

# Desiccation-tolerant plants: phylogenetic, ecological and economic aspects

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# Tropical botany and biodiversity research



Carnivory



Resurrection plants

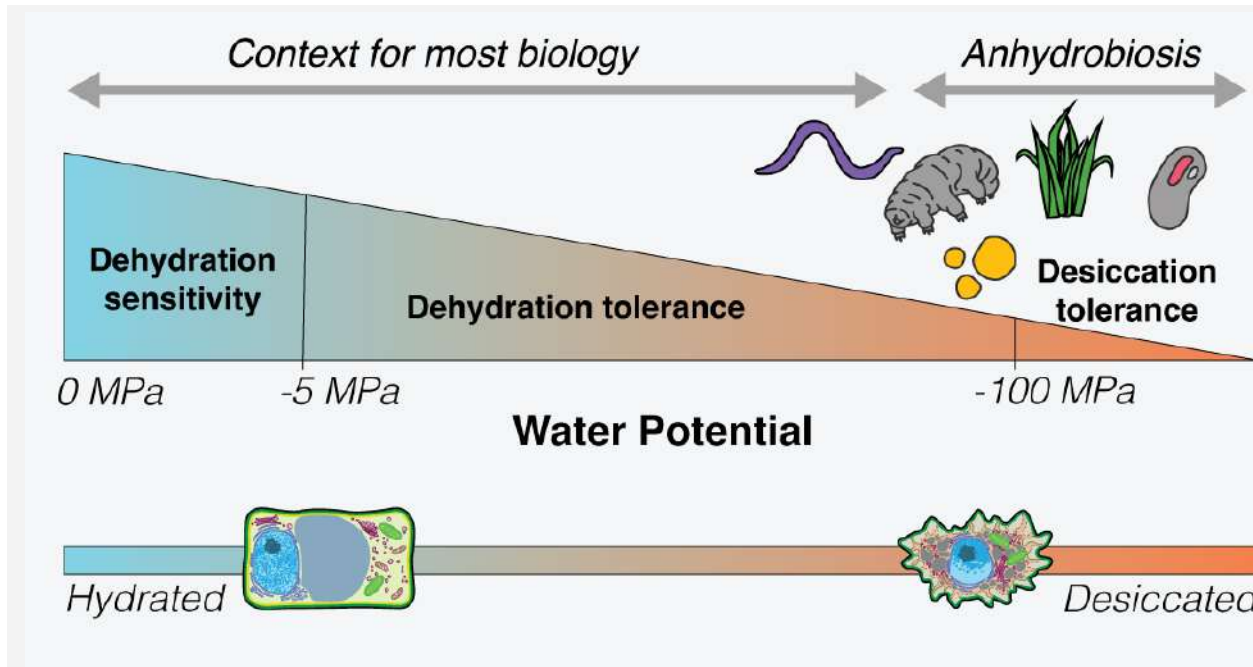


Biology of basal angiosperms



Useful plants e.g. *Cola*

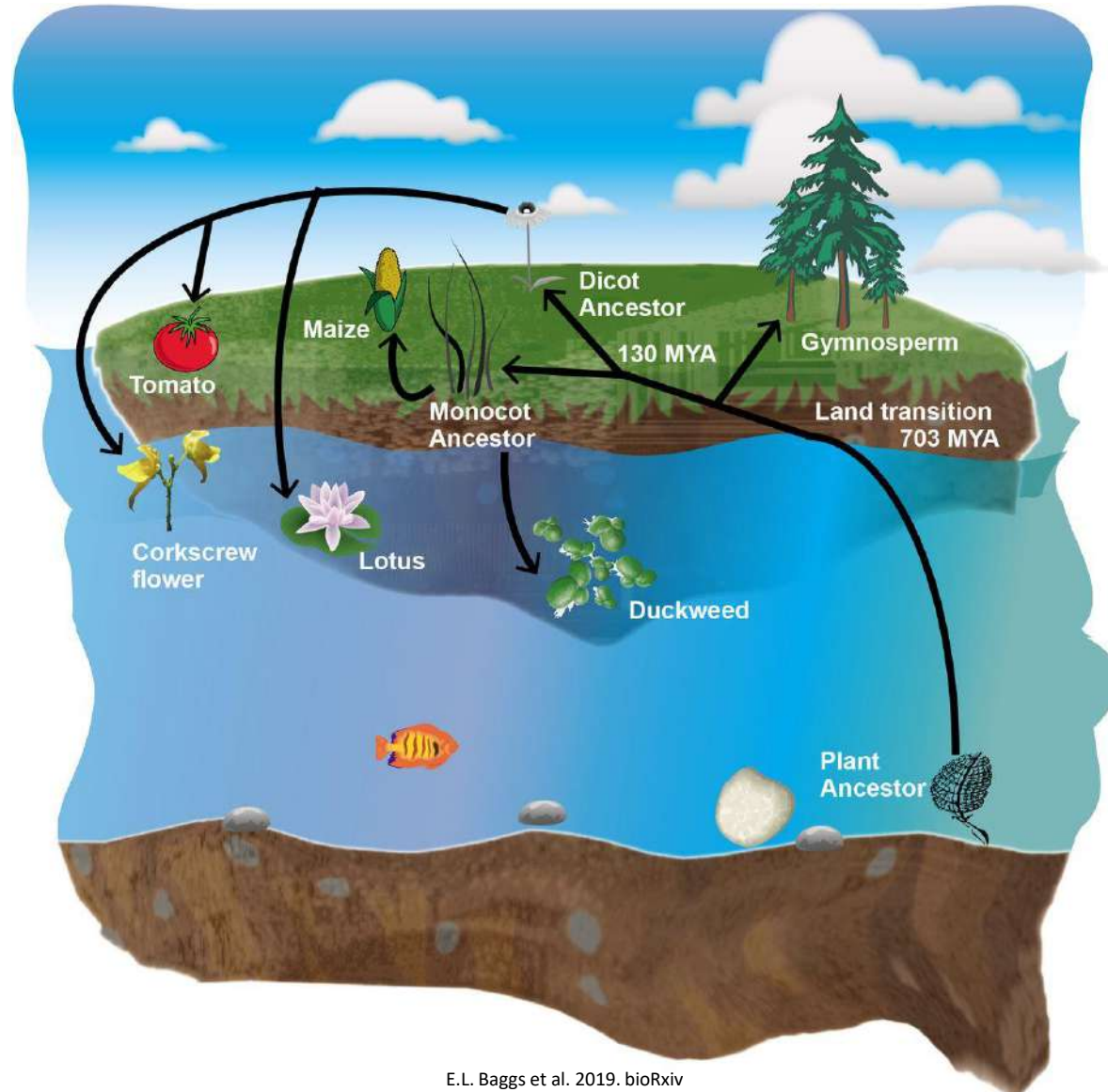
# Working Definitions



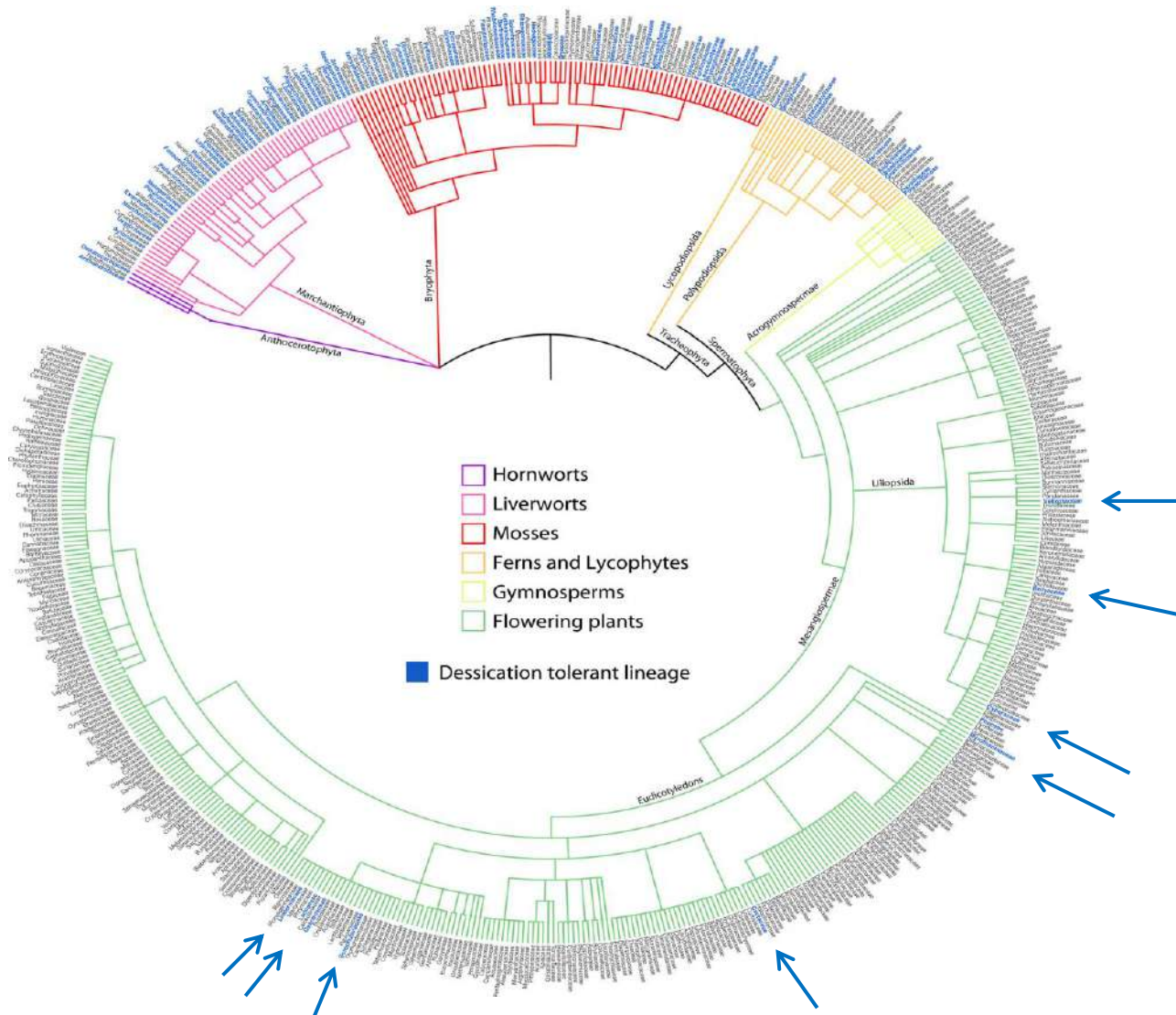
**Anhydrobiosis:** The process of drying to a quiescent state, where there is insufficient water to hydrate cellular macromolecules and membranes, and resume normal cellular function when rehydrated.

**Desiccation tolerance:** The ability to dry to a quiescent state and resume normal cellular function when rehydrated. Typically, organisms and cells are considered desiccation-tolerant when they can revive after being dried to, or below, -100 MPa (~10% dry mass).

# Conquest of land



# Desiccation-tolerance is a basal and polyphyletic trait



**3.4 BYA**

Evolution of desiccation tolerance in microbes



**65,000 BCE**

Earliest evidence of desiccation-tolerant seeds forming a vital component of human diet, Aboriginal Madjedbebe, Northern Australia



**370 BCE**

First European description of how to keep seeds alive in desiccated state (Theophrastus of Eresos)



**1878**

Recognition that desiccation tolerance is widespread throughout the tree of life



**1986**

Late embryogenesis abundant (LEA) gene transcripts discovered in maturing seeds



The role of sugars in desiccation tolerance is revealed in seeds



**2024**

Over a dozen genomes of desiccation-tolerant species sequenced and assembled



First microfossil evidence of desiccation-tolerant land plants

**475 MYA**



Earliest record of cultivation of edible grasses from desiccation-tolerant seeds, Ohalo II people, shores of the Sea of Galilee

**21,000 BCE**



First animal observed to survive in dry sediment (rotifers; Von Leeuwenhoek)

**1702**



Importance of antioxidants for desiccation tolerance is shown in bacteria

**1968**



Vitrification discovered during dehydration

**1986**



Genomes of desiccation-tolerant plants *Oropetium thomaeum* and *Boea hygrometrica* and sequenced

**2015**





## Rock outcrops:

- Patchily distributed habitats dominated by a hard, stony surface
- Protruding above their surroundings

## Inselbergs

## Tepuis



# Granitic and gneissic inselbergs

## - Habitat types



# Desiccation tolerant vascular plants

- Adaptations to unpredictable water scarcity



dry

wet

dry

*Microdracoides squamosa*

**Drying without dying:**  
Desiccation tolerant vascular plants: „resurrection plants“



dry

wet

dry

*Myrothamnus moschatus*

*Microdracoides*



Trilepideae  
Cyperaceae

*Afrotrilepis*



*Coleochloa*



*Trilepis*



# Desiccation tolerant vascular plants

Rock outcrops and tree canopies are centers of diversity for „resurrection plants“

- Vascular plants are rarely desiccation tolerant (c. 1500 spp.)
- ferns dominate (filmy ferns!)
- important angiosperm families: Velloziaceae, Cyperaceae, Poaceae, Gesneriaceae, Linderniaceae, Myrothamnaceae, Bromeliaceae (?)



# Desiccation-tolerant vascular plants

- Homoiohydrous:  
> 99% of land plants
  - Poikilohydrous:  
< 1% of land plants
- „Problems“:
- very slow growth
  - large investments  
(protection, repair)



# Learning from nature: drought tolerance of plants

Irrigated rice fields in Burkina Faso



Improving water efficiency of agricultural crops!



*Oropetium*



*Tripogon*



*Microchloa*



# ALEPH

## Australian Lunar Experiment Promoting Horticulture

Seeds and resurrection plants survive in a dehydrated dormant state and will be carried in on the lunar lander and germinate and reactivate upon watering...

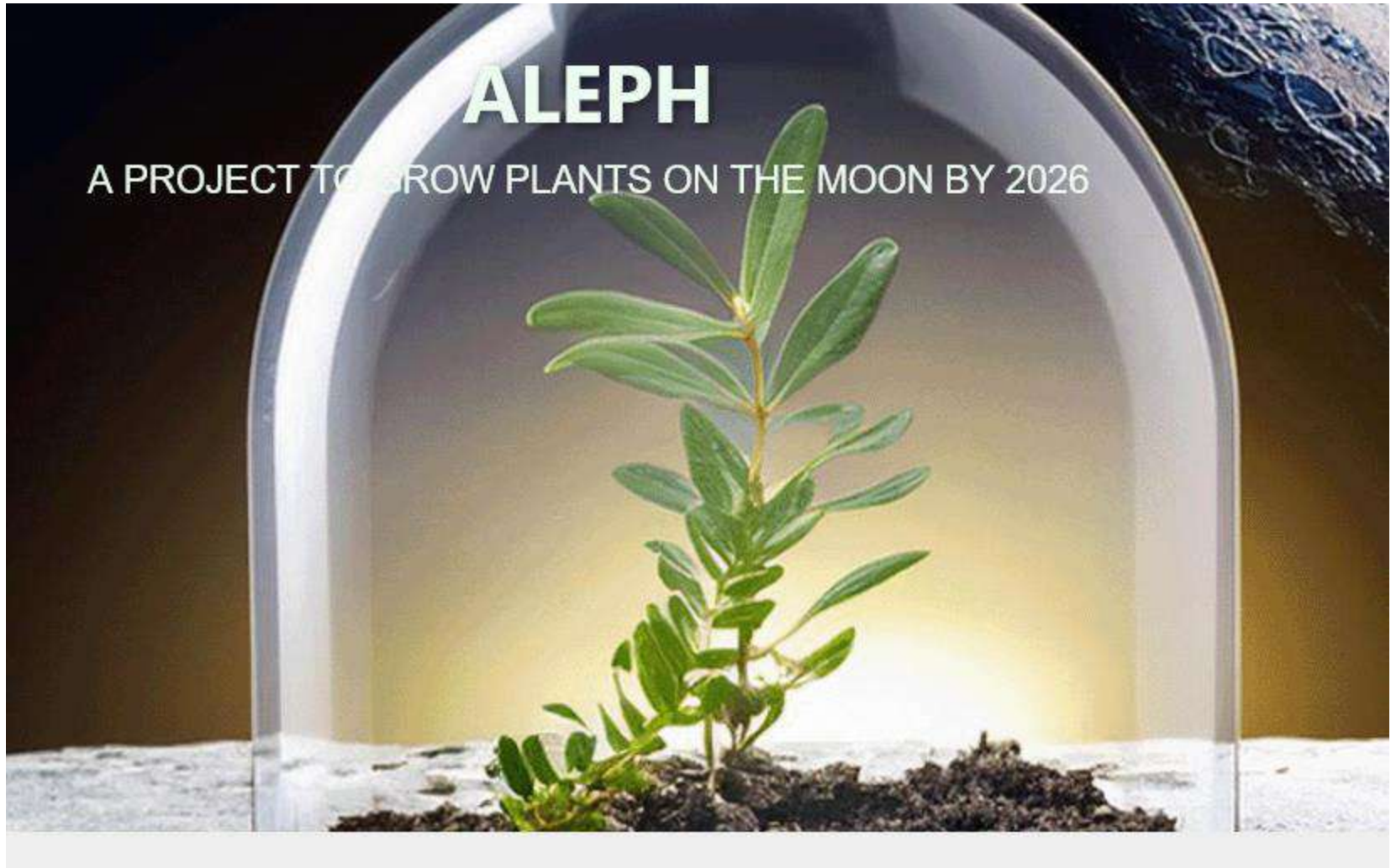
Extreme environments not just belong to outer space: in a changing climate, there are increasingly more weather disasters occurring everywhere, which is threatening plant health and food security.

If you can create a system for growing plants on the moon, then you can create a system for growing food in some of the most challenging environments on Earth.

*Tripogon loliiformis* (Poaceae)



<https://lunaria.one/aleph/>





Für spätere Kolonisierung

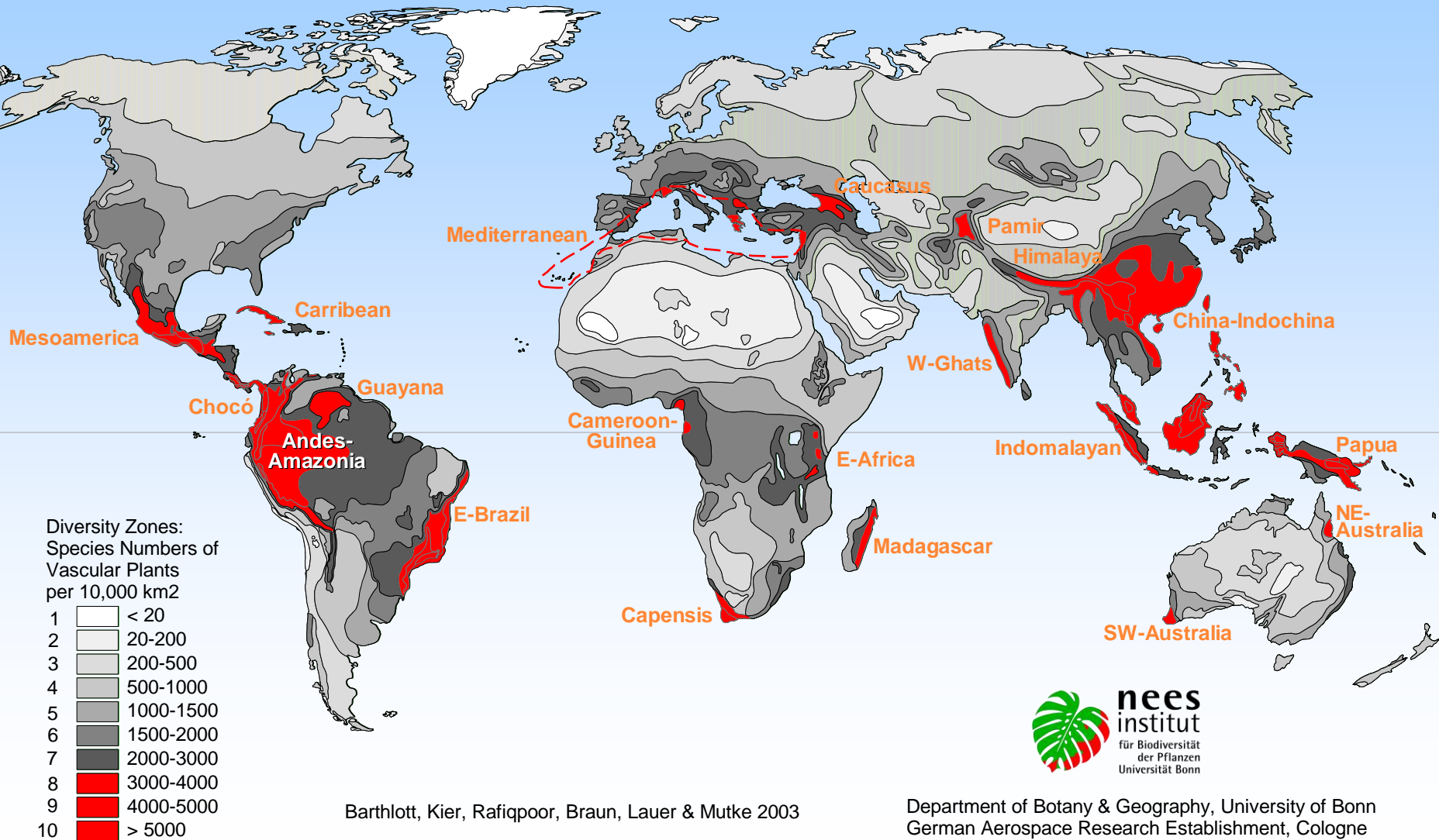
# Forscher wollen Pflanzen auf dem Mond züchten

Brüh  
Die  
Kaf  
Per F  
Sie e

Härt  
Da  
Wi  
Wol

# BIODIVERSITY: GLOBAL SPECIES NUMBERS OF PLANTS

## Centers of Diversity

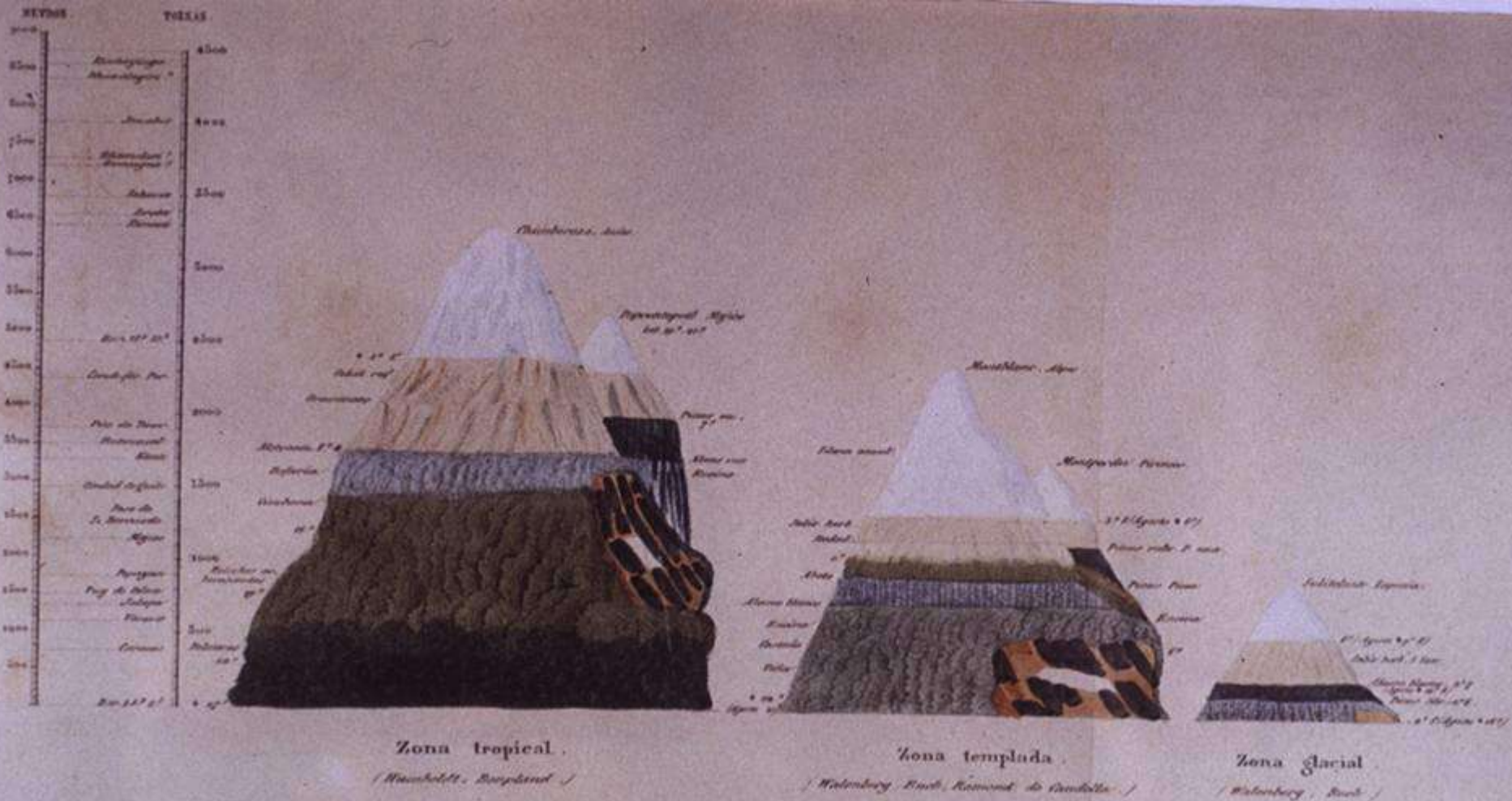


Barthlott, Kier, Rafiqpoor, Braun, Lauer & Mutke 2003



Department of Botany & Geography, University of Bonn  
German Aerospace Research Establishment, Cologne

# Elevation levels of vegetation according to Alexander von Humboldt



**eastern slopes of the Andes  
Megadiversity hotspot!**



## Epiphytic mosses and ferns





Hymenophyllaceae  
filmy ferns

Desiccation-tolerance!



# Future perspectives

- Identifying desiccation-tolerant plants and conservation of their natural growth sites
- Rock outcrops and tree canopies
- Development of more resilient crops
- Xero-conservation
- Enhancing interdisciplinary cooperation

