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Africa as an evolutionary arena for large fruits

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S35: Dispersal in Macroecology and Macroevolution
MSc. Friederike J. R. Wölke

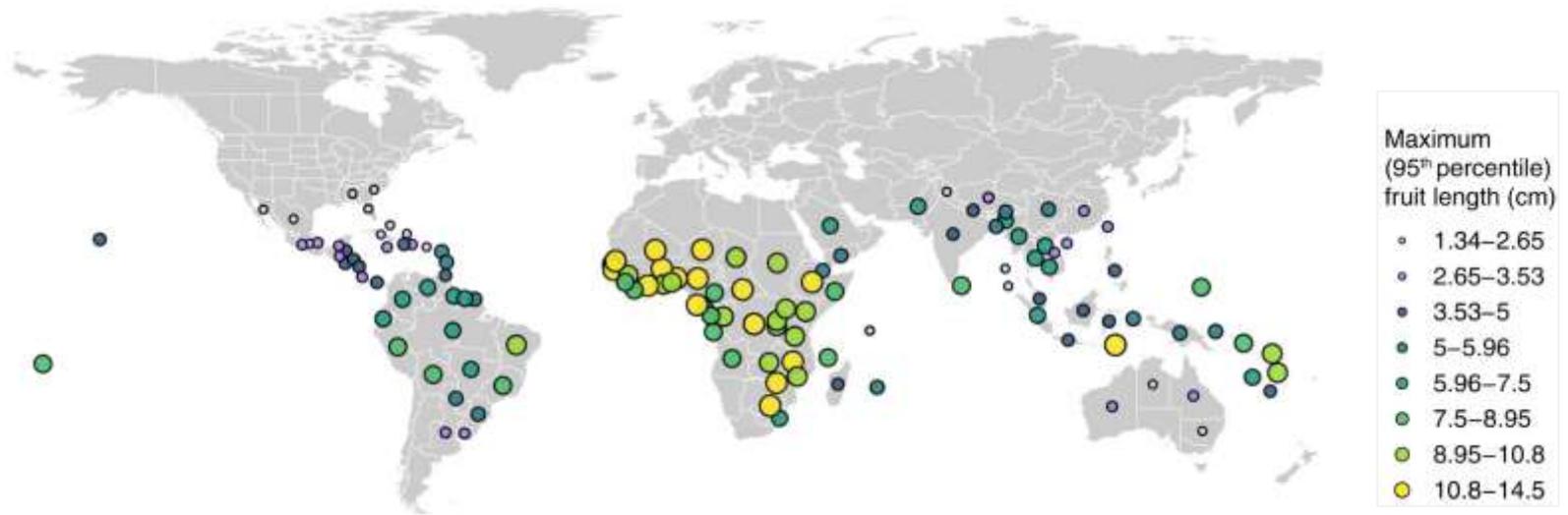
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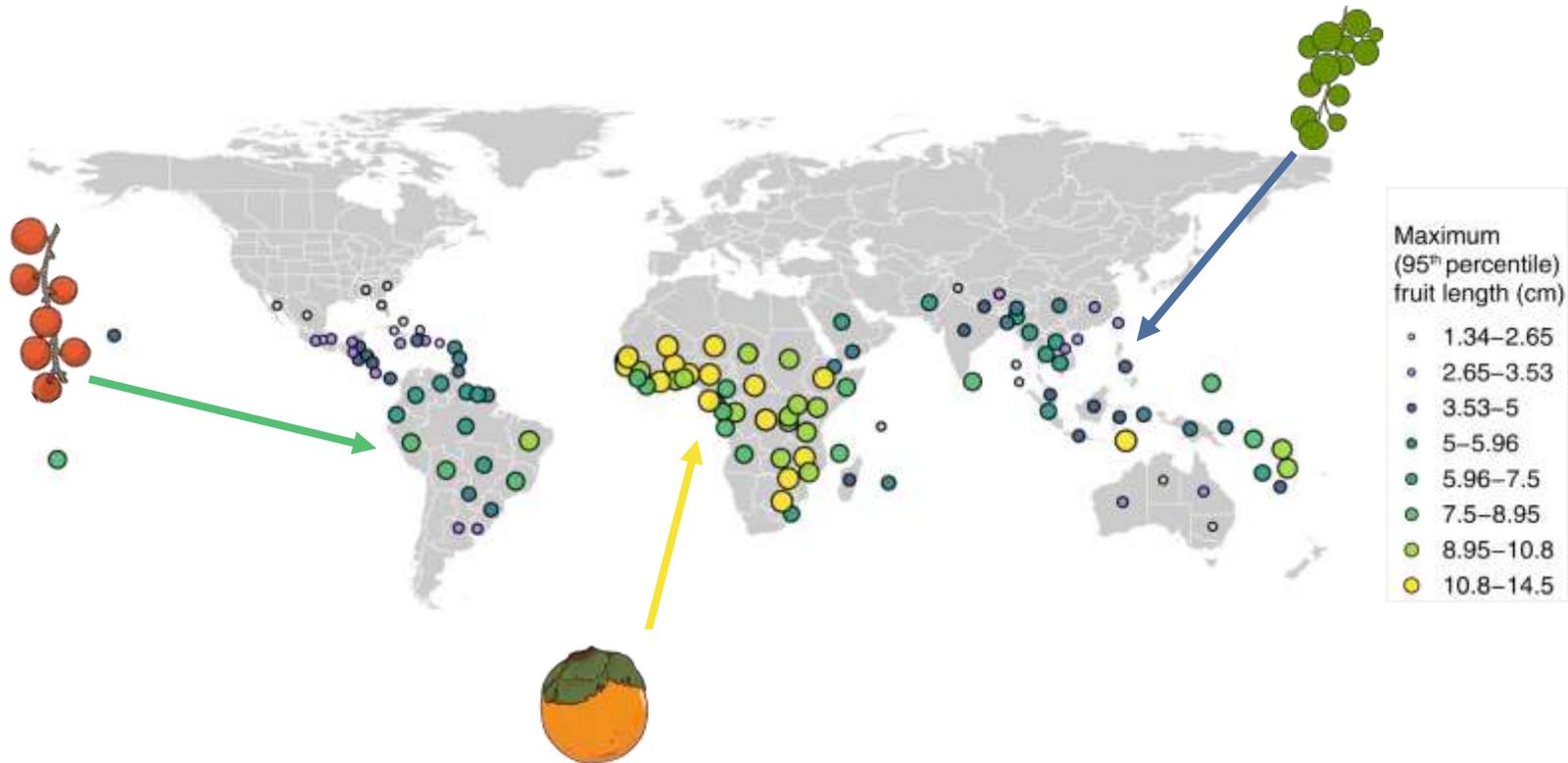
New Phytologist

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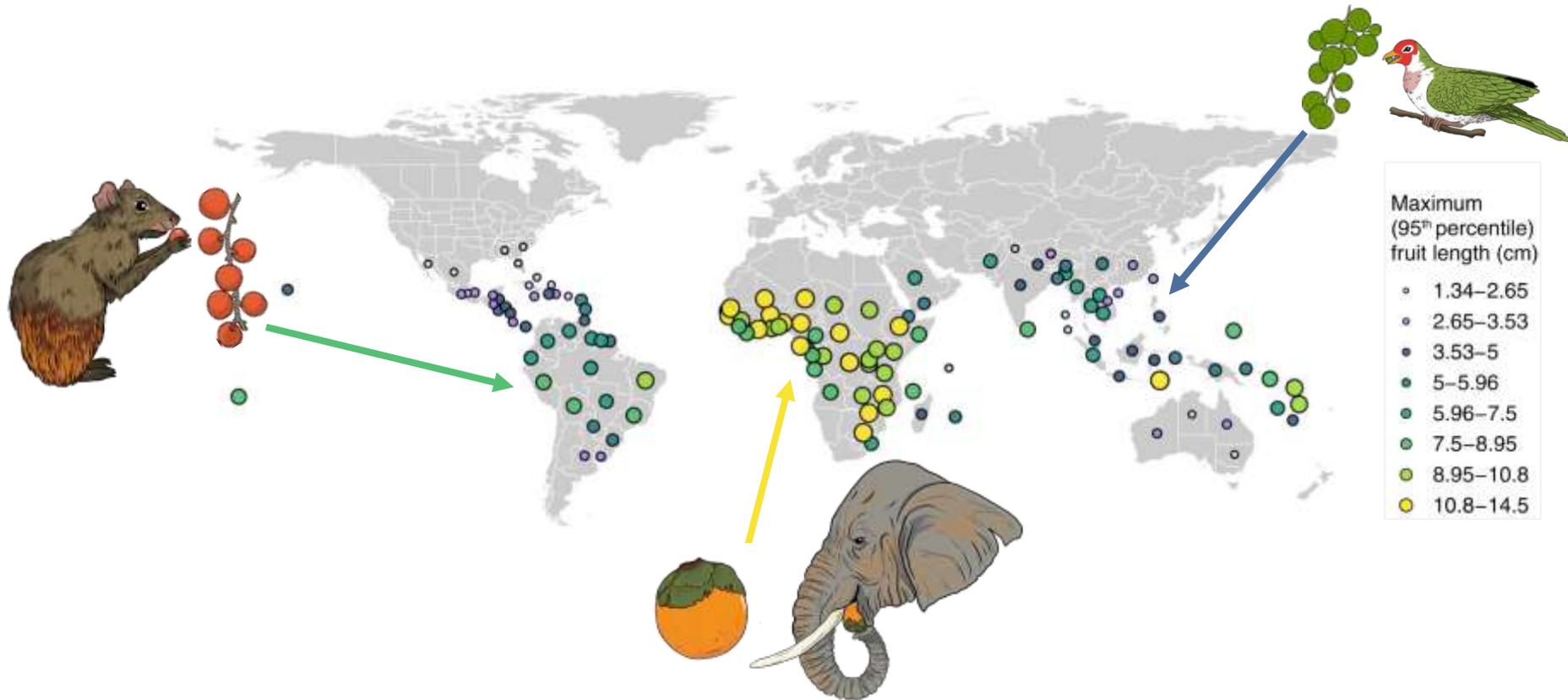
Fruit sizes differ across broad-scale ecological communities



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Quantifying **community downsizing** of **Late Pleistocene frugivorous megafauna**

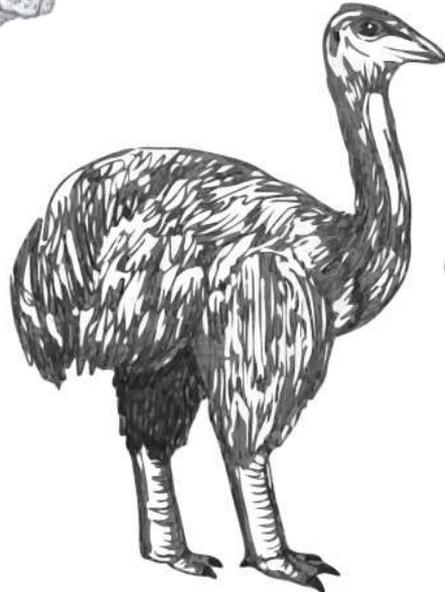
(~ 130,000 years ago until present)



Diprotodon (Giant wombat, Australia, ~2,800 kg, † 46,000 years ago)



Ailuropoda baconi (Panda, Indo-Malay region, † unknown, 129,000-11,700 years ago)

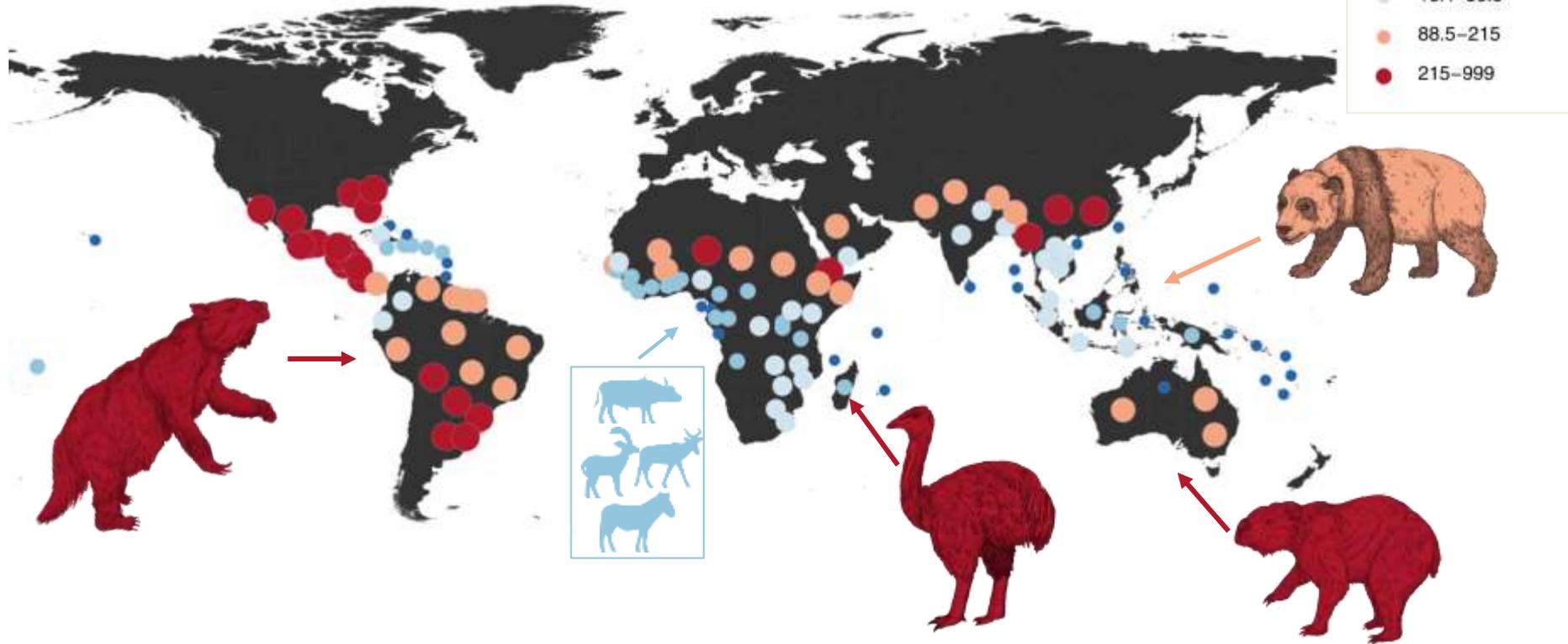


Aepyornithiformes (Elephant birds, Madagascar, ~1,000 kg, † 900-1,200 years ago)



Megatherium (Giant sloth, South America, ~4,000 kg, † 12,000 years ago)

Africa is unique in downsizing of mammalian frugivore assemblages



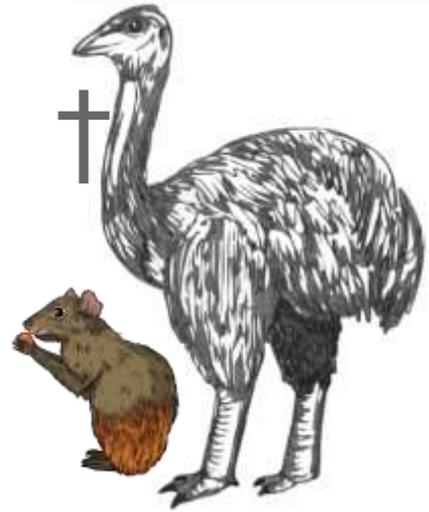
4 Data: PHYLACINE (primary and secondary frugivores), scale: botanical countries (TDWG3) (Wölke et al., 2023)

© characteristic regional extinct megafrugivores by Alexandra Koch: Madagascar: *elephant bird*, Americas: *Megatherion*, Asia: *Ailuropoda*, Australia: *Diprotodon* / selection of extinct African browsers adapted from Stuart 2014 (Geol. J.)

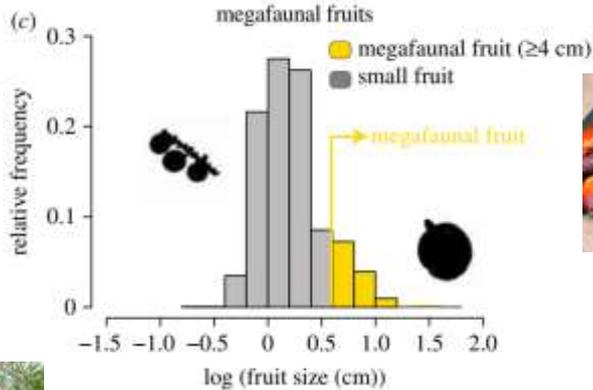
Is the current distribution of large fruits related to the long-term stability of seed-dispersing megafaunal communities through time?



→ Macroevolutionary and macroecological framework for palms



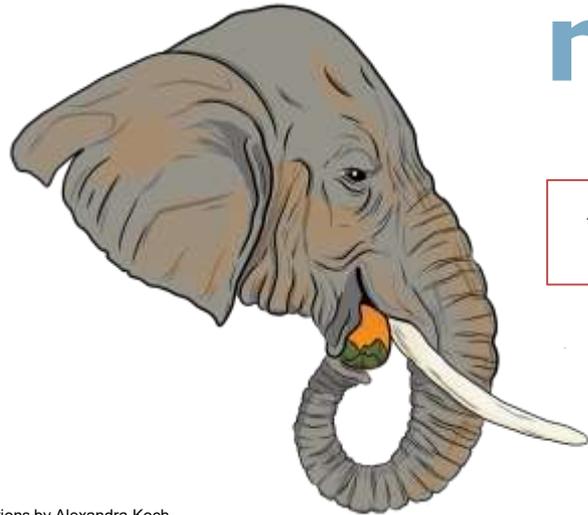
Study system: Palm family (Arecaceae)



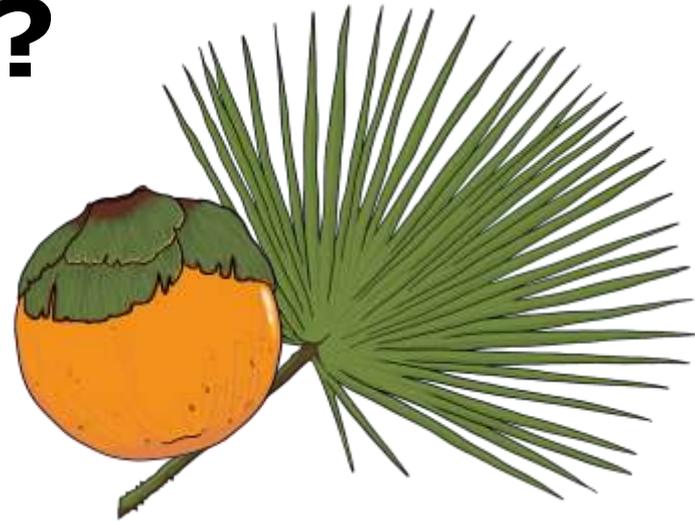
Onstein *et al.*, 2018

- 2500+ species
- pantropical distribution
- environmental heterogeneity: savanna and forest
- large diversity of fruits and fruit sizes: few seeds and animal-dispersed
- year-round fruiting times: keystone resource for frugivores
- high proportion of megafauna-adapted species

Has **fruit size** evolved in response to **adaptive processes** or has it evolved **neutrally**?



→ Phylogenetic comparative methods
(evolutionary trait models)



Neutral evolution

(Brownian Motion process)

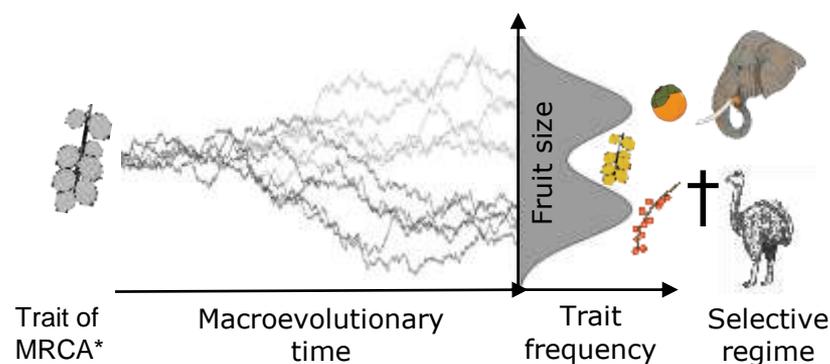
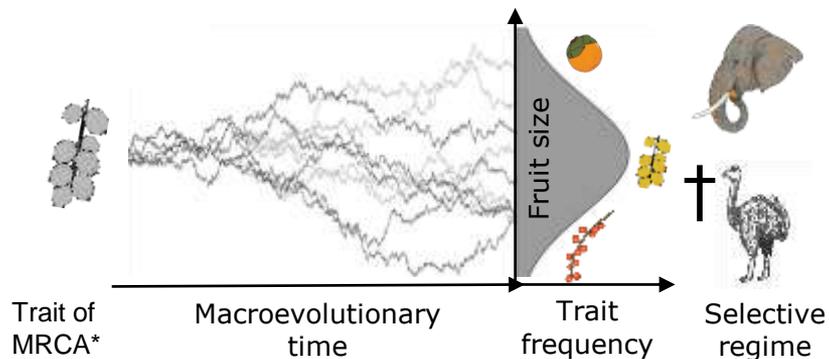
- Trait evolves **stochastically** along the branches of a phylogeny (e.g., following genetic drift)
- Parameter:
(1) stochastic rate



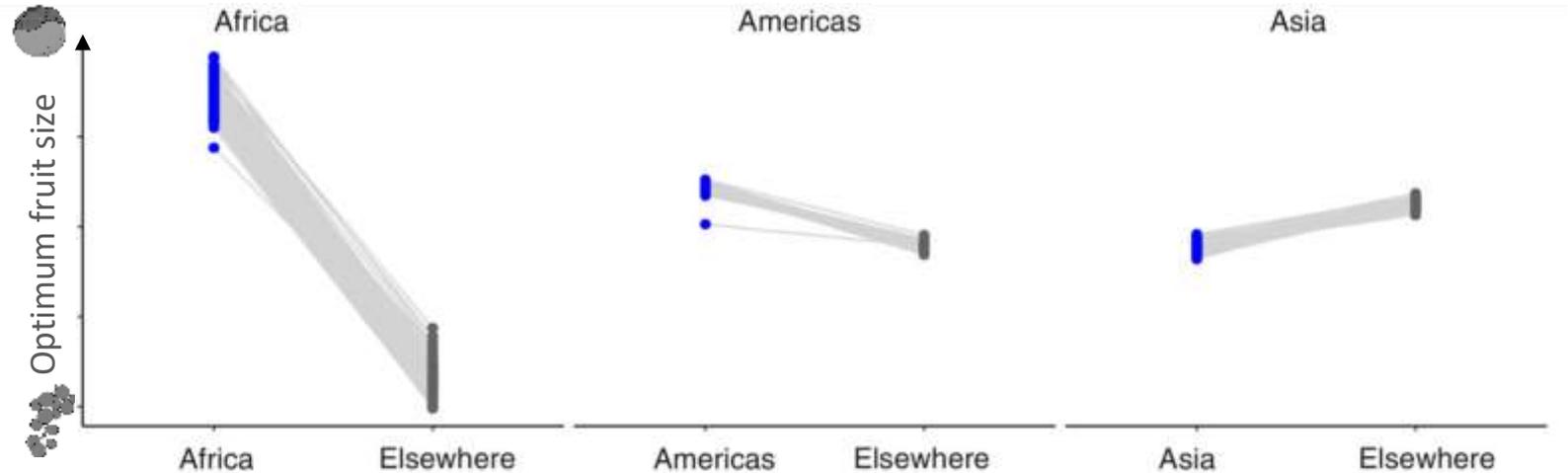
Adaptive evolution

(Ornstein-Uhlenbeck process)

- Trait evolution is driven by a **selective force** that pulls the trait towards a certain **optimum** trait value under different **selective regimes**
- Parameters:
(1) stochastic rate
(2) strength of selection
(3) optimum trait value

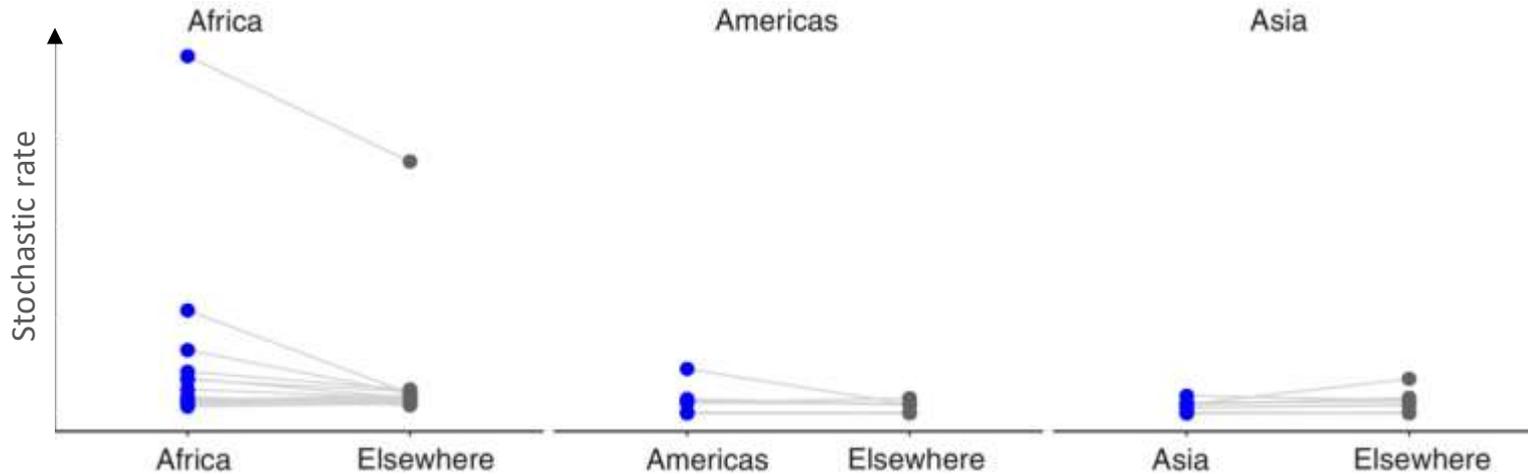


Adaptive processes drive fruit size evolution in palms



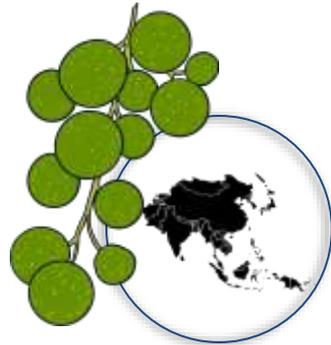
Optimal fruit size in Africa is twice as large than elsewhere.

Faster trait disparification in Africa

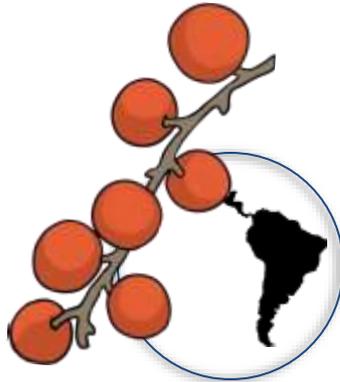


Evolutionary constraints on fruit sizes were lifted in Africa
(potentially through the stable availability of seed-dispersing megafauna)

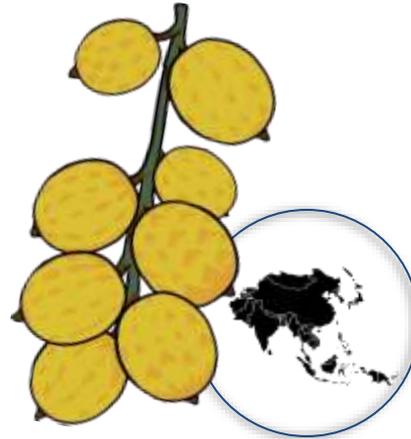
What (else) drives the current broad-scale distribution of the largest fruits?



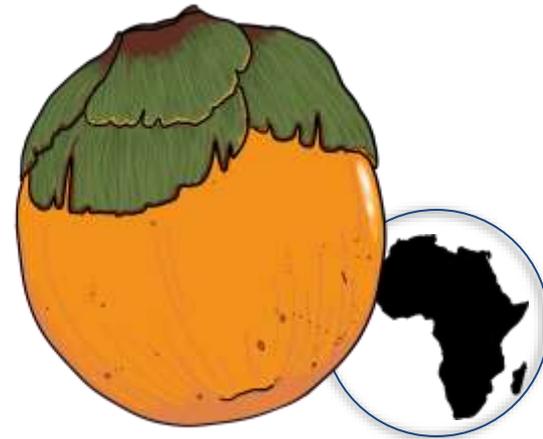
Corypha utan



Ceroxylon quindiuense



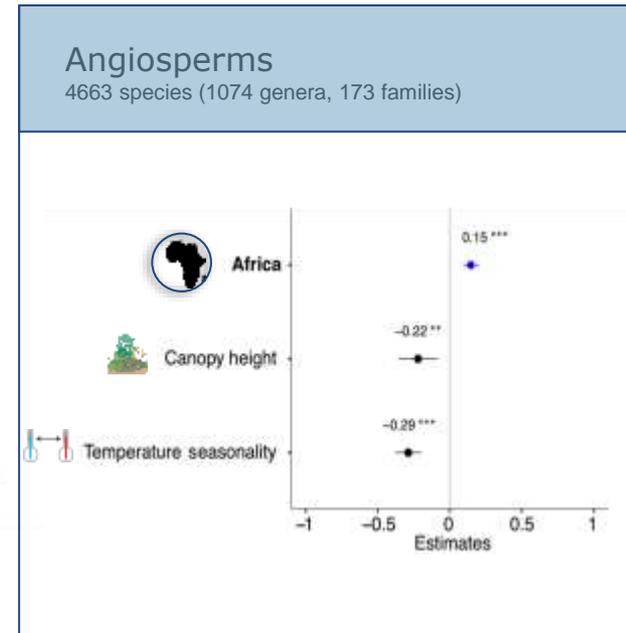
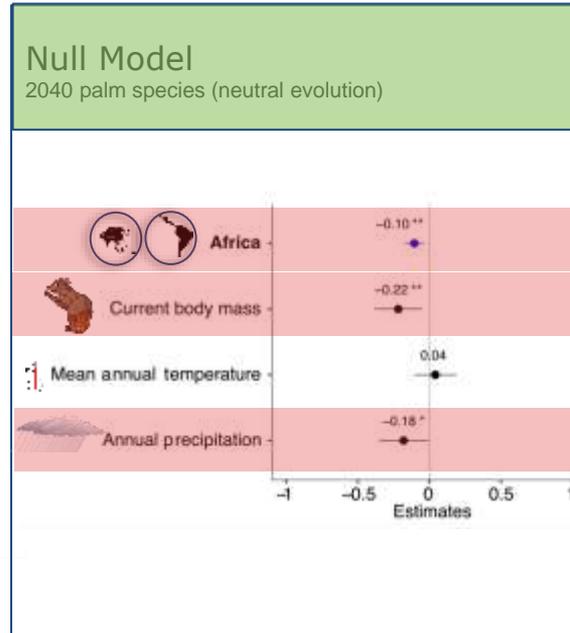
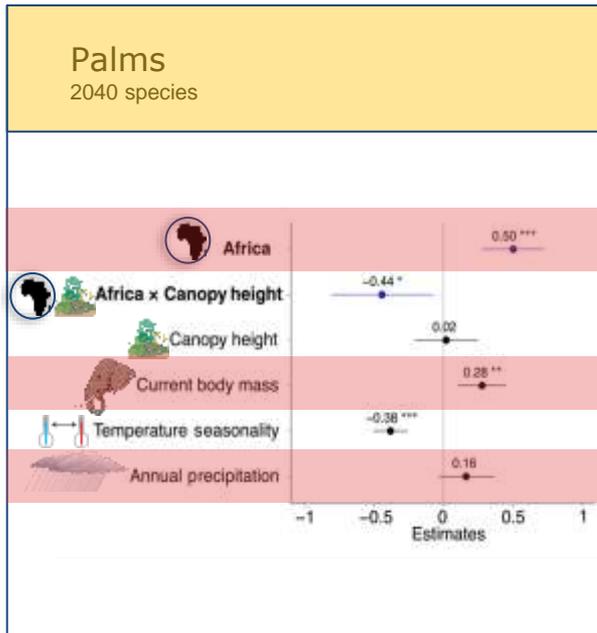
Calamus ornatus



Borassus aethiopum

→ Linear models, spatial-autoregressive models

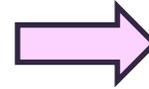
Savanna expansion and paleoclimatic fluctuations played a unique role in the evolution of large fruits in Africa



No significant interaction between current frugivore body mass and Africa → similar effect across continents

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Thank you!



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