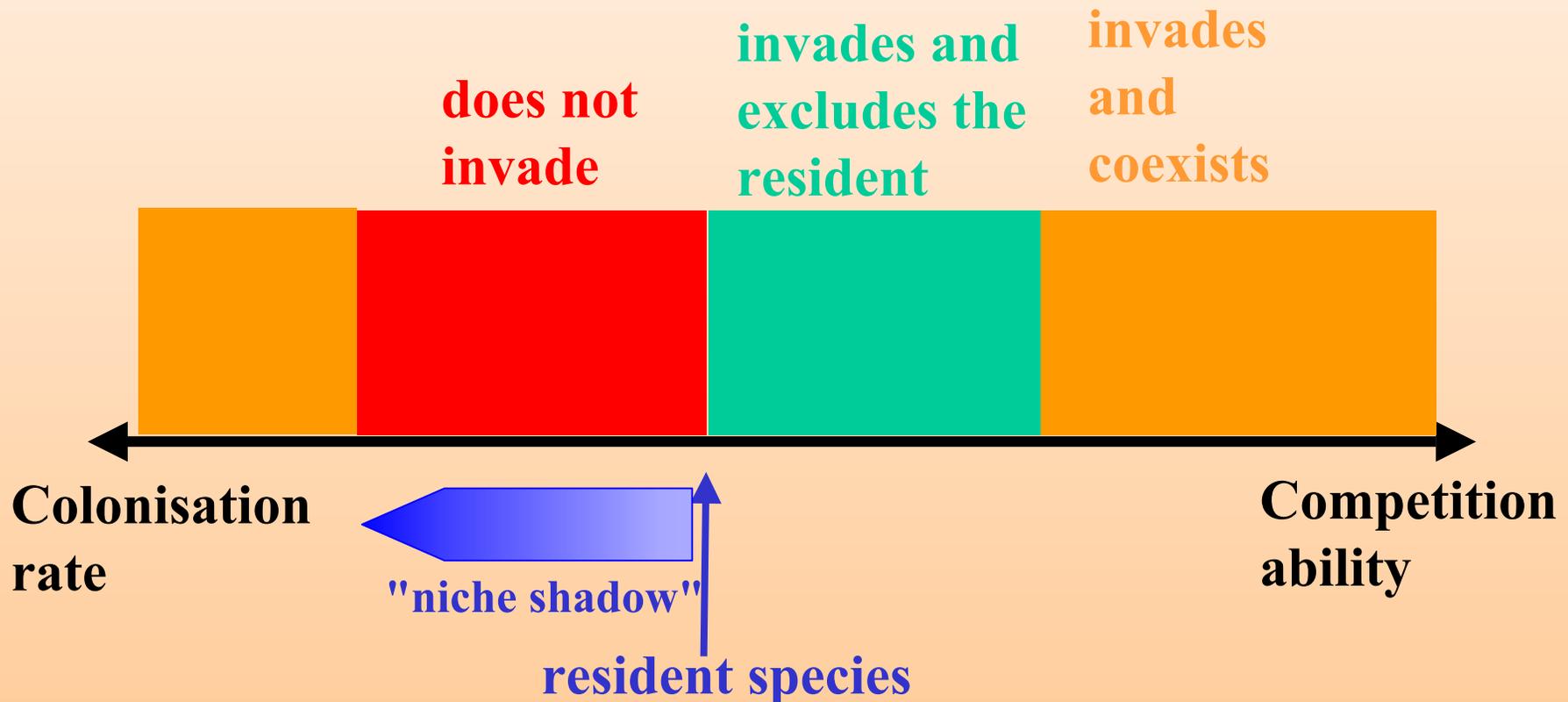
What traits allow a species to invade a resident community ?

- **Basic conditions** : be introduced, tolerate physical conditions (e.g. climate)
- **Once the basic conditions are met, insertion into the local community.**

Coexistence rules	condition	trait
Ecological niche	Find an empty niche	Habitat or resource specialization
Predator-prey Parasite-host	resist local enemies	Defences
Metapopulation	avoid or resist local competition by residents	Competitive ability, colonisation rate

A classical model of coexistence within a single niche under the competition-colonization trade-off

- Metapopulation model of coexistence (e.g. Tilman 1994)
- Colonise empty sites *vs* outcompete others in occupied sites
- High competition ability implies lower colonisation rates :
should an invader be a good competitor or a good colonist ?



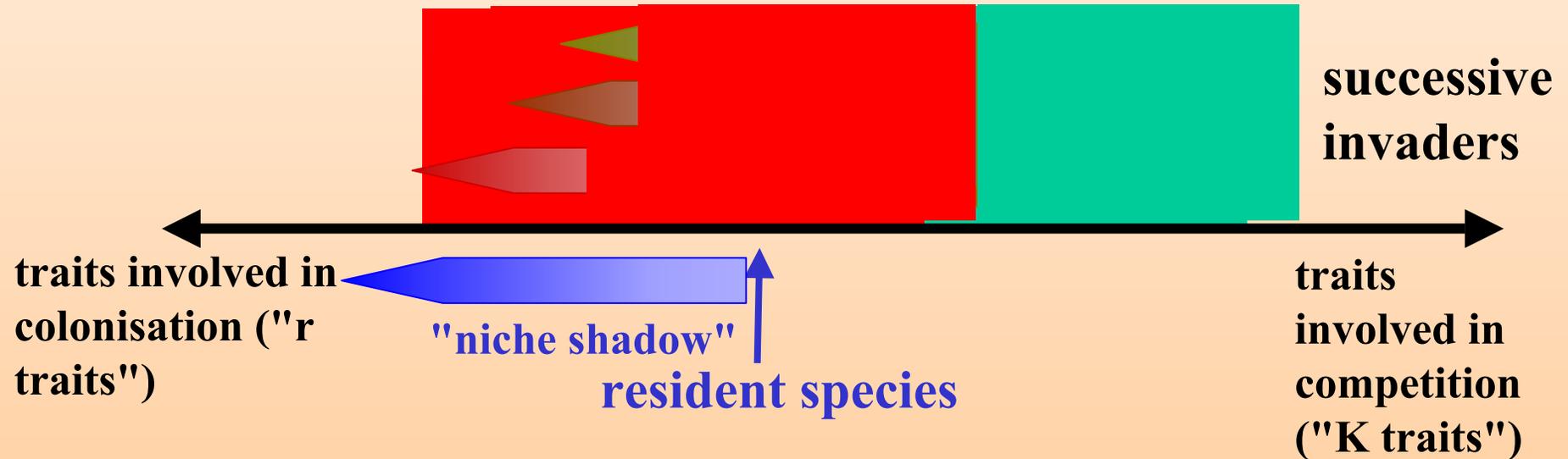
The invasive series approach

Invasive series : a series of **closely related** taxa or genotypes that successively invade the same territory

ecological niches
are similar

potential trade-offs
can be observed

differences are
small



Predictions

- In an invasive series, successive invaders should sequentially displace each other
- Trait changes should follow a consistent direction : decrease in "r" traits (e.g. fecundity) and an increase in "K traits" (e.g. investment per offspring, prereproductive growth)
 - * among species : directional species replacement ("community evolution")
 - * within species : *in situ* evolution

First example : Tephritid flies in La Réunion (Indian Ocean)



*Ceratitidis
catoirii*

endemic



C. capitata

1939

Africa



C. rosa

1955

Africa



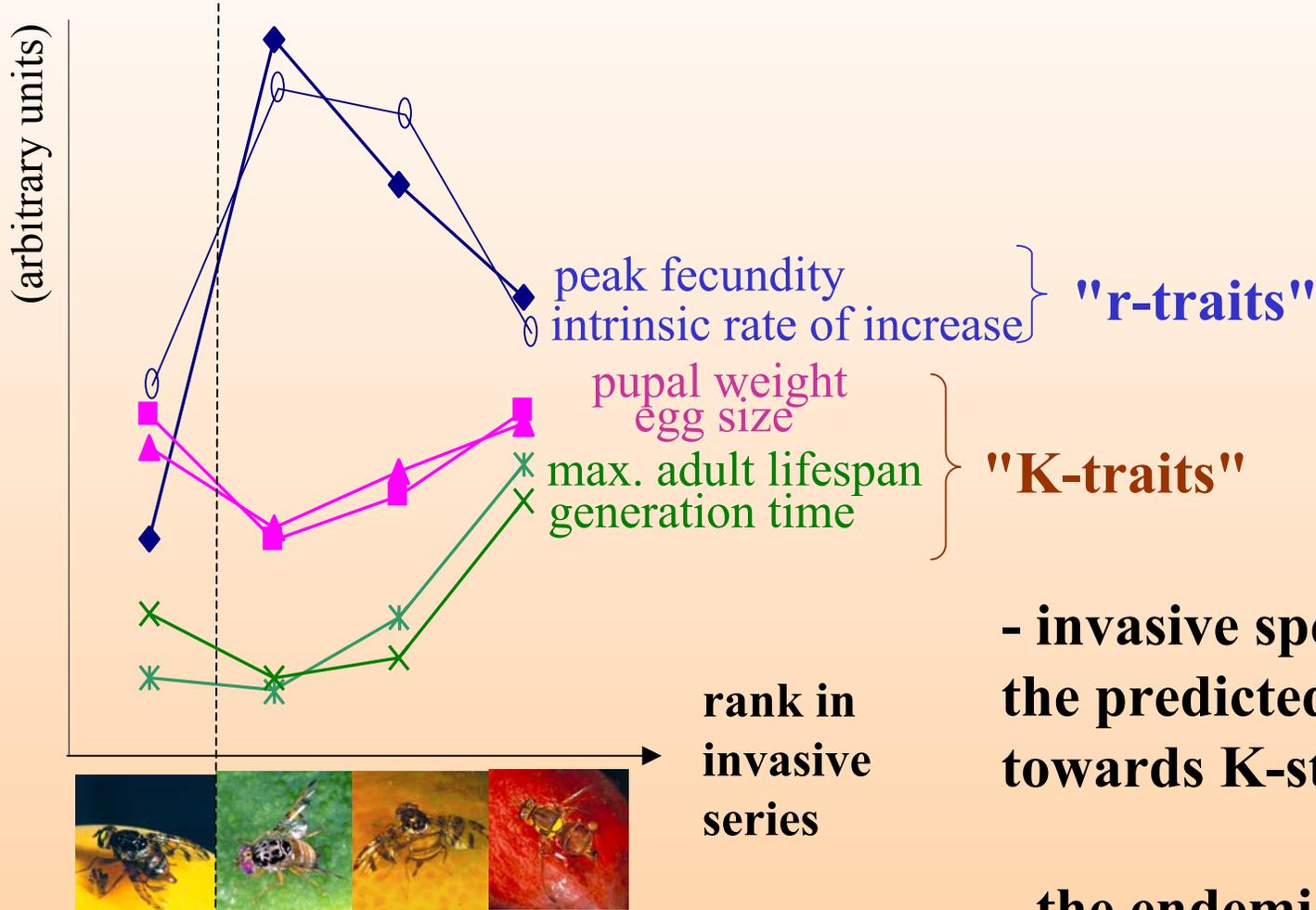
*Bactrocera
zonata*

1991

Asia

- each newly introduced species becomes numerically dominant and largely displaces previous ones

Comparison of life-history traits among Tephritid species



- invasive species show the predicted trend towards K-strategies

- the endemic species has both low survival and low fecundity : it does not fit in

Second example : *Melanoides* freshwater snails

- ◆ Habitat : tropical streams
- ◆ Taxon : *Melanoides tuberculata*



- ▶ Parthenogenetic
- ▶ Viviparous

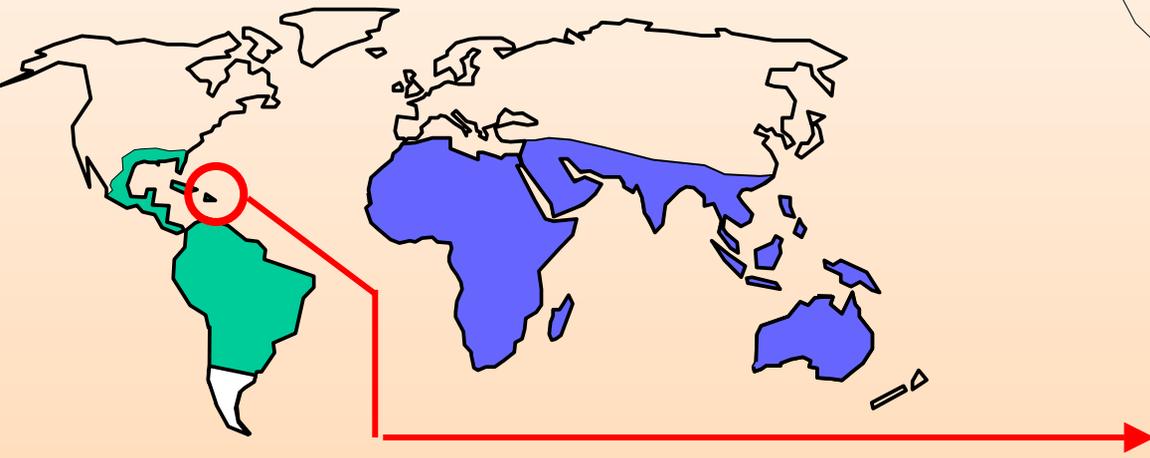
- ▶ 7 morphs =
7 microsatellite genotypes =
7 clones (parthenogenetical lines)



PAP, FAL, PDC, MAD, CPF, FDF, MA

Invasion history

▶ Continental scale

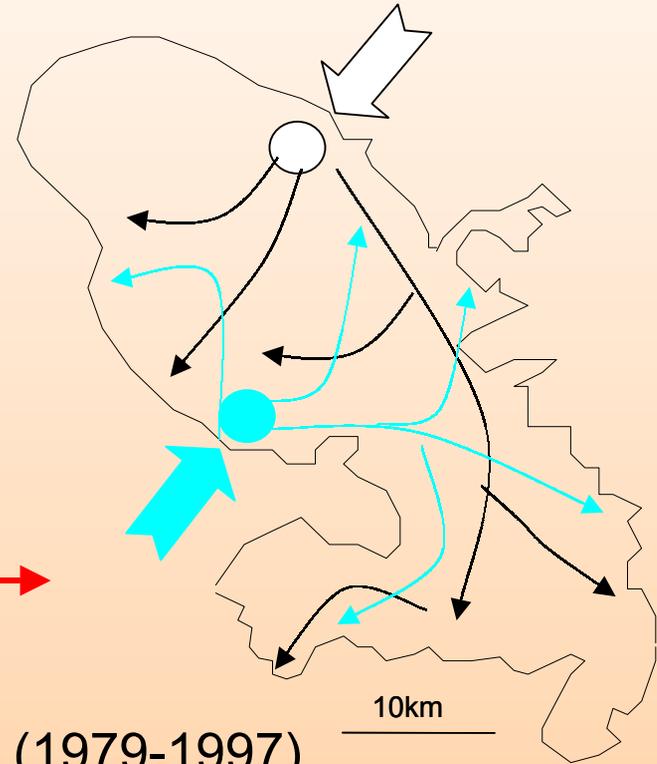


Before 1940

Since 1940

▶ Local scale

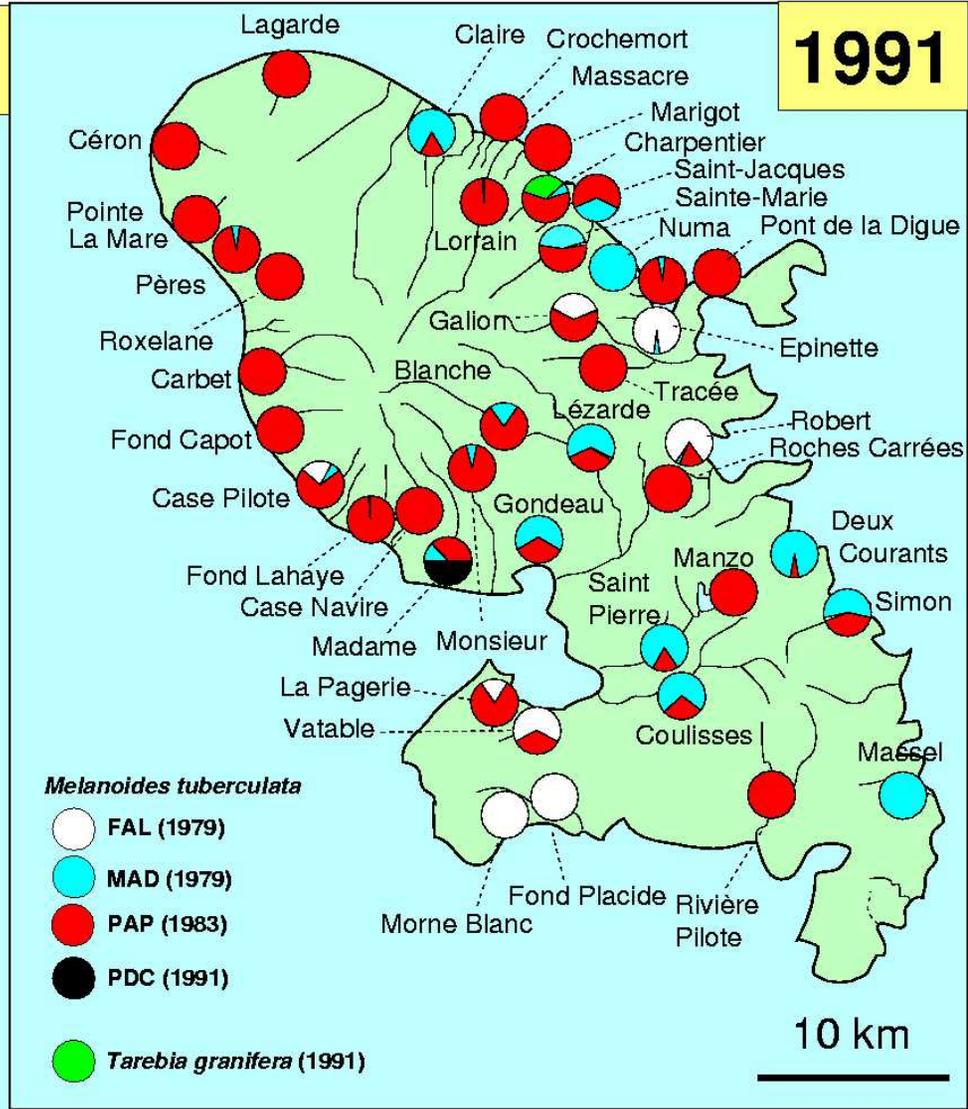
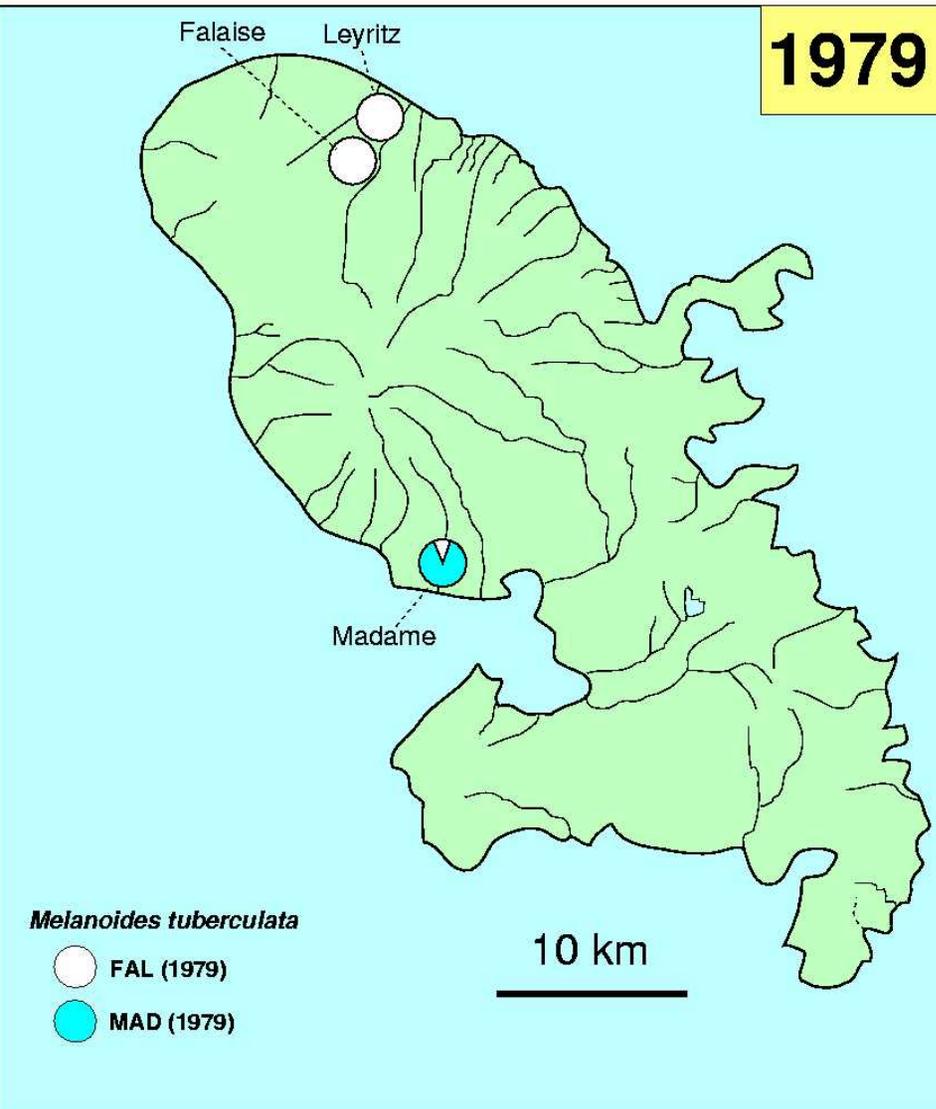
Martinique

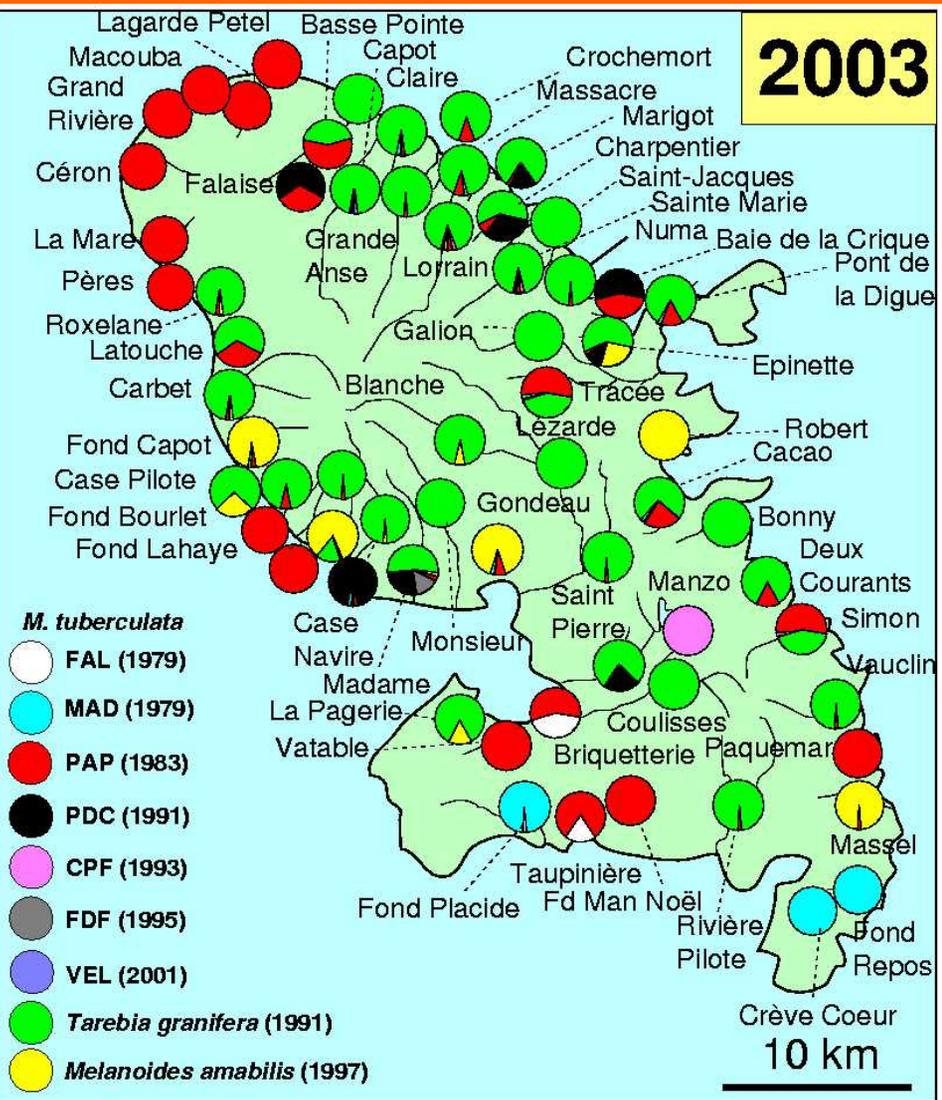
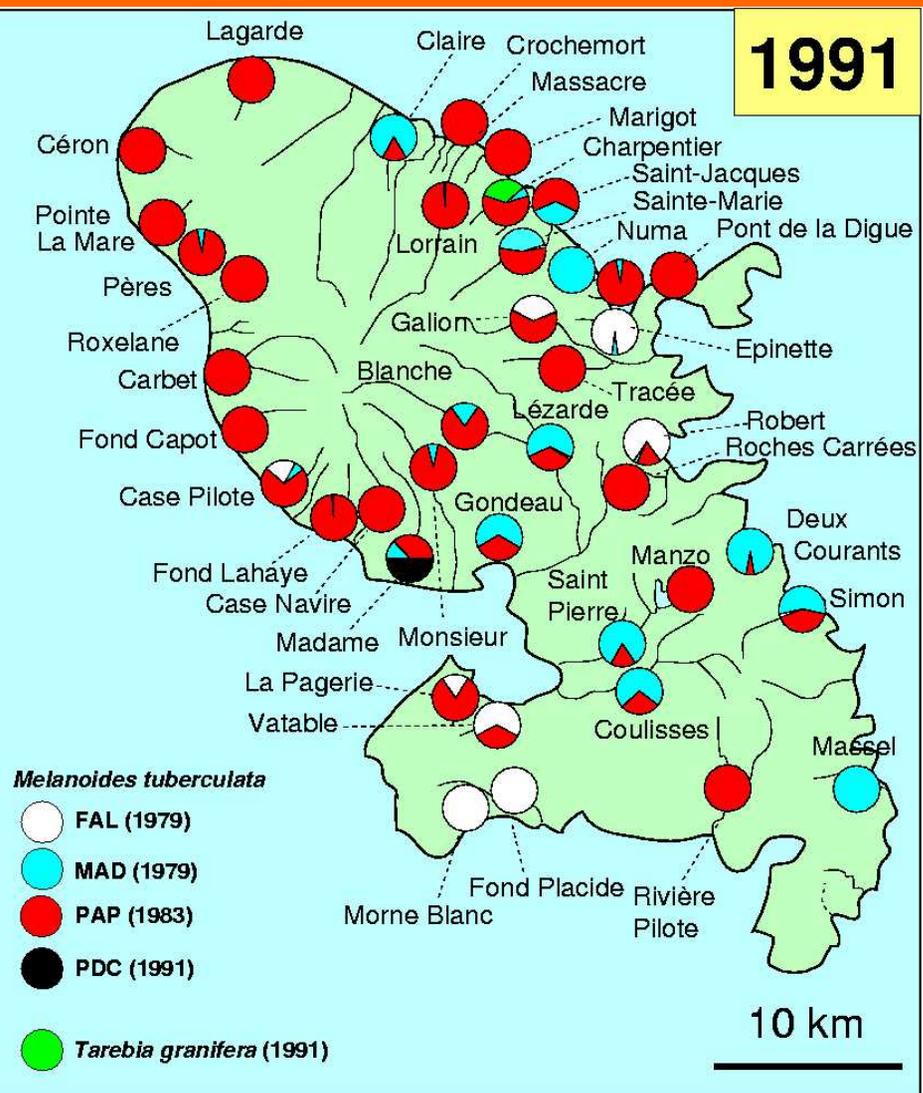


- first local occurrence (1979-1997)
- local spread in a few years

-Long-term yearly survey of morph frequencies in >110 sites in Martinique

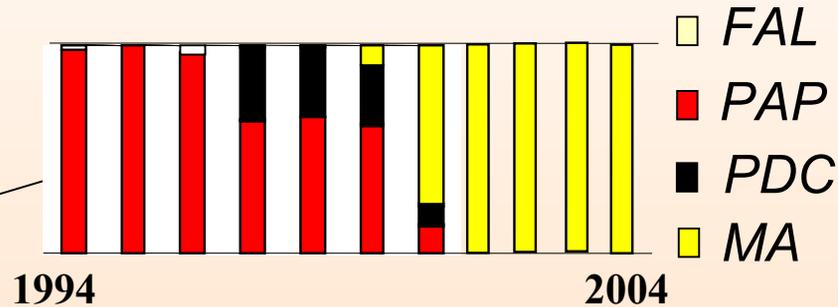
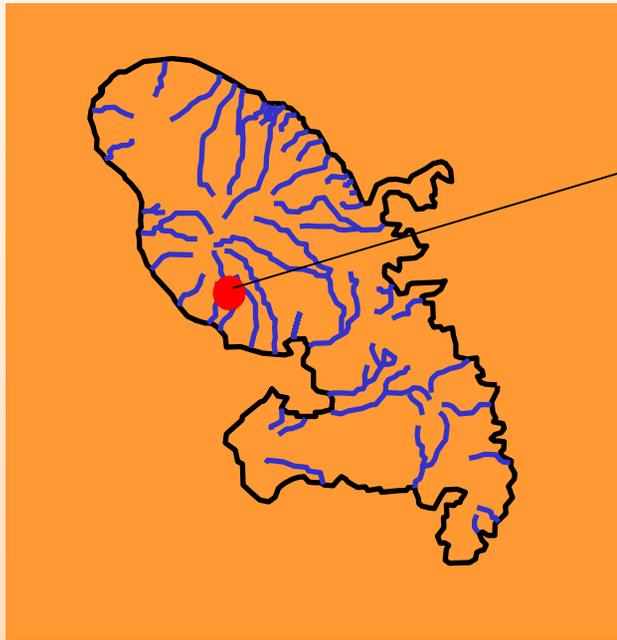
Genetic changes in the invaded area (1)





Genetic changes in the invaded area (2)

- ▶ A typical example of within-site change



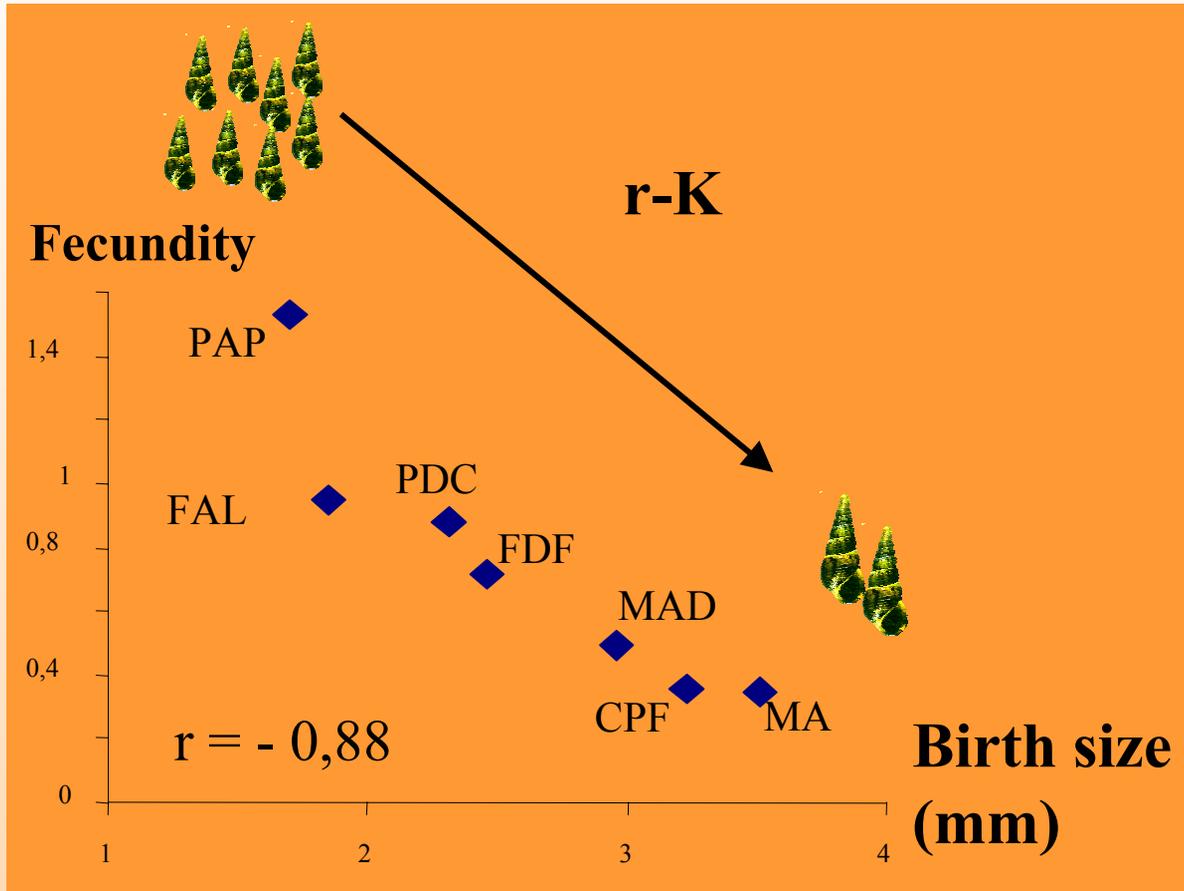
**Competitive replacement
among genotypes (morphs)**

- ▶ A hierarchical replacement sequence, repeatable across sites (1979-2003)



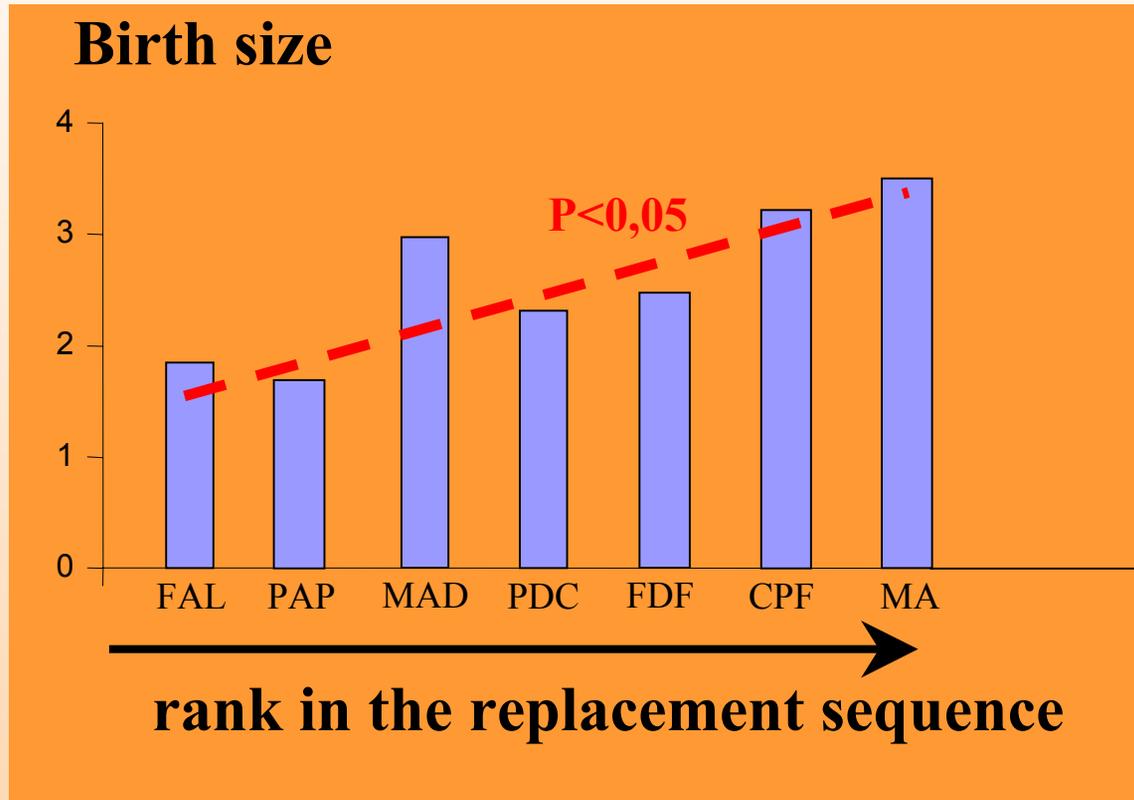
FAL < PAP < MAD < PDC < FDF < CPF < MA

Trade-offs among traits in *Melanoides*



- pronounced life-history differences among morphs
- many small or few large : the r-K gradient

Evolution of traits along the r-K gradient (3)

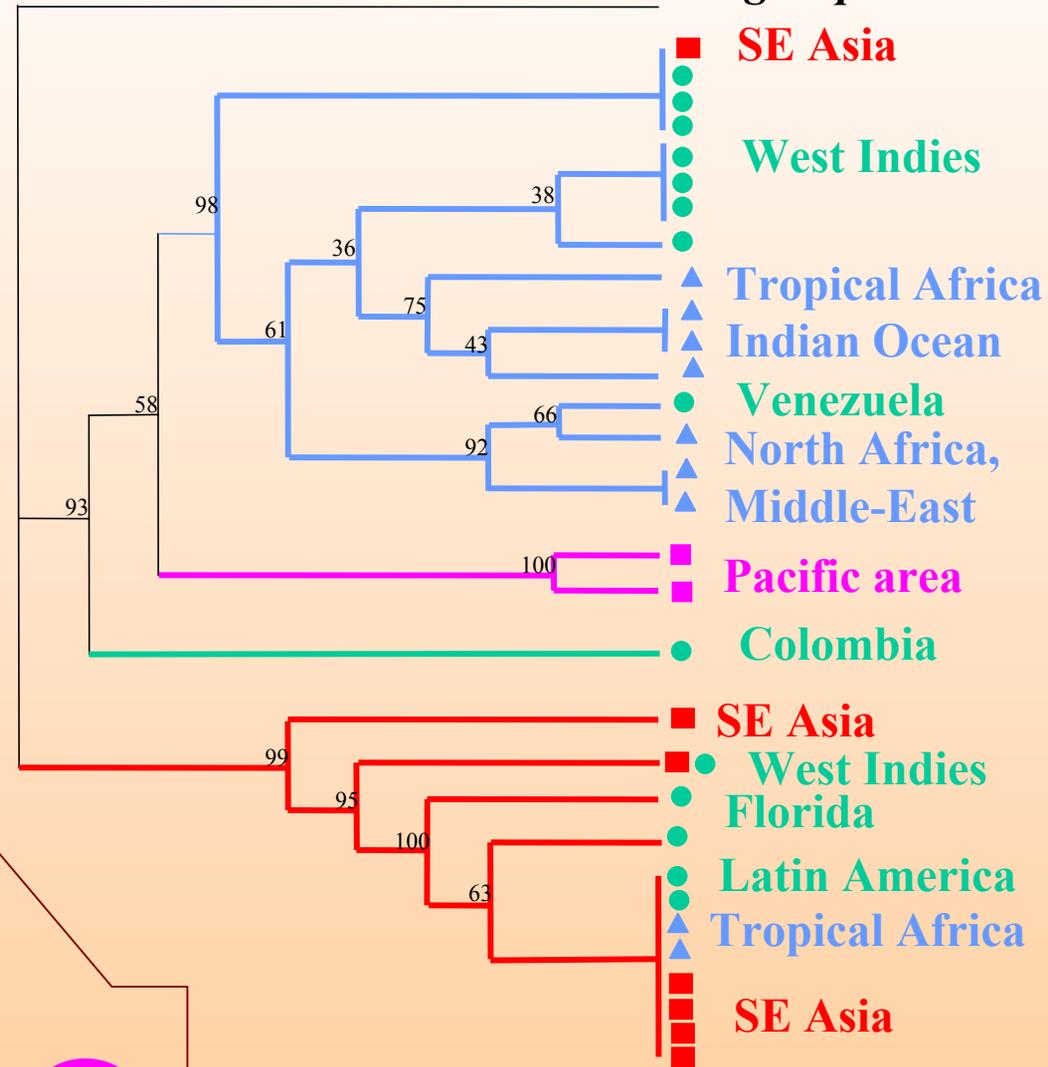


-Directional selection towards a K-oriented strategy

Genetic variance is largely provided by repeated introductions

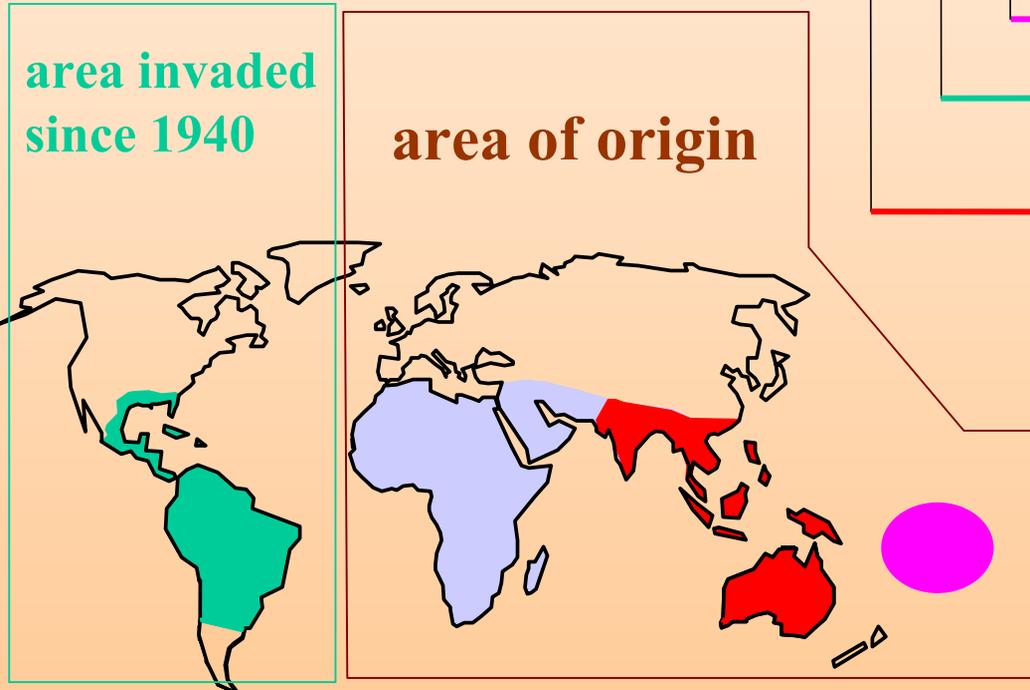
➤ **Several independent introductions in America**

outgroup



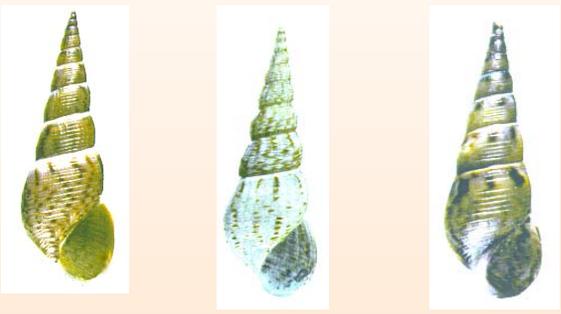
area invaded since 1940

area of origin

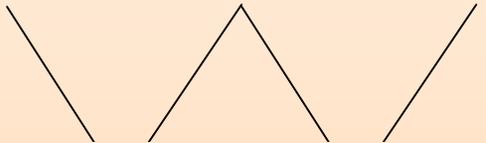


Hybridization : another source of genetic variance in the invaded area

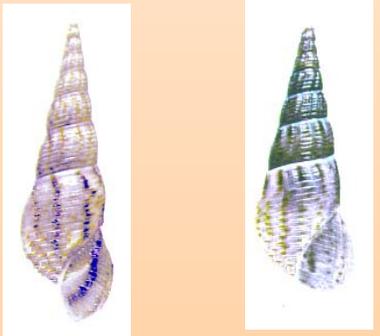
Melanooides tuberculata



PAP FAL PDC

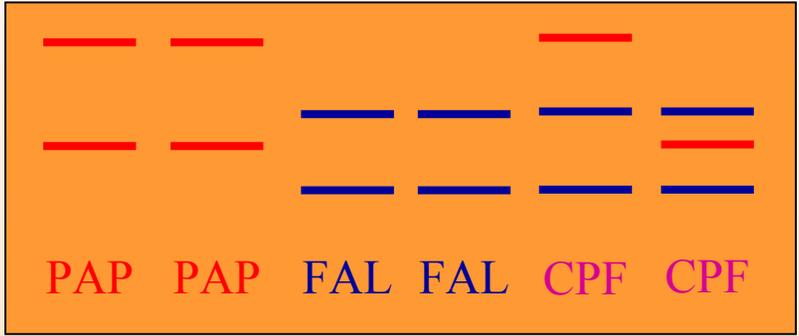


Two hybridization events



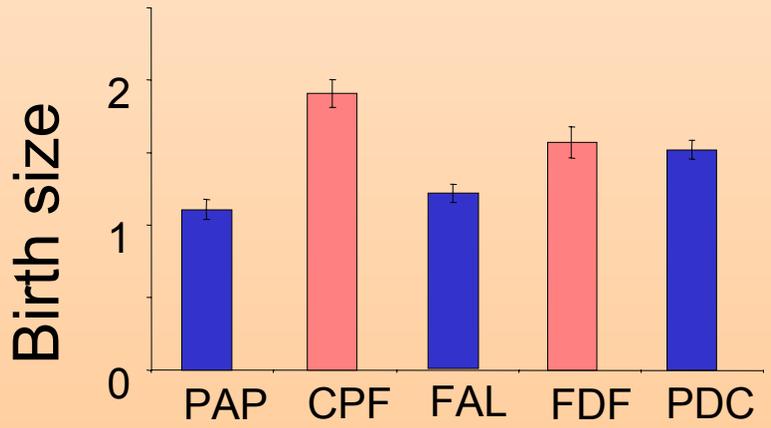
CPF FDF

Microsatellite genotypes : evidence for hybrid origin



Similar situation for FDF

Hybrids show heterosis and outcompete their parents



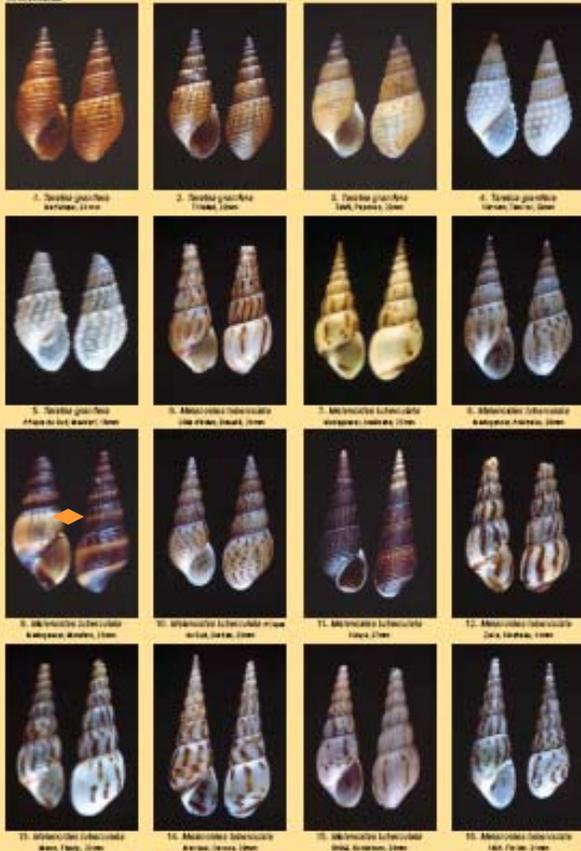
Conclusions on Melanoides invasions

- ◆ Invaders accumulated genetic variation from **repeated introductions from different origins** and, secondarily, from **sexual reproduction among them**
- ◆ This allowed the invasive species to **rapidly evolve towards more competitive strategies**

General conclusion

- ◆ To invade, a genotype globally needs **more K-oriented traits than its resident relatives when present.**
- ◆ This can lead to (i) ***in situ* evolution** towards a K-strategy within an invasive species (ii) **directional species replacement** towards K-strategies within a community, if sufficient variation is provided by repeated introductions and/or recombination
- ◆ However, trade-offs are not always perfect, as illustrated by the endemic *C. catoirii*. In some cases, it may be difficult to deduce competition ranks purely from traits.
- ◆ How does this interact with niche differentiation and character displacement ?

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Thank you