PLANT OF THE DAY: Marsh-elder

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

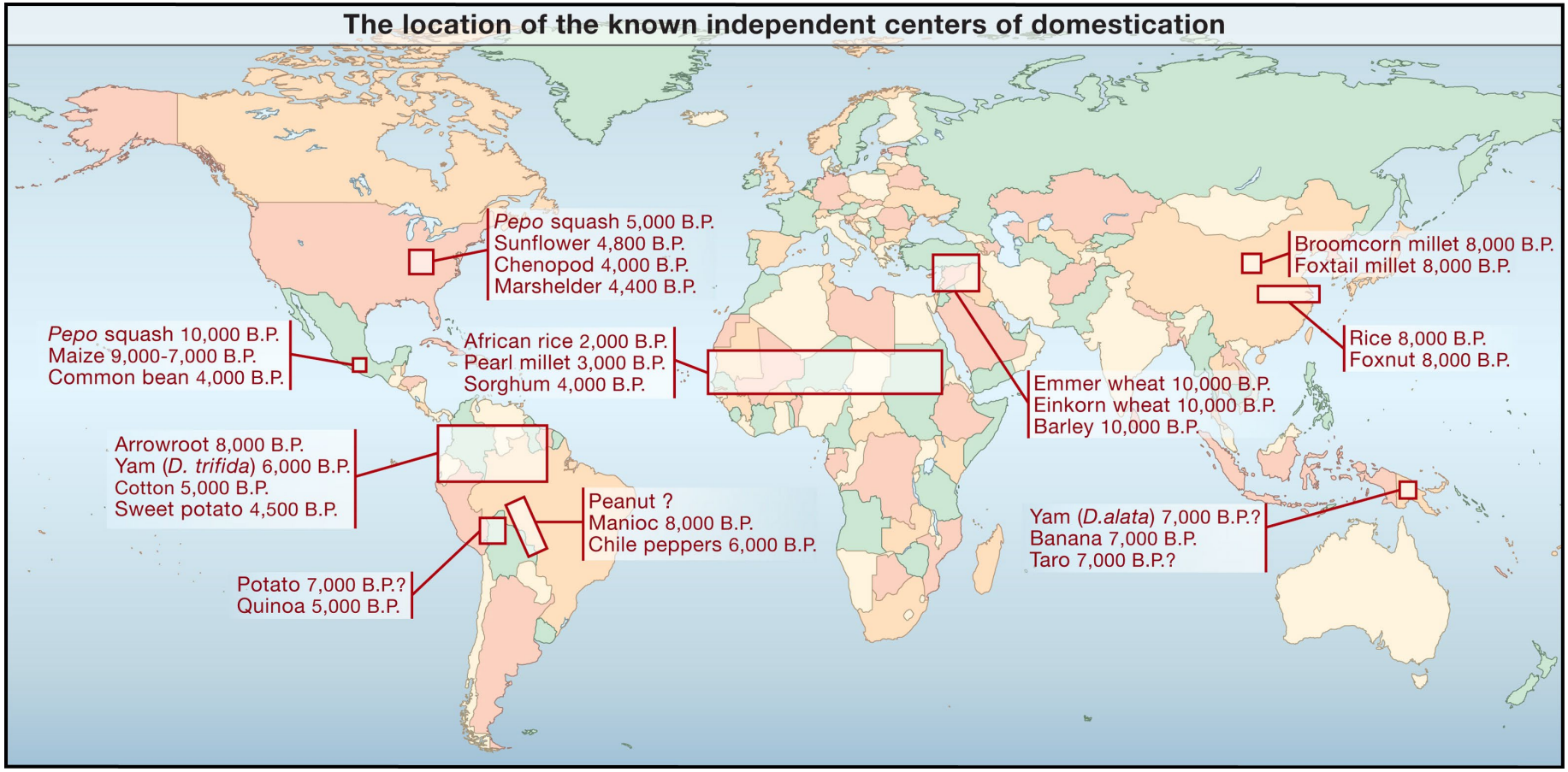
Marshelder (*Iva*)

Crop domestication

Big Questions:

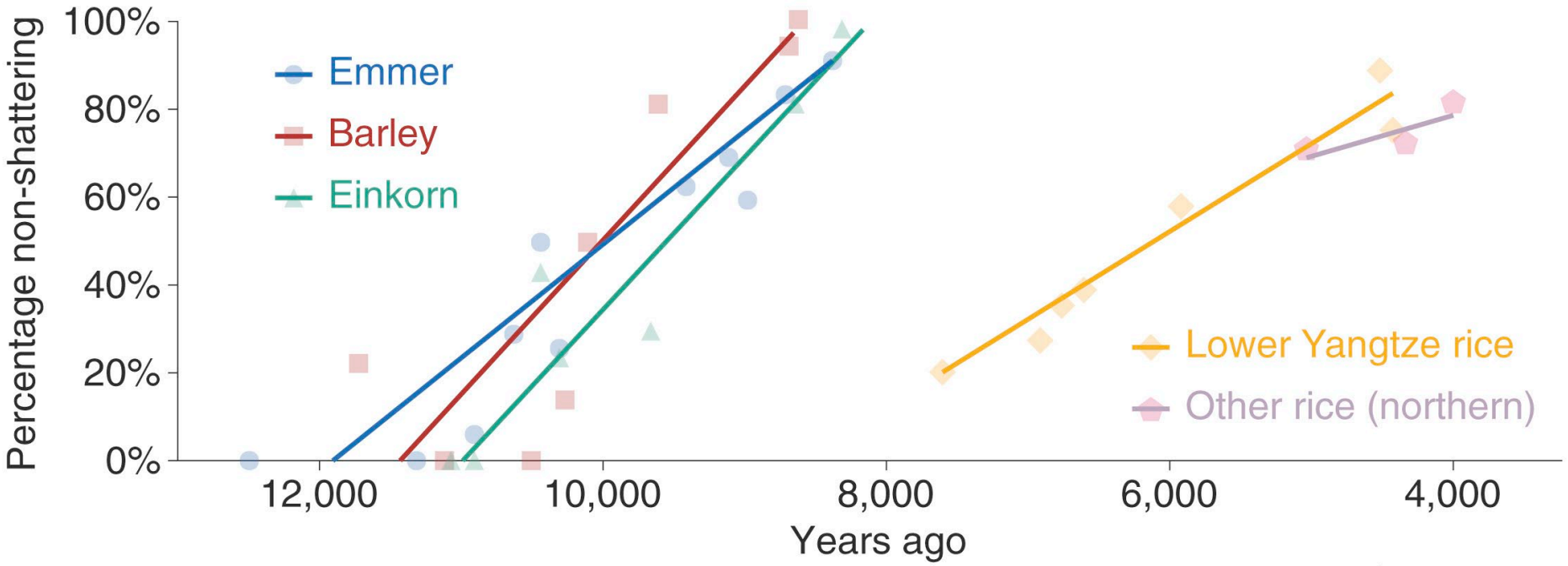
- Where, why and when were plants domesticated?
- What are domestication traits?
- What is the difference between domestication, diversification and improvement?
- What kinds of genetic changes are under selection during domestication?

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)

Speed of domestication

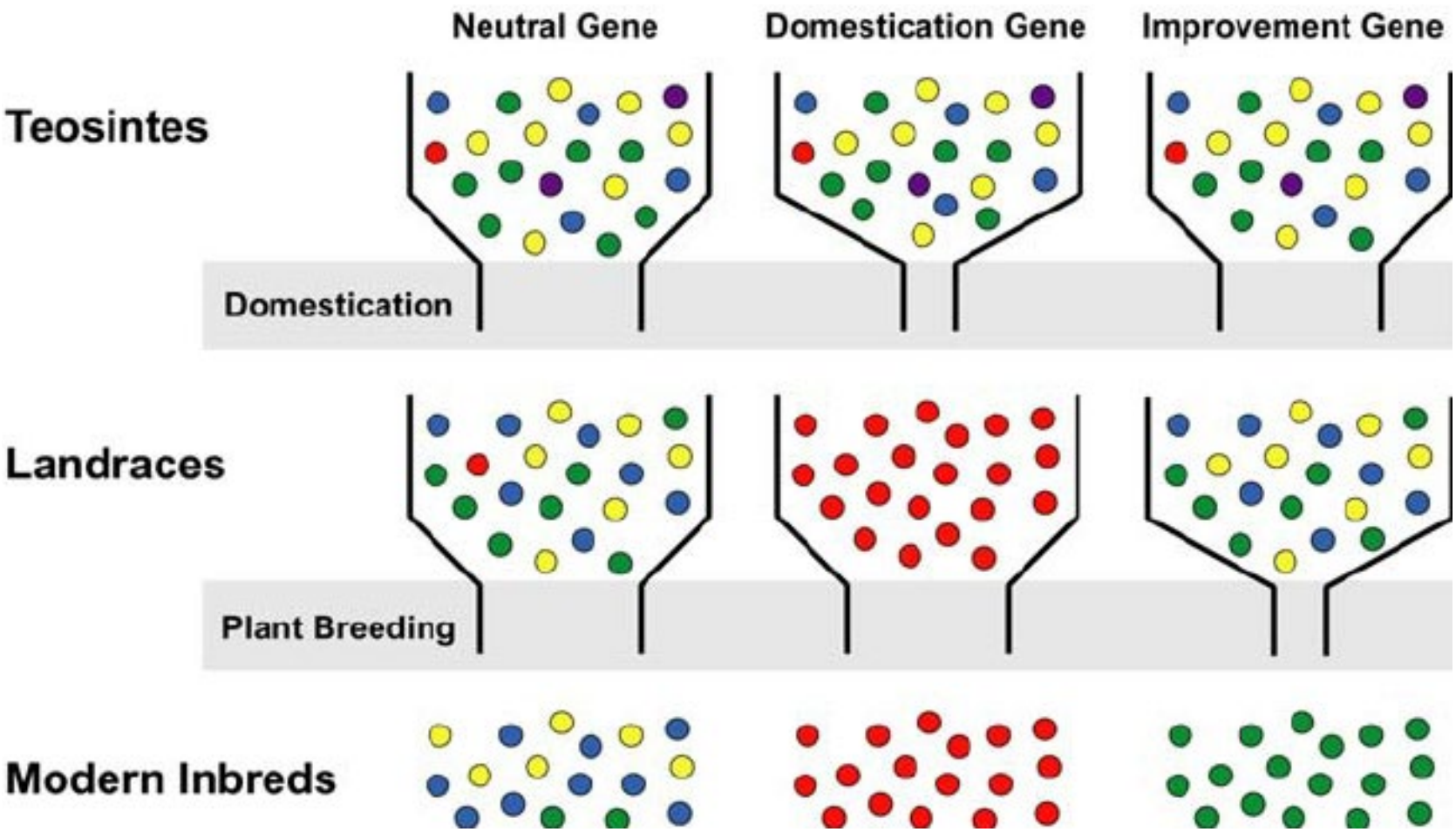


Emmer = Tetraploid wheat
Einkorn = Diploid wheat

Current Biology

Purugganan 2019

Domestication / Improvement Bottlenecks



Yamaski et al. 2005

Domestication / Improvement Bottlenecks

- Loss of diversity often seems to be linear with time rather than clear bottlenecks.
-
- The level of diversity loss depends on the species and the level of domestication.

- Breeding between cultivars or with wild progenitors can restore diversity.

Domestication Syndrome

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

Table 1. Traits associated with plant domestication (Murphy 2007)

Trait	Wild Plant	Domesticated Crop
Height	Tall	Short/dwarf
Growth Habit	Branched/Bushy	Compact
Ripening	Asynchronous	Synchronous
Seed Dormancy	Present	Absent
Seed Shattering	Shattering heads	Non-shattering heads
Fruit/Seed Size	Small	Large
Ease of dispersal	Highly dispersible	Loss of dispersal
Threshing	Hard	Easy
Reproduction	Out-breeding	Self-fertilizing
Germination	Asynchronous	Synchronous
Hairs/spines	Present	Absent/reduced
Toxins	Present	Absent/reduced

Domestication traits

Loss of Shattering

Domestication traits

Less branching

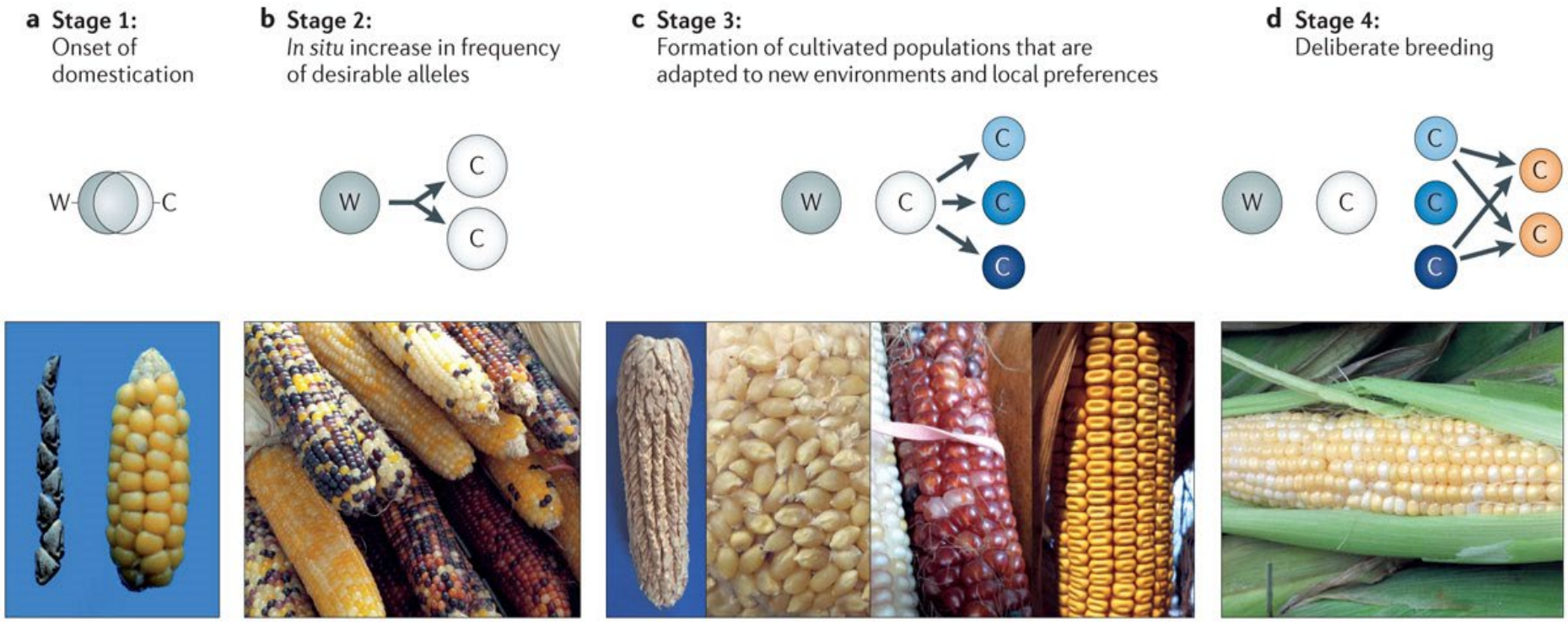
Domestication traits

Fewer larger fruits

Domestication as a Process

- The distinction between ‘domesticated’ or ‘not domesticated is an over-simplification
- Some crops have moved further along this process than others.

Domestication process



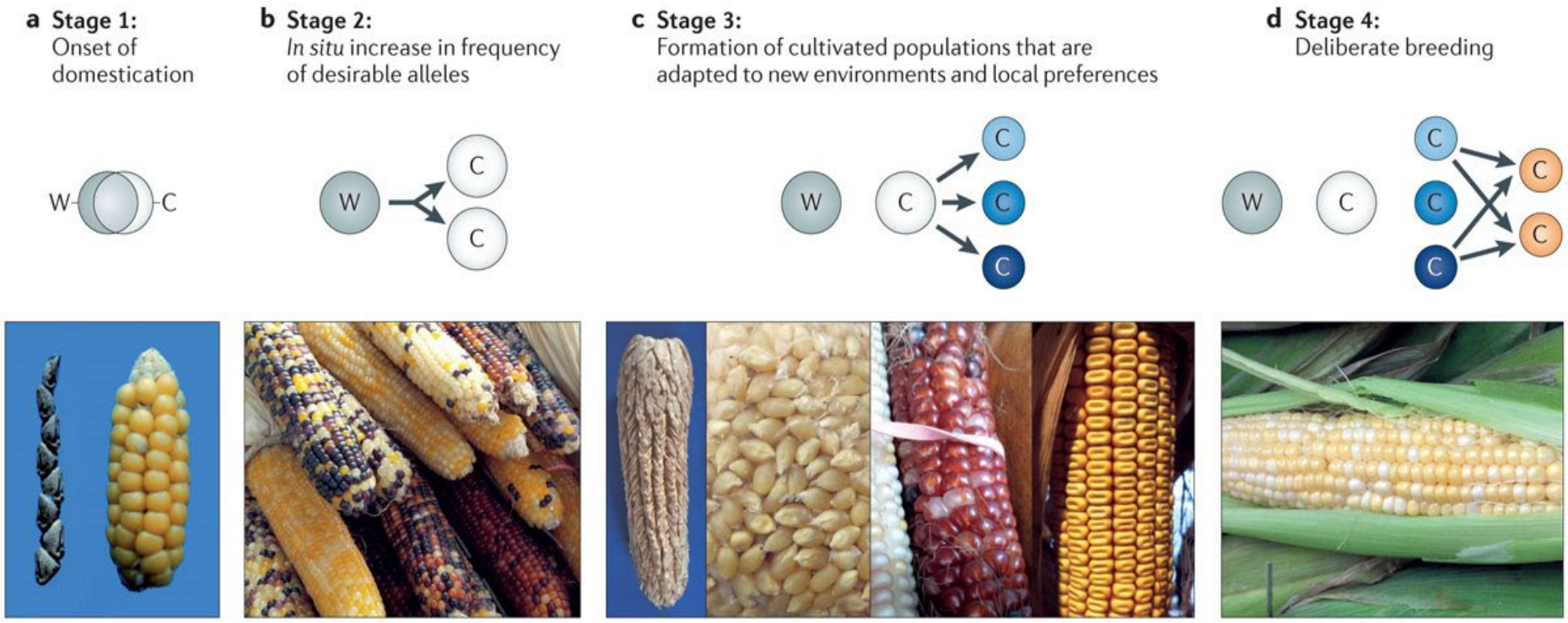
Domestication

Diversification

Improvement

Meyer and Purugganan, 2013

Domestication process



Domestication

Diversification

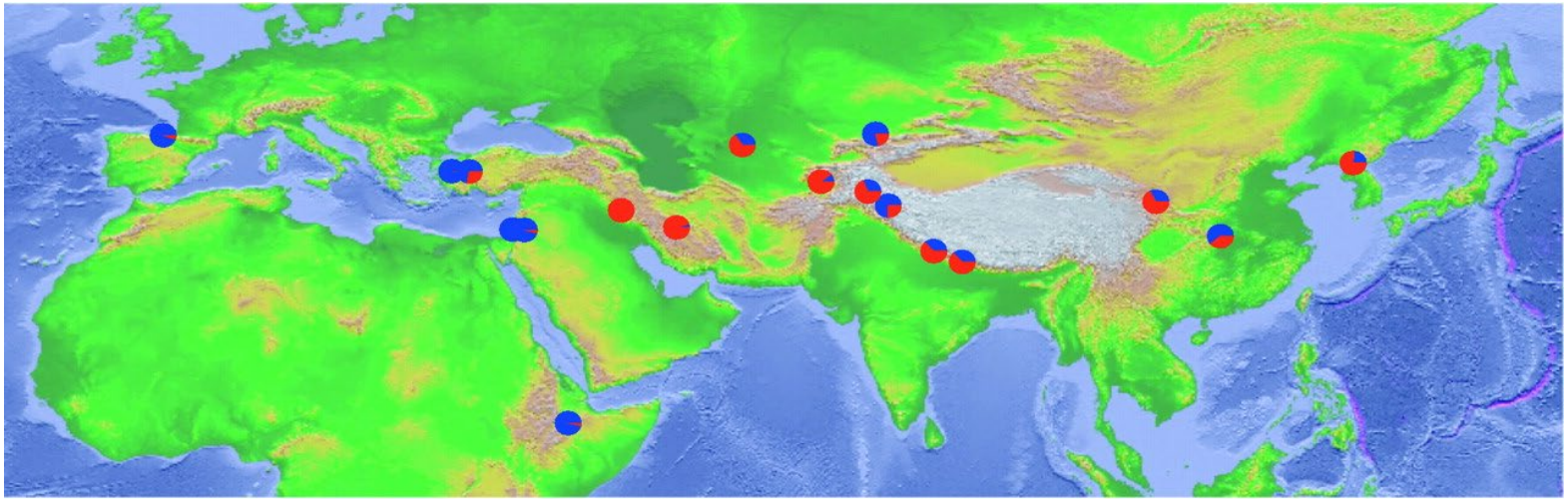
Improvement

How might improvement traits be different from domestication traits?

Meyer and Purugganan, 2013

Domestication process

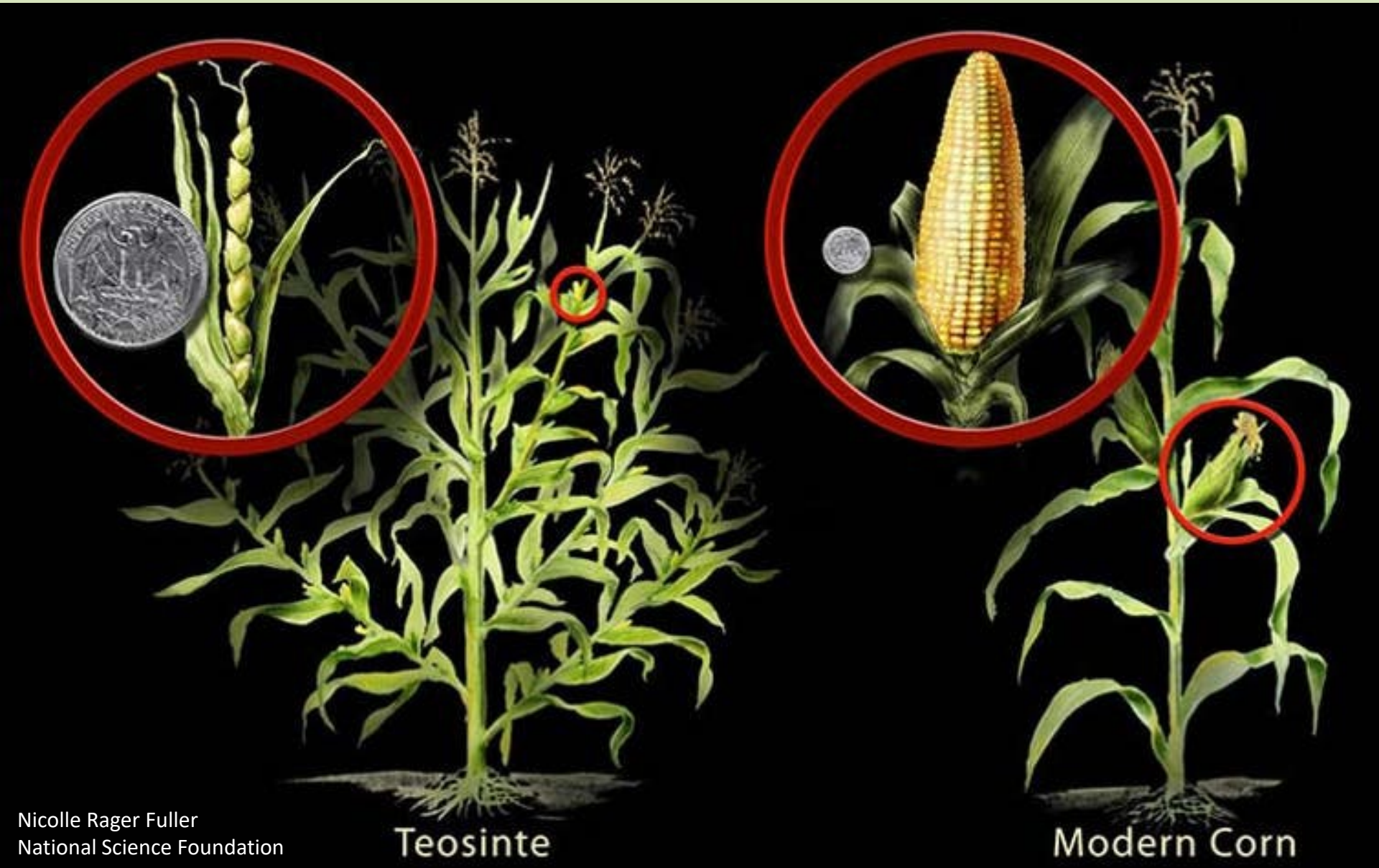
- Plants can have multiple origins of domestication
- Examples include barley, bottlegourd, coconut, common bean
- Gene flow between cultivate crops and wild progenitors during domestication is also possible



Morrell & Clegg, 2007

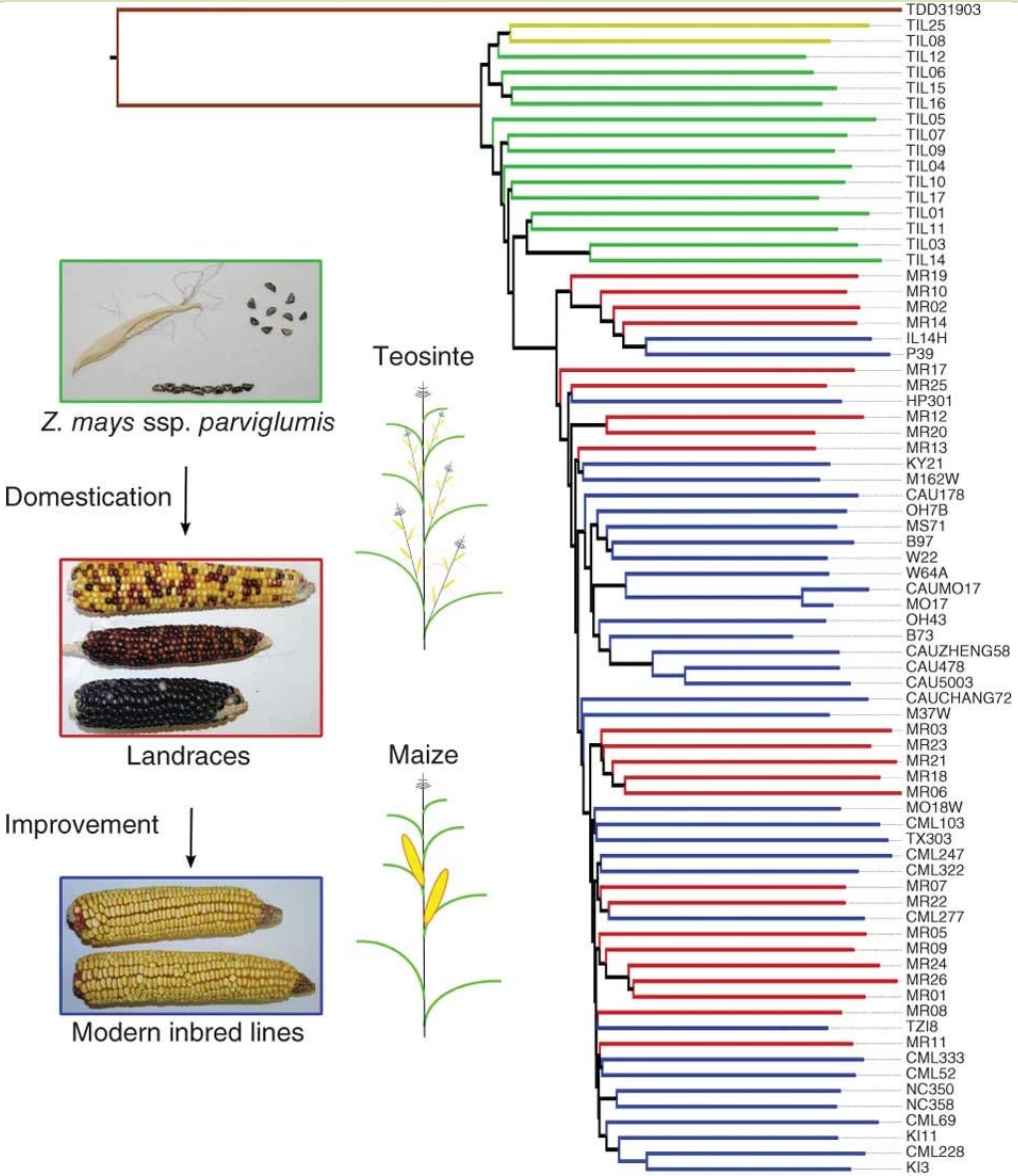
Estimated probabilities of eastern and western wild barley origin in red and blue

Maize domestication



Nicolle Rager Fuller
National Science Foundation

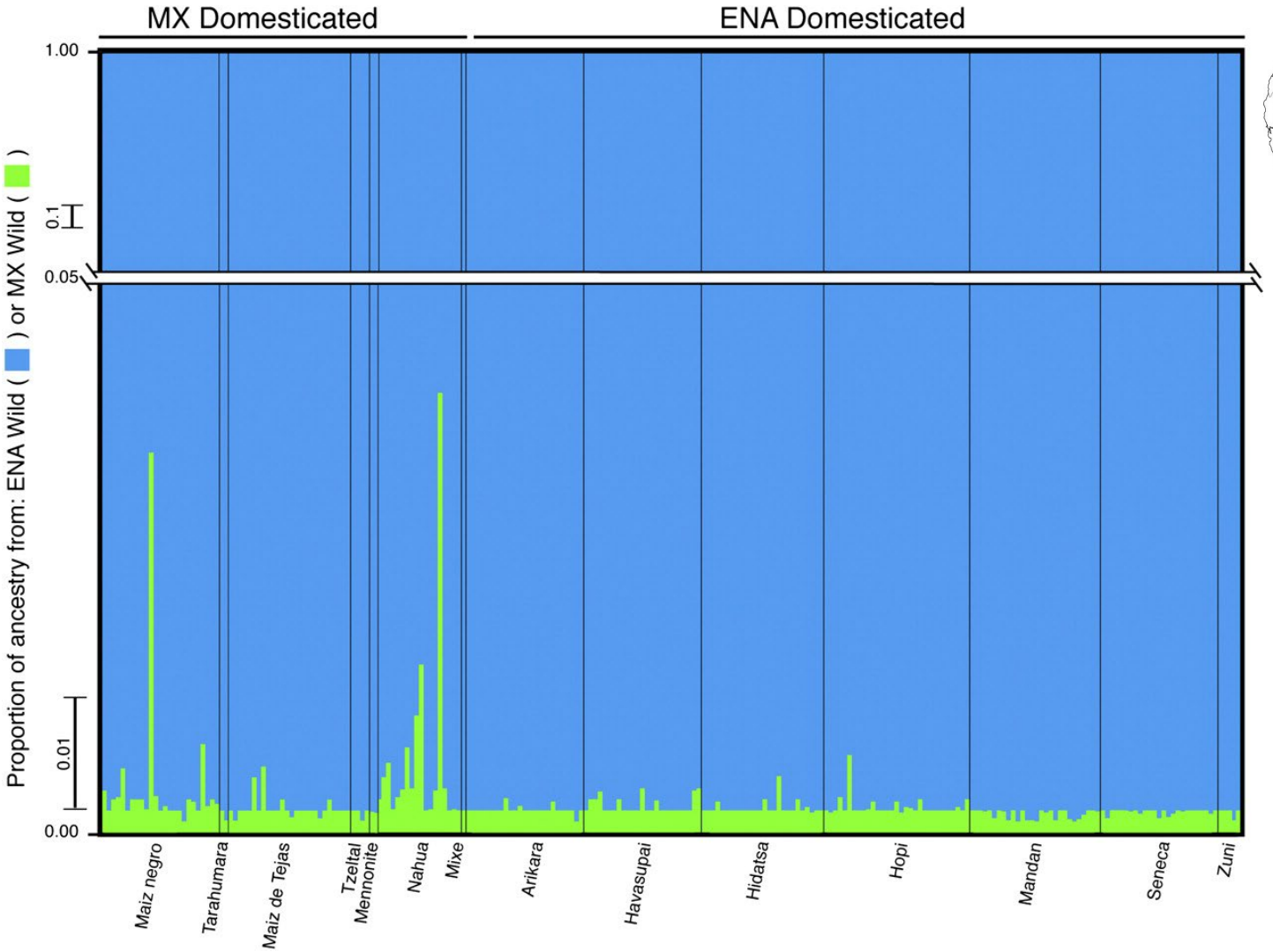
Maize domestication



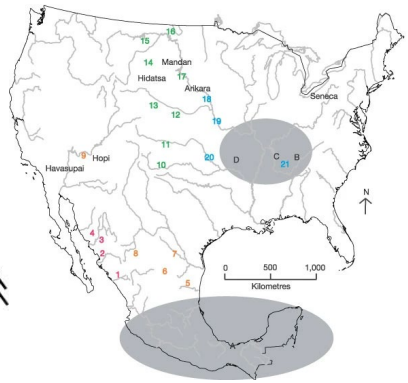
Single origin

Hufford *et al.* 2012

Sunflower domestication



Single origin

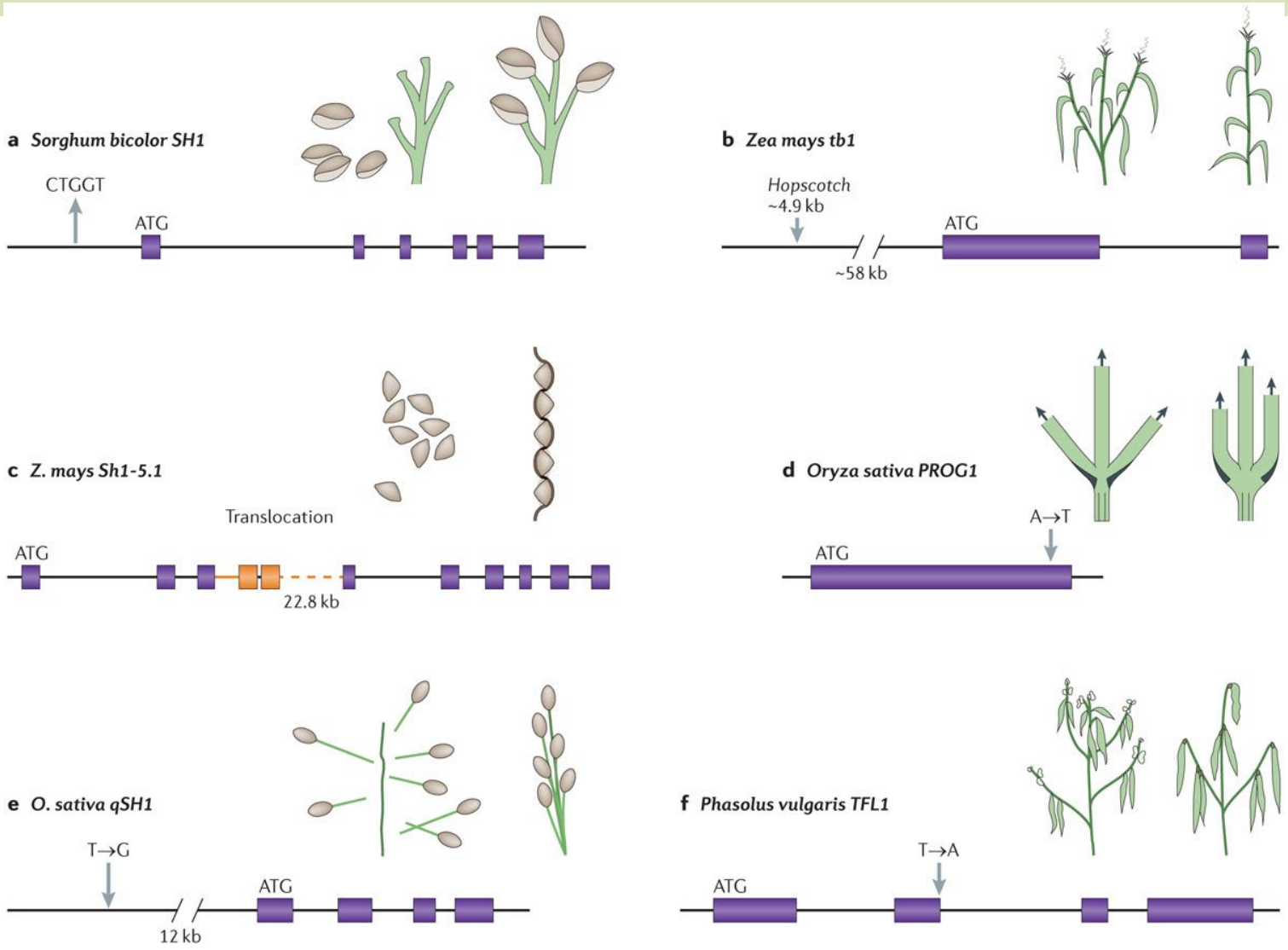


Harter et al. 2004;
Blackman et al. 2011

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

Domestication genes



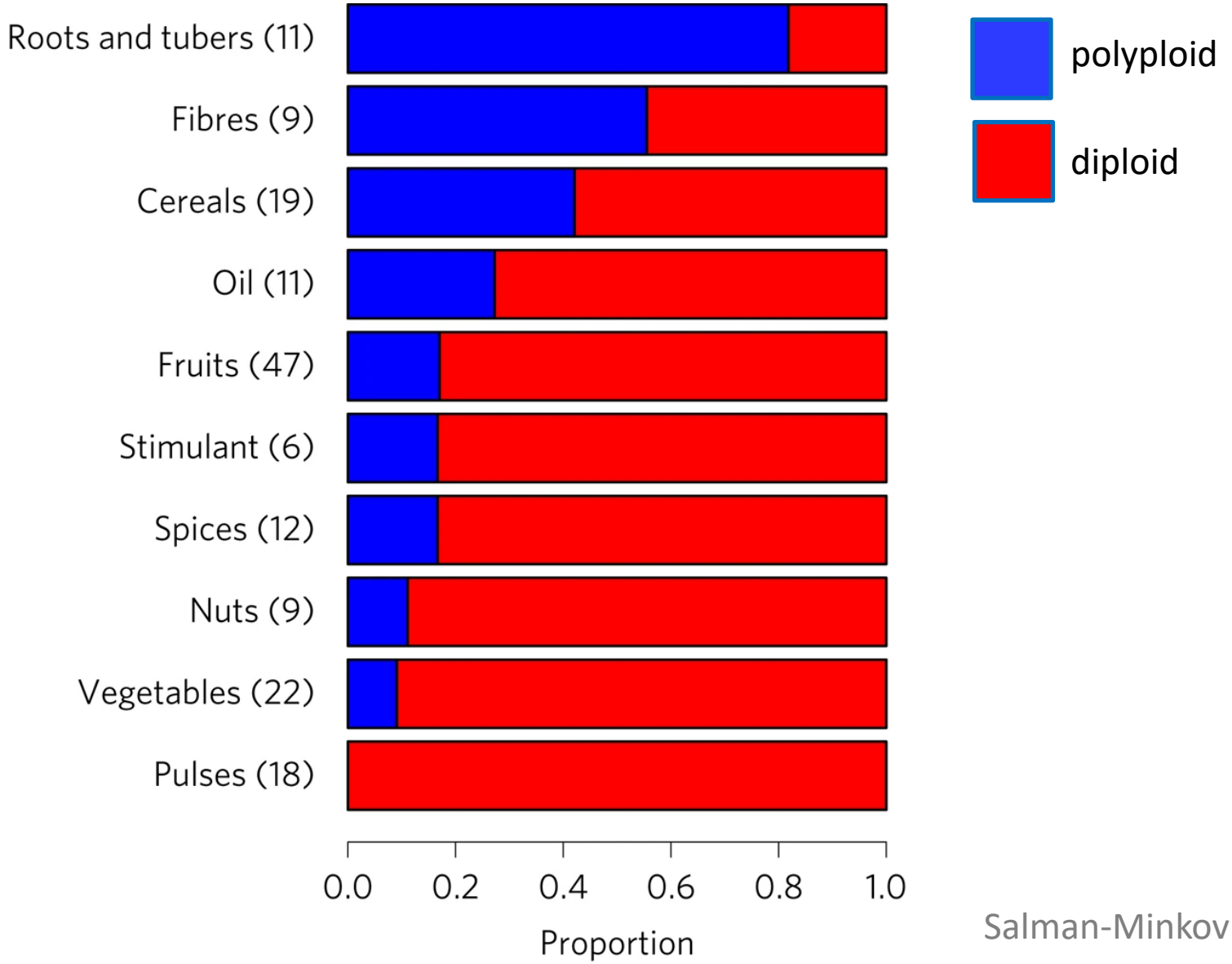
Meyer & Purugganan 2013

Nature Reviews | Genetics

Genetic parallelism

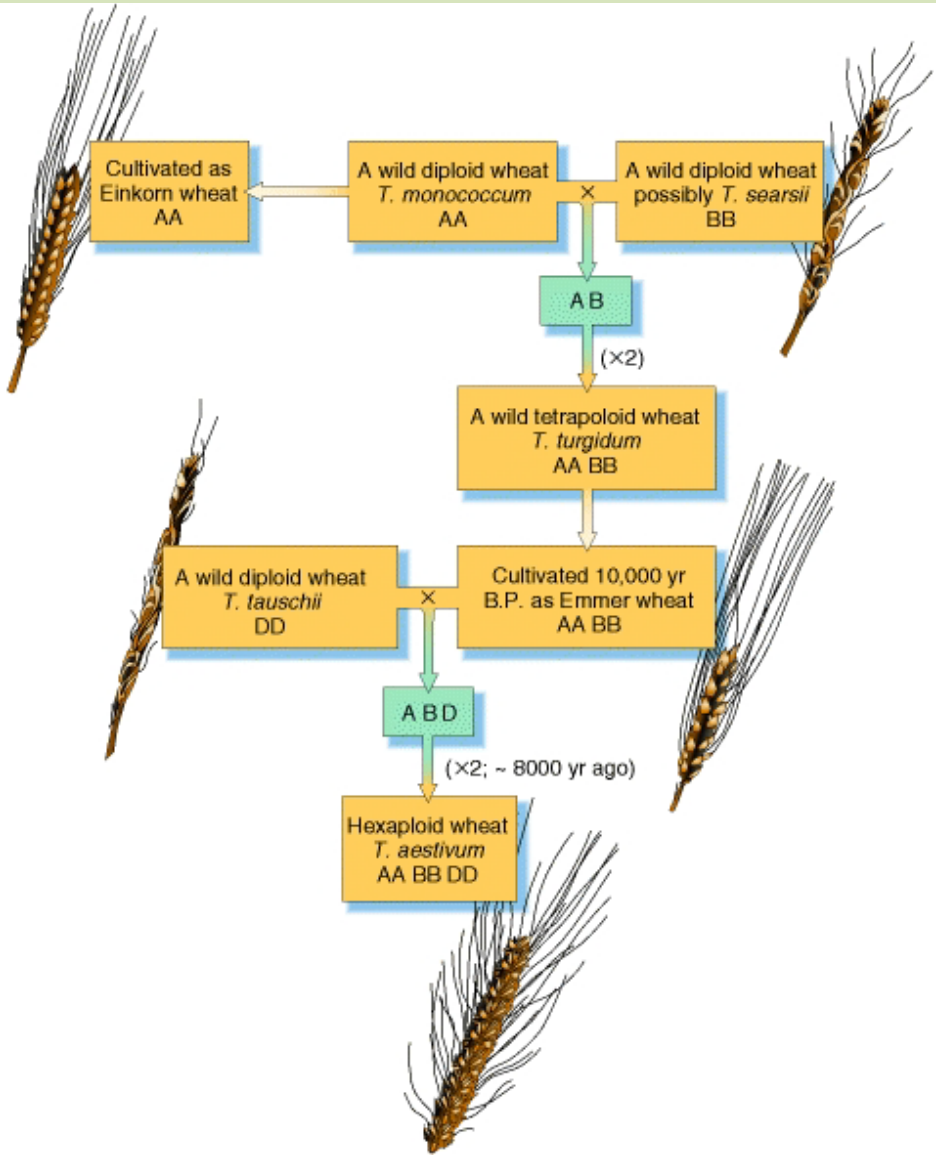
- Sticky rice is caused by a mutation in the WAXY gene
- Mutations in the same gene cause sticky varieties in broomcorn millet, foxtail millet and three *Amaranthus* spp. pseudocereals

Polyploidy and domestication



Salman-Minkov et al. 2016

Polyploidy and domestication



Unanswered questions

- Why are some crops only weakly domesticated?
- Are the major effect domestication genes cloned so far representative of other domestication genes?
- What is the role of reproductive isolation in domestication?