Plant of the day: Marshelder

- Close relative of ragweed and sunflower
- Domesticated in eastern North America as an oilseed
- Domesticated form now extinct

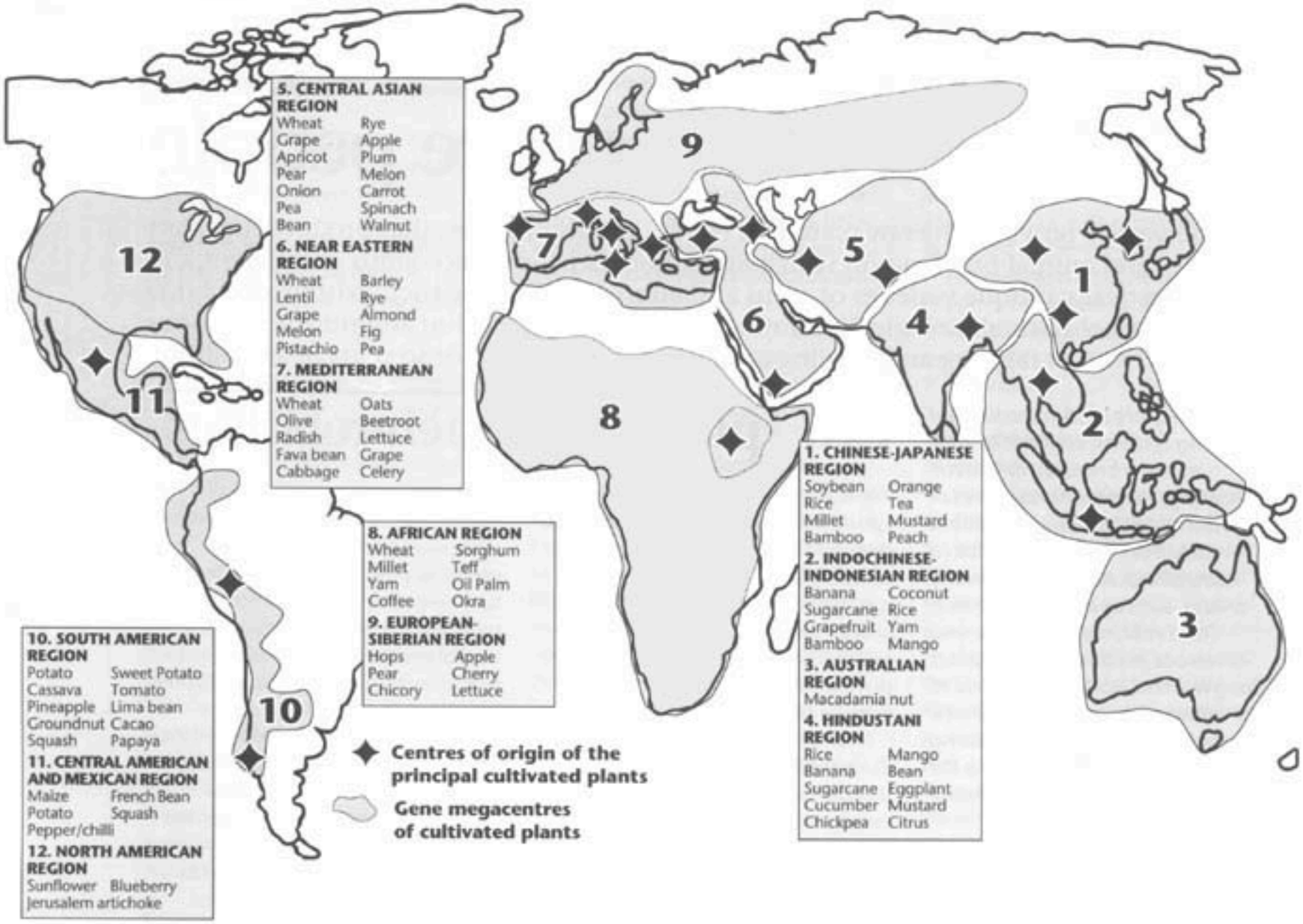
Marshelder (*Iva*)

Crop domestication

Big Questions:

- Where, why and when were plants domesticated?
- What are domestication traits?
- What is the difference between domestication, diversification and improvement?
- What kinds of genetic changes are under selection during domestication?
- Do analyses of evolution under domestication inform us about evolution under natural selection?

Centres of domestication



Archaeological evidence suggests that hunter-gatherers independently began cultivating food plants in at least 12 regions of the world (Doebley et al. 2006)

Reasons for domestication

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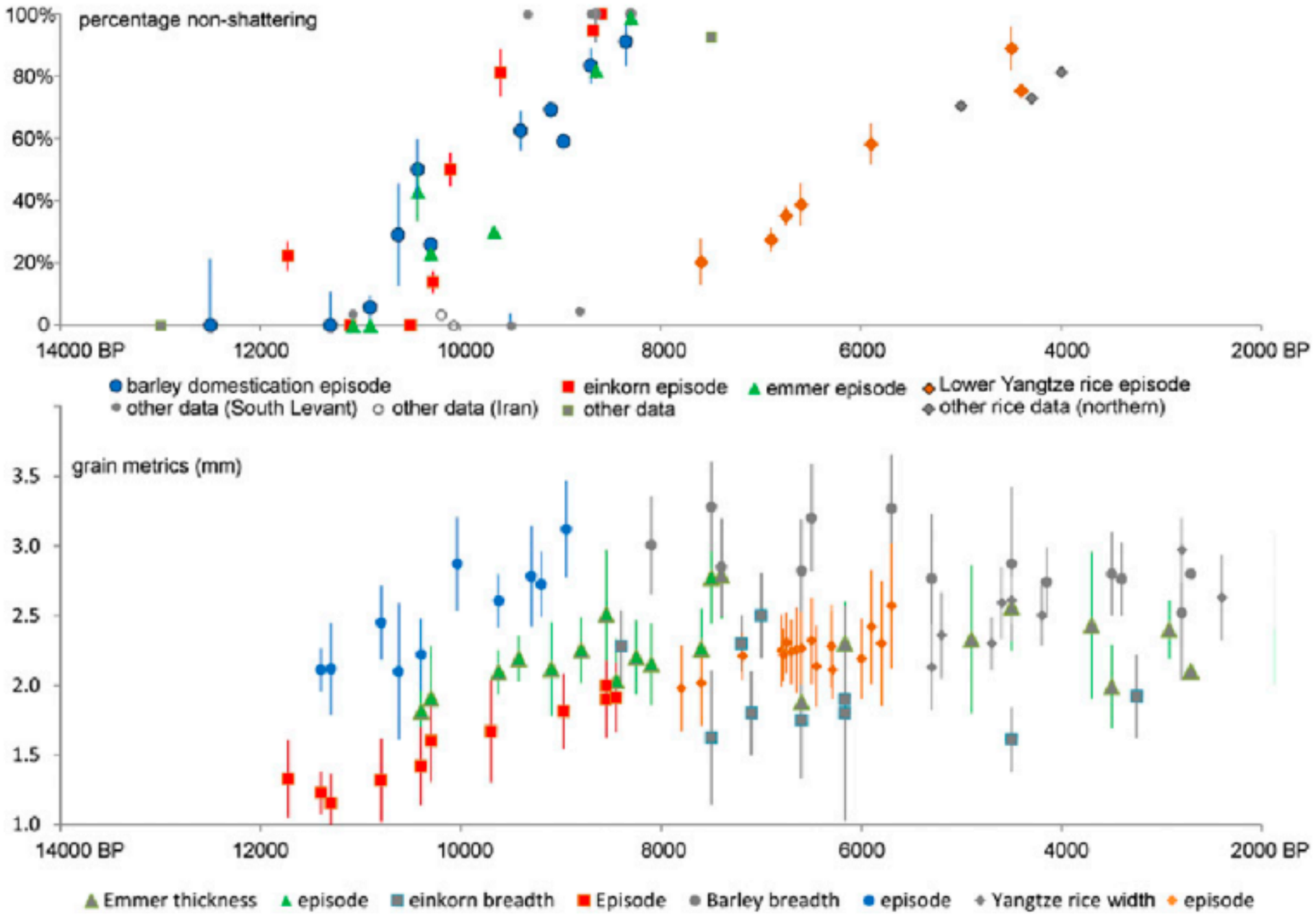
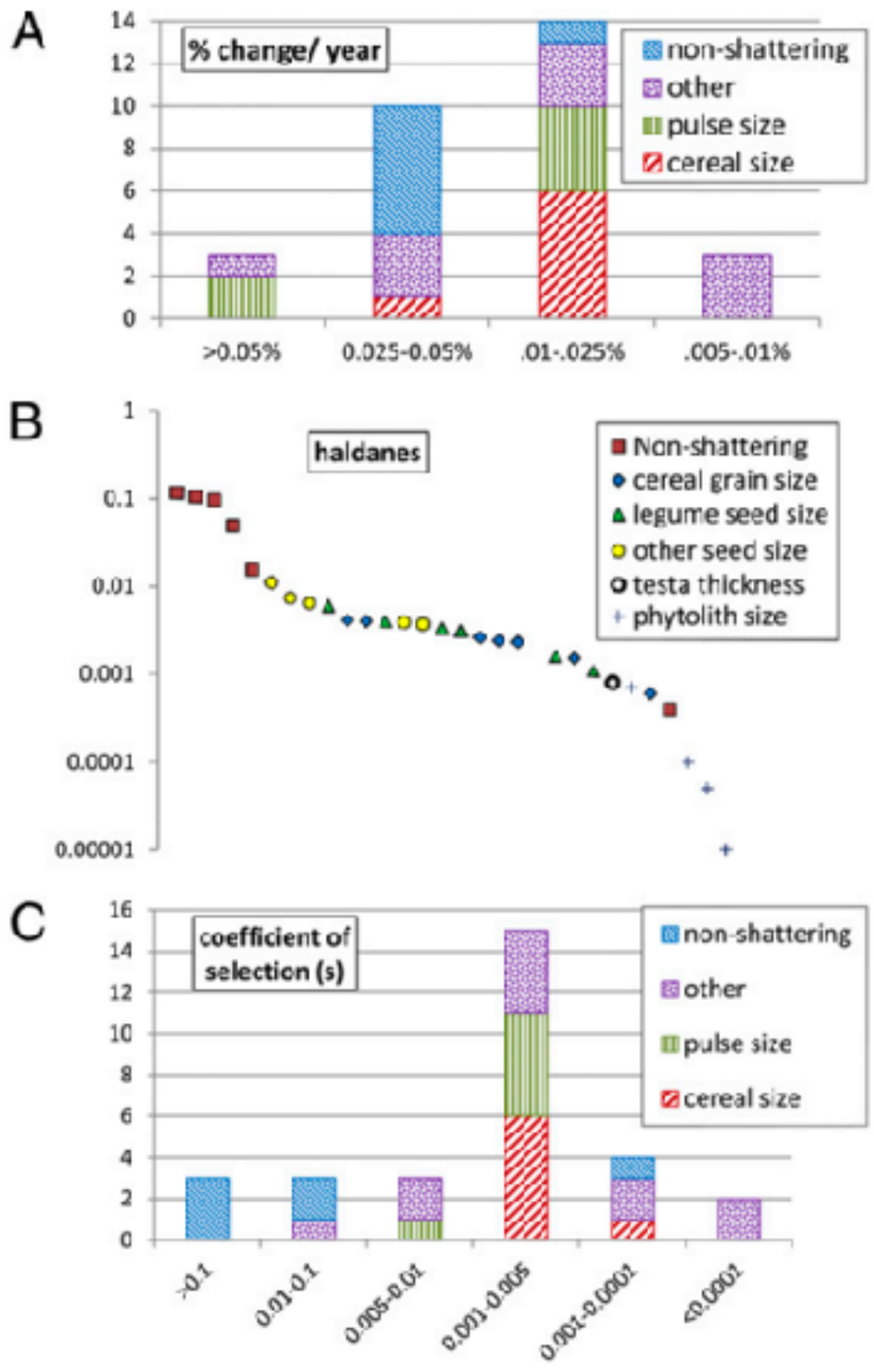
Why were plants domesticated?

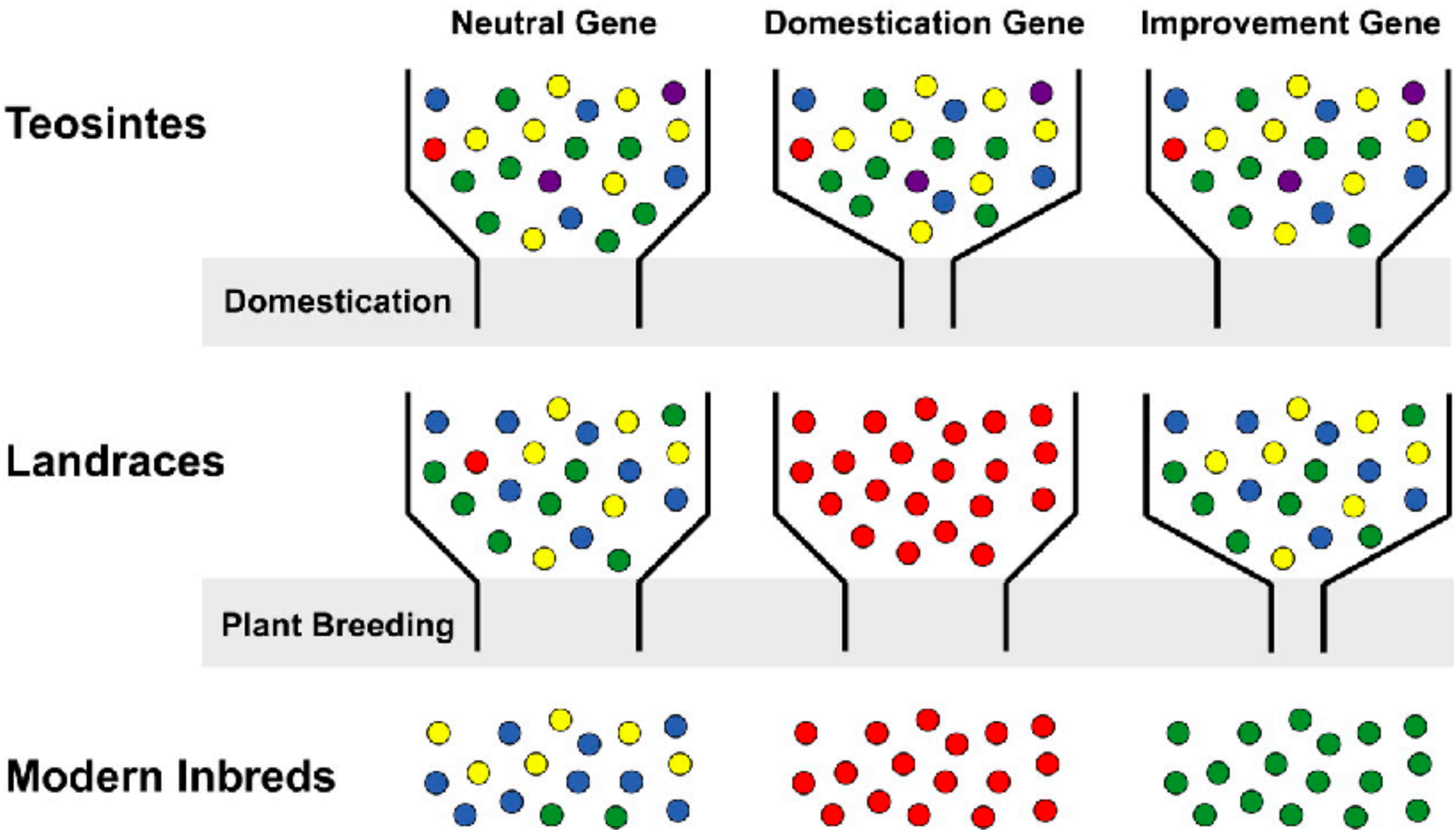
Speed of domestication



Speed of evolution



Domestication bottlenecks



Domestication Bottlenecks

- Breeding between cultivars or with wild progenitors can restore diversity.
- The level of bottleneck depends on the species and the level of domestication

Domestication Syndrome

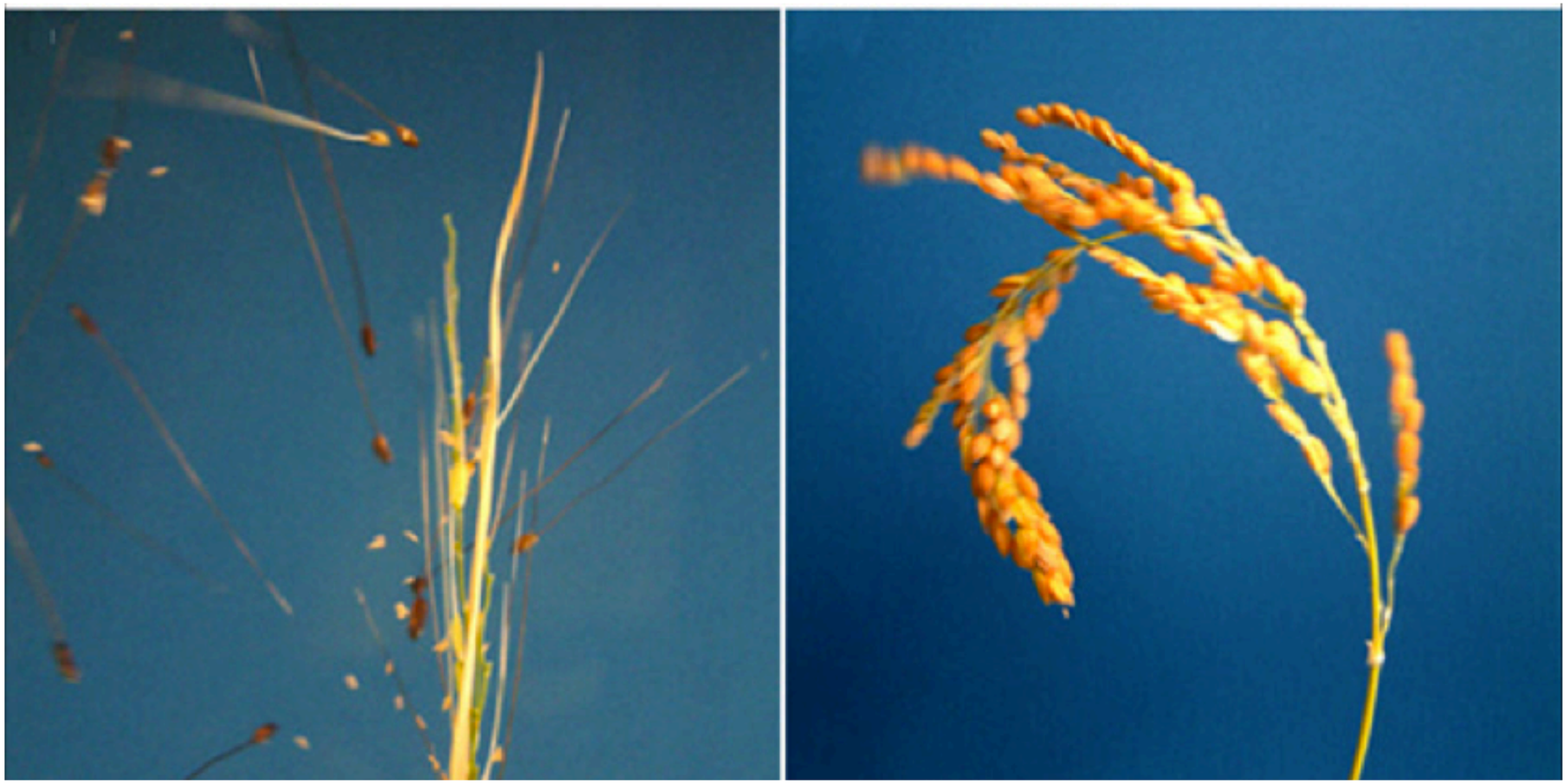
A domestication syndrome describes the properties that distinguish a certain crop from it’s wild progenitor.

THINK - PAIR - SHARE

What are some domestication traits?
What about for seed crops vs. root crops vs. fruit crops?

Domestication traits

A lack of shattering



Domestication traits

Less branching

Domestication traits

Fewer larger fruits

Domestication as a process

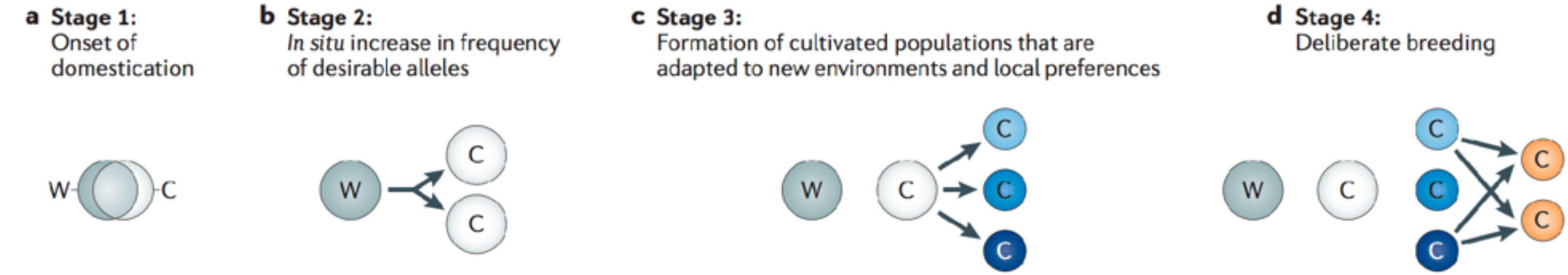
- The distinction ‘domesticated’ or ‘not domesticated’ is an over-simplification

- Some crops have moved further along this process further than others.

- We can recognize different levels of domestication

- How can we decide which level?

Domestication process

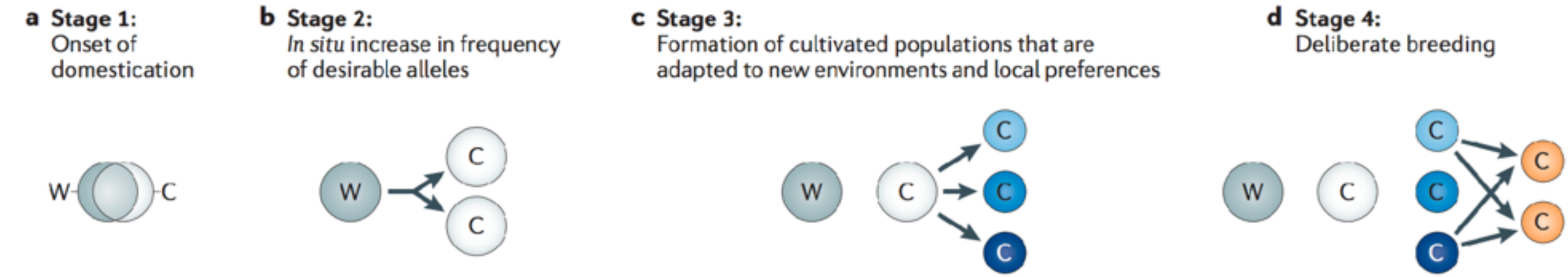


Domestication

Diversification

Improvement

Domestication process

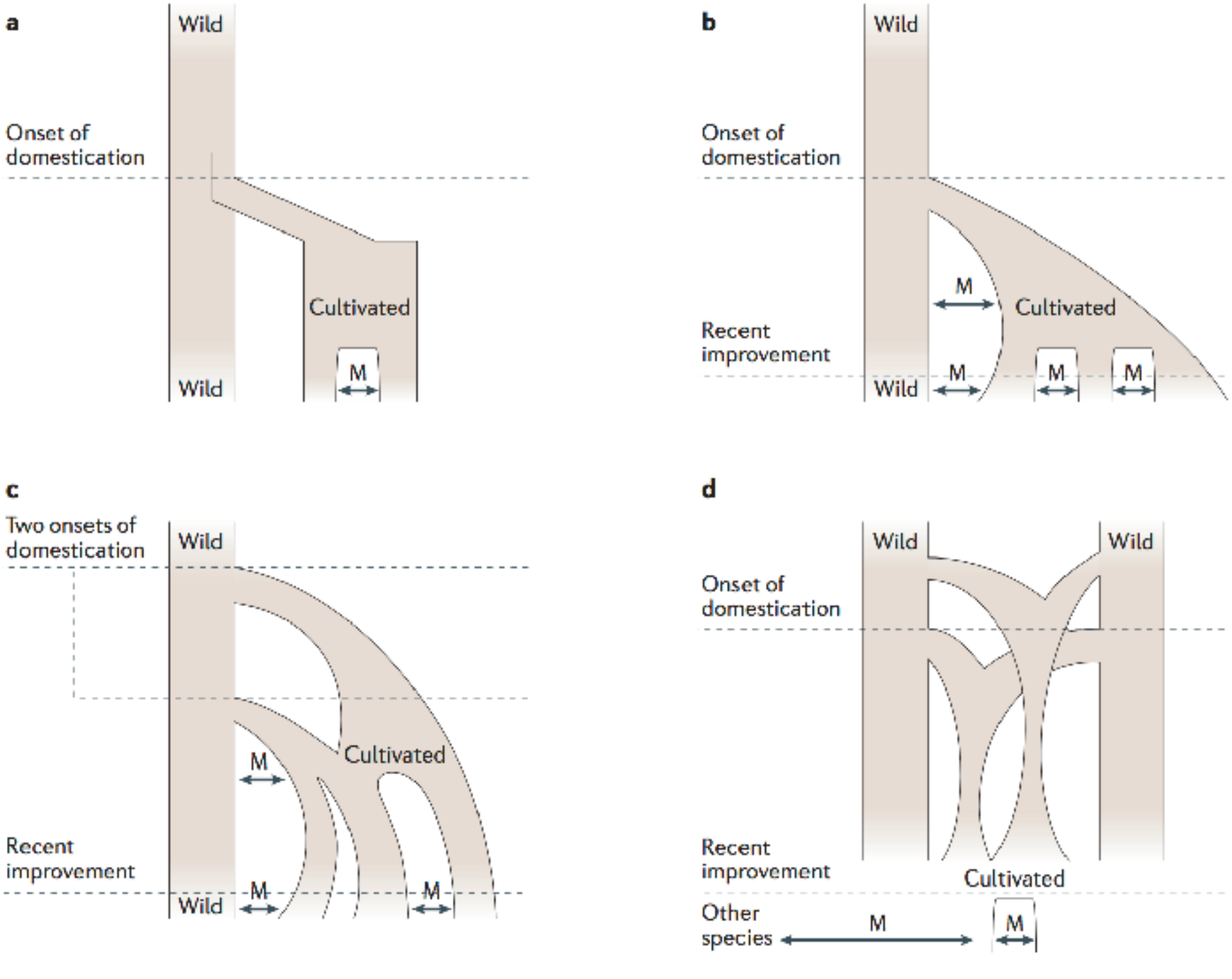


Domestication Diversification Improvement

How might improvement traits be different from domestication traits?

Domestication process

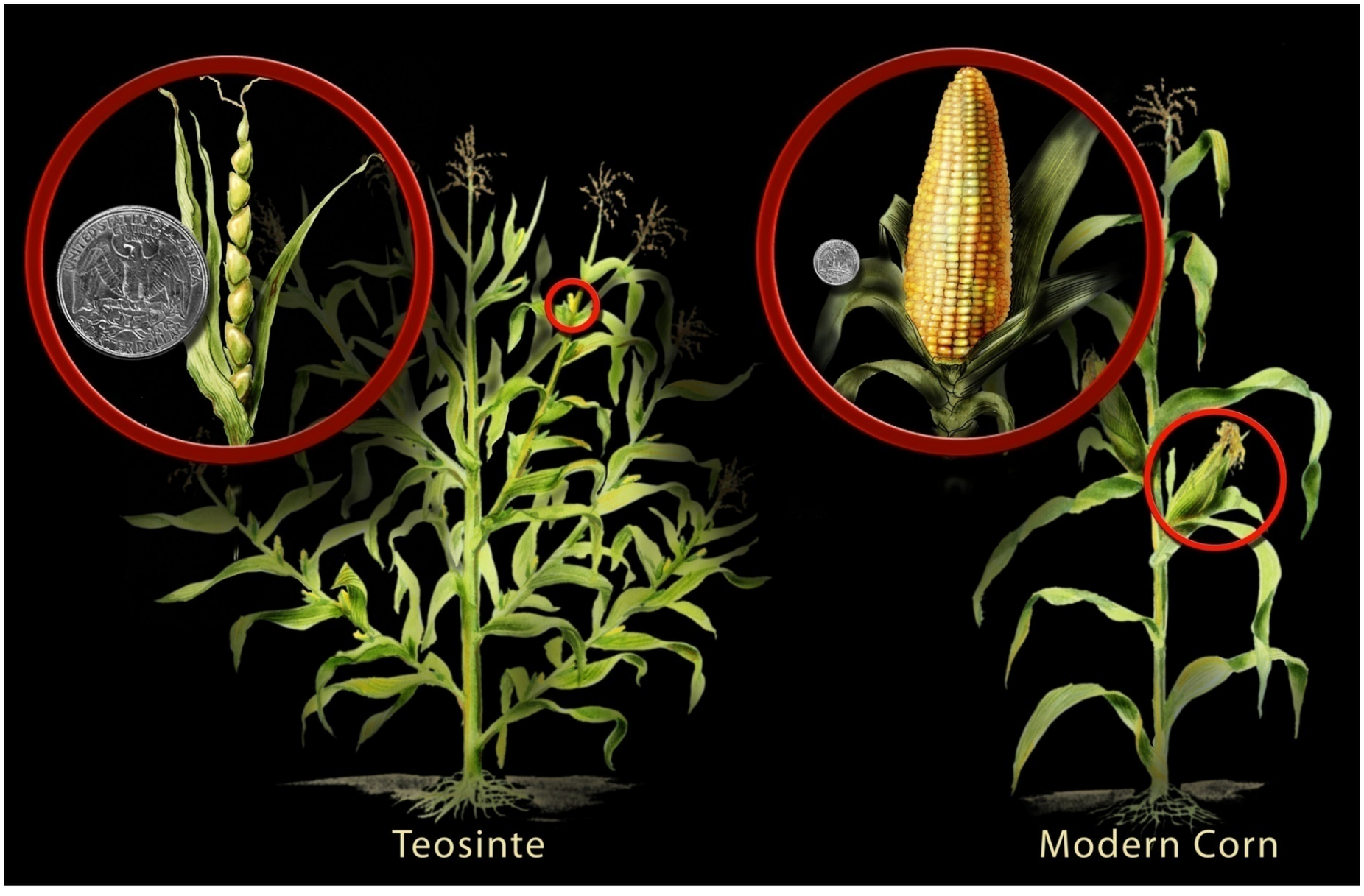
Older view



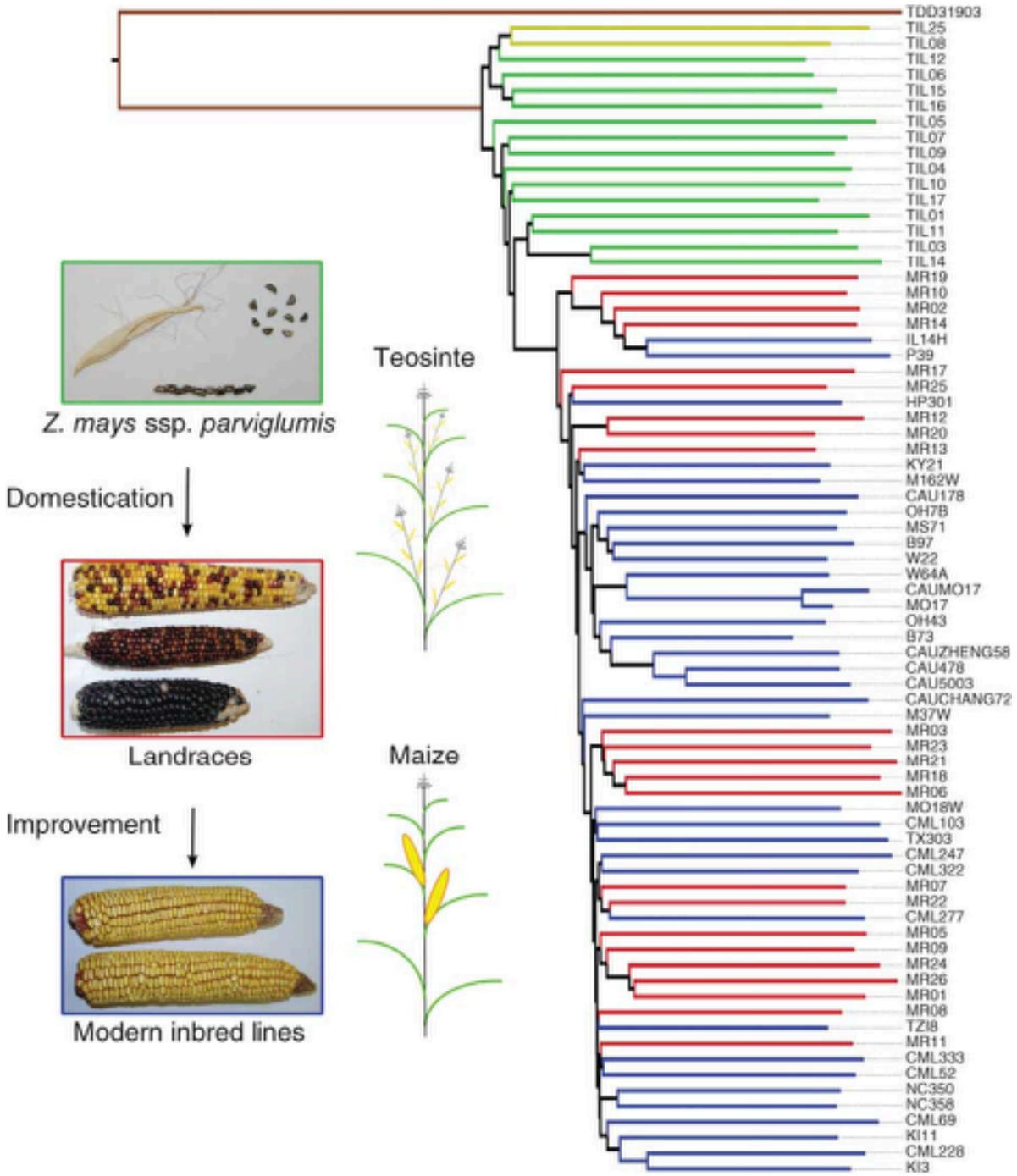
Domestication process

- Plants can have multiple origins of domestication
    - Barley, bottlegourd, coconut, common bean
- Gene flow between cultivate crops and wild progenitors during domestication is also possible

Maize domestication



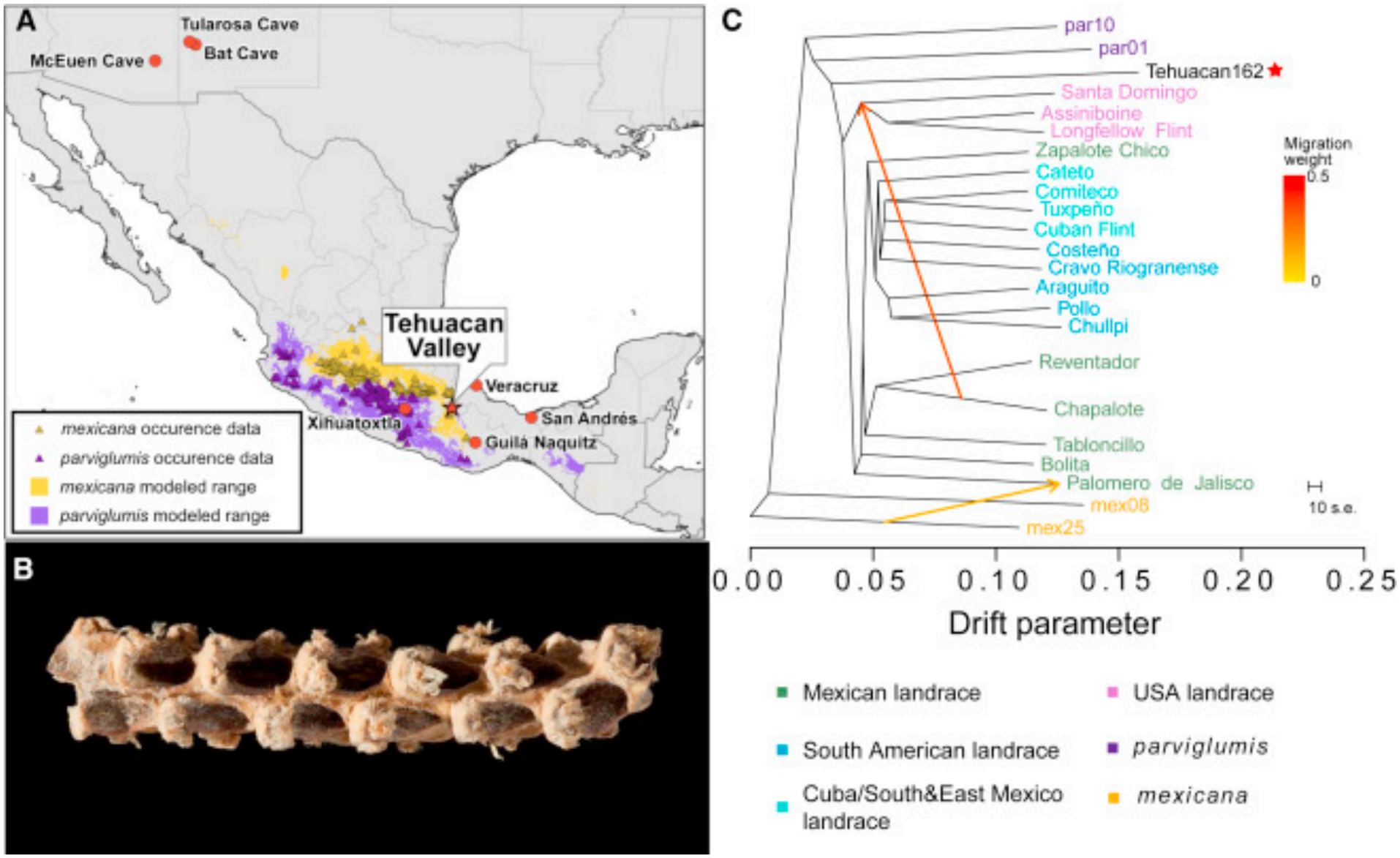
Maize domestication



Single origin

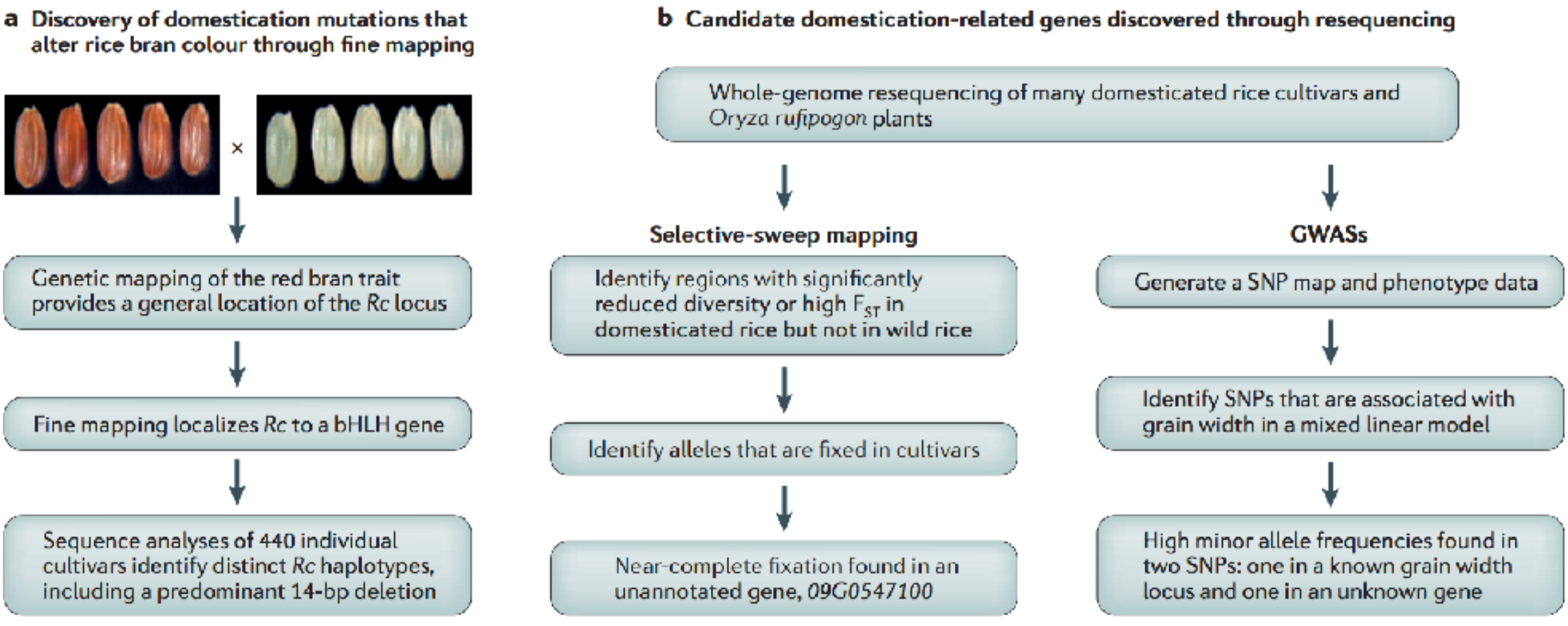
Hufford *et al*. 2012

Maize domestication



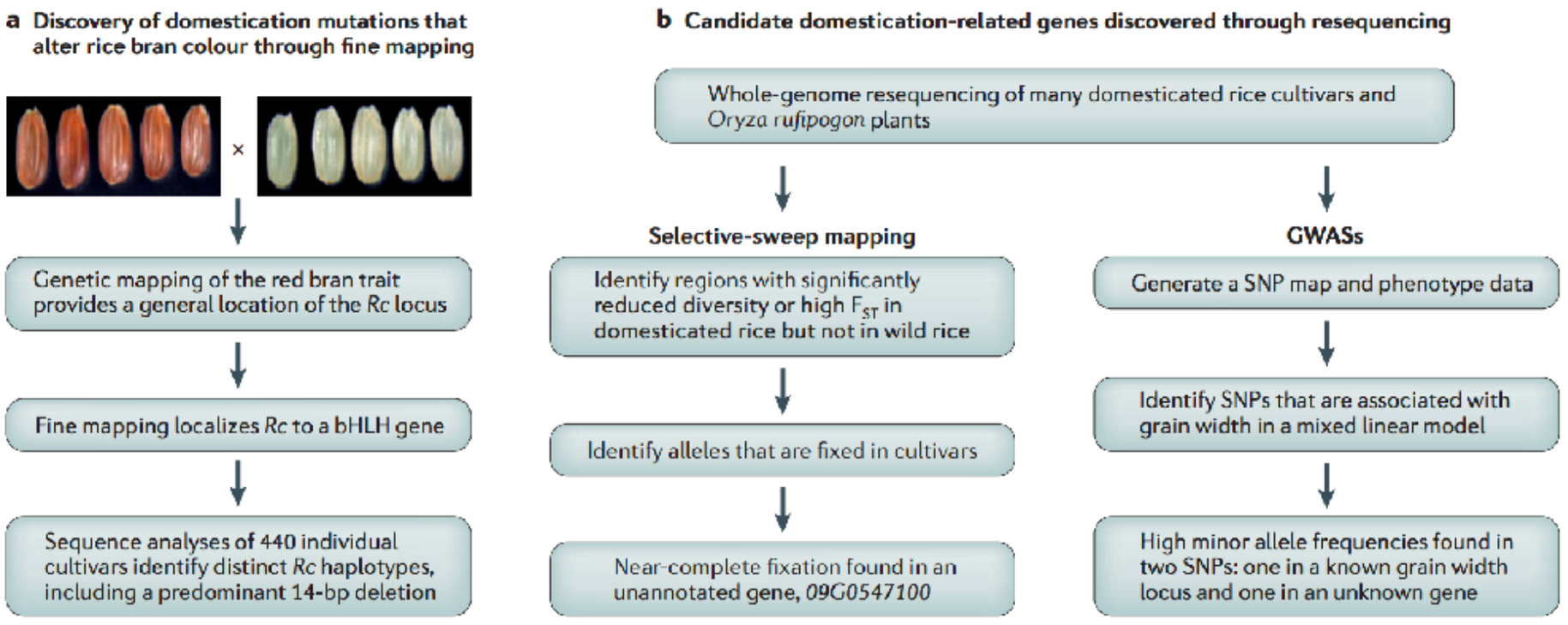
5310 year old maize cob! Ramos-Madrigal *et al.* 2016

Detecting domestication genes



Meyer and Purugganan 2013

Detecting domestication genes



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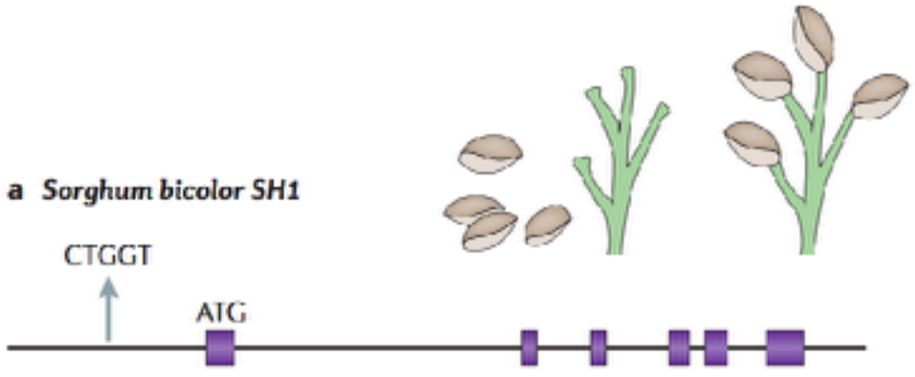
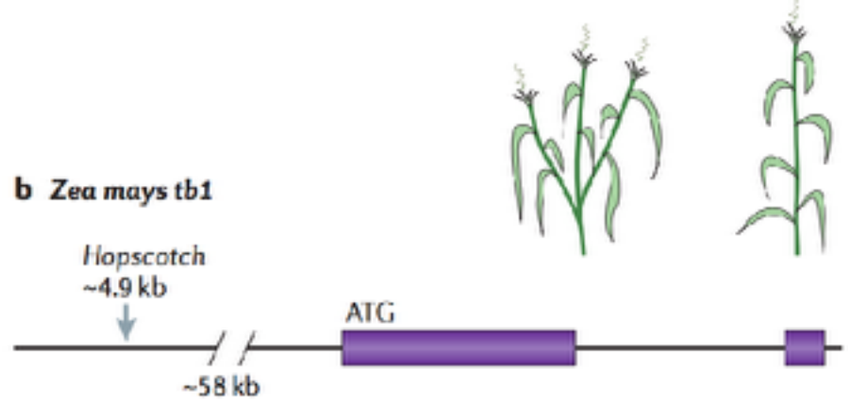
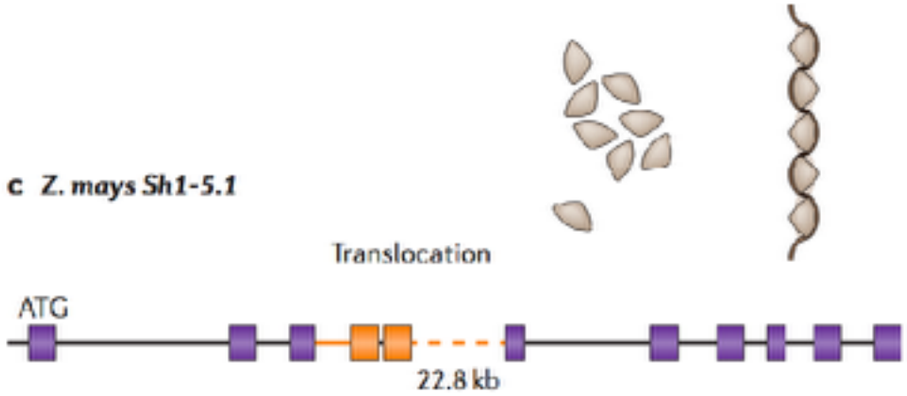
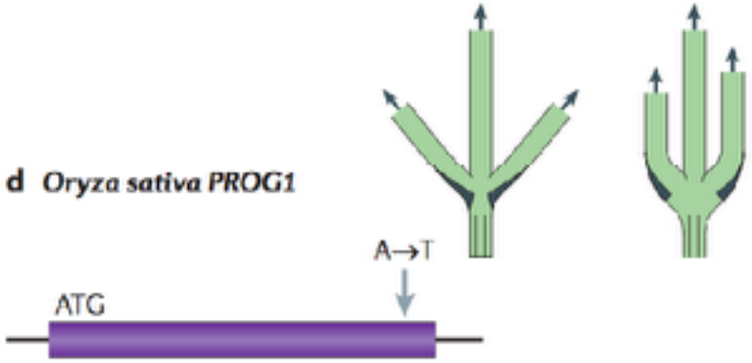
What are some weakness of each method?

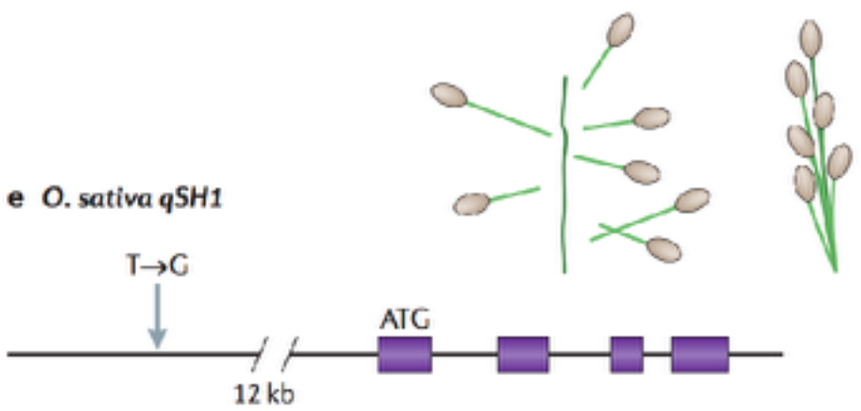
Domestication genes

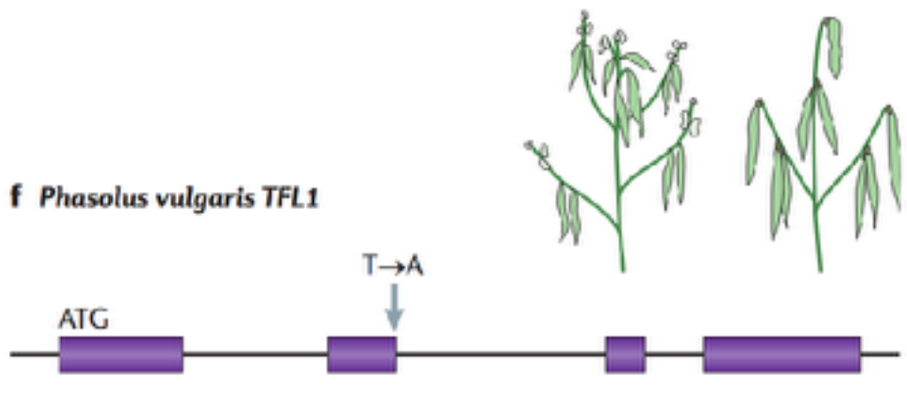












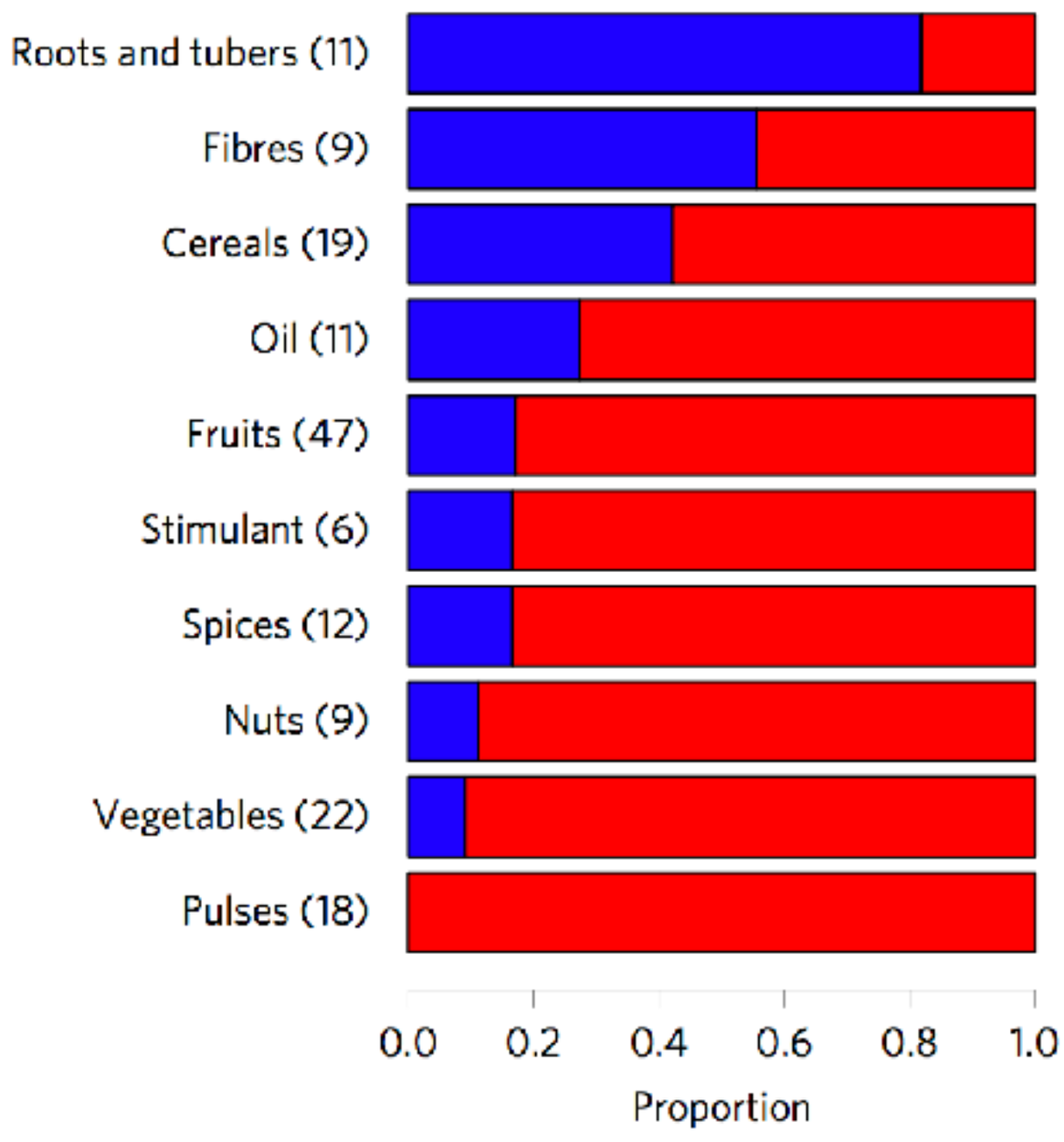
Domestication genes

- A majority of domestication genes are transcription factors
- Are enriched for genes of large effect (loss of function alleles)
- Can be new mutations or be found in the wild progenitor

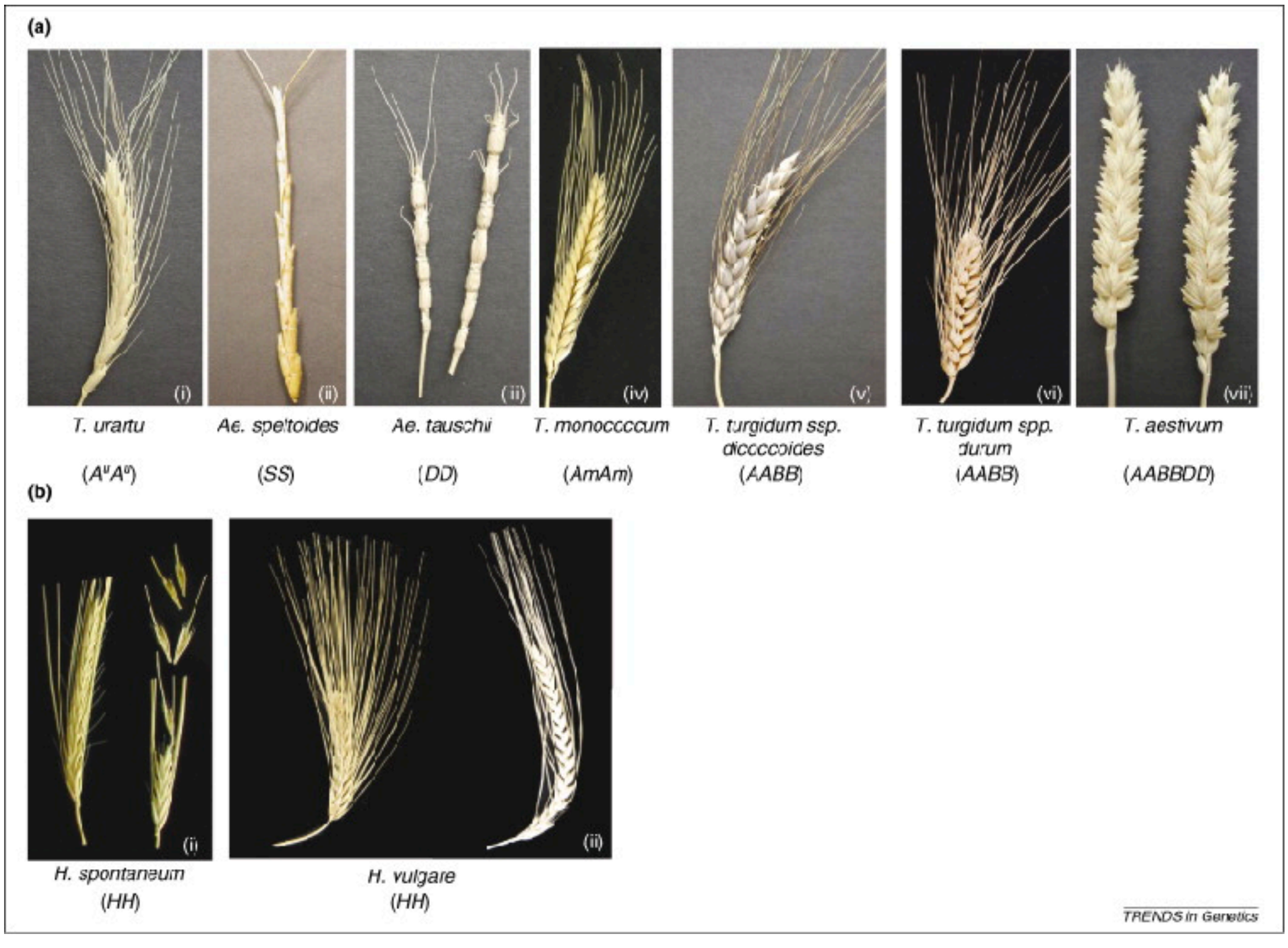
Genetic parallelism

- Sticky rice is caused by a mutation in the WAXY gene
- Mutations in the same gene cause sticky varieties in broomcorn millet, foxtail millet and three *Amaranthus* spp. pseudocereals

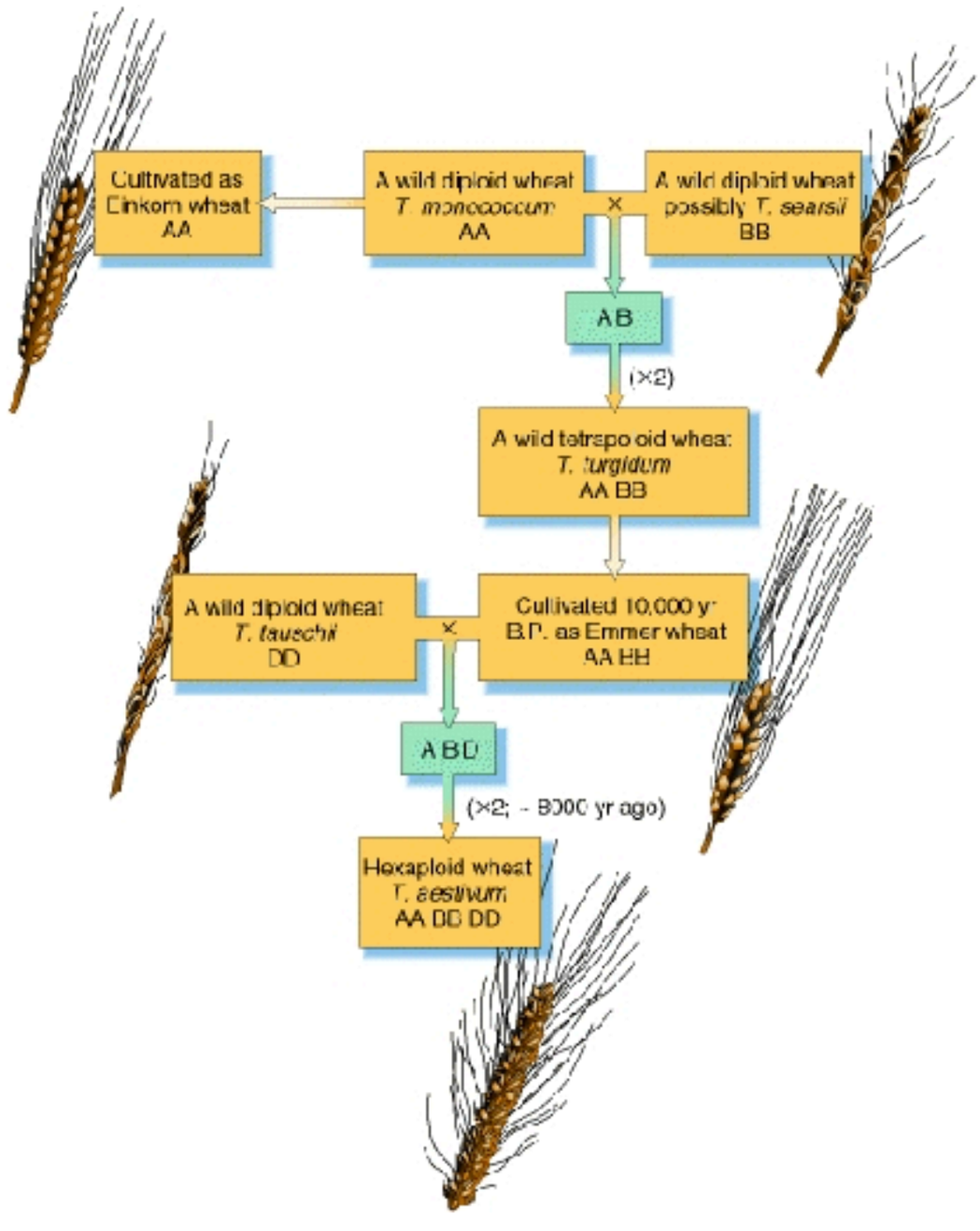
Polyploidy and domestication



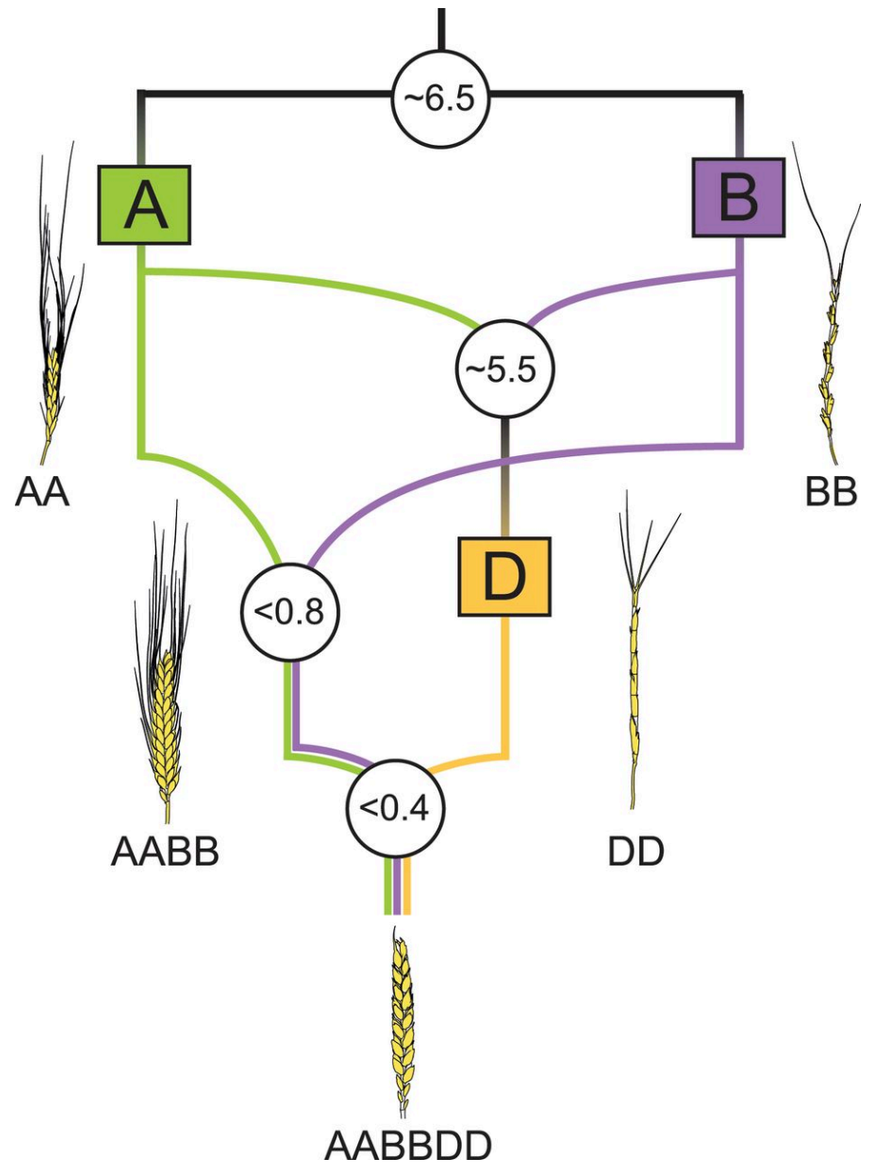
Polyploidy and domestication



Polyploidy and domestication



Polyploidy and domestication



Unanswered questions

- Why are some crops only weakly domesticated?
- Are the major effect domestication genes/mutations cloned so far representative of other crops/genes/ mutations?
- What is the role of reproductive isolation in domestication? What about gene flow from wild relatives?
- Do domesticated plants carry high levels of genetic load?