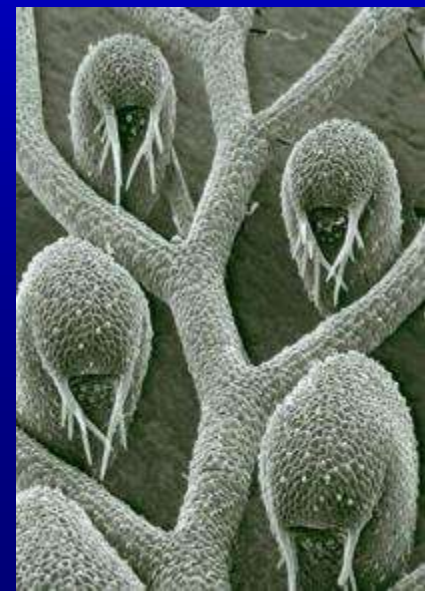


Flora and vegetation of tropical inselbergs: adaptive traits, species richness and conservation

Stefan Porembski, University of Rostock

- Habitat types
- Adaptive traits: desiccation tolerance, carnivory
- Cultural importance and Conservation





Leopoldina
Nationale Akademie
der Wissenschaften

1900: **Insel**berg **Insel**: island Berg: mountain



Wilhelm Bornhardt



Inselbergs are old habitat islands

- Geomorphology
well known
- Biology
largely neglected

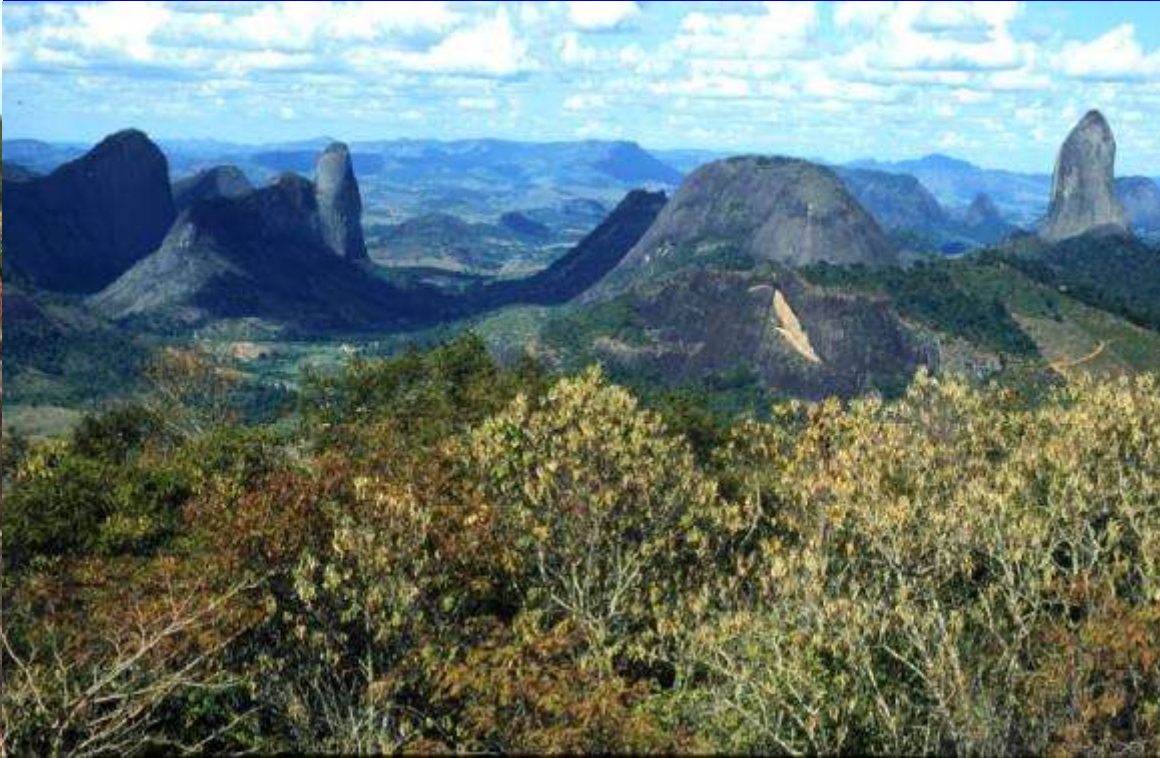


Inselbergs: terrestrial habitat islands

- Size spectrum

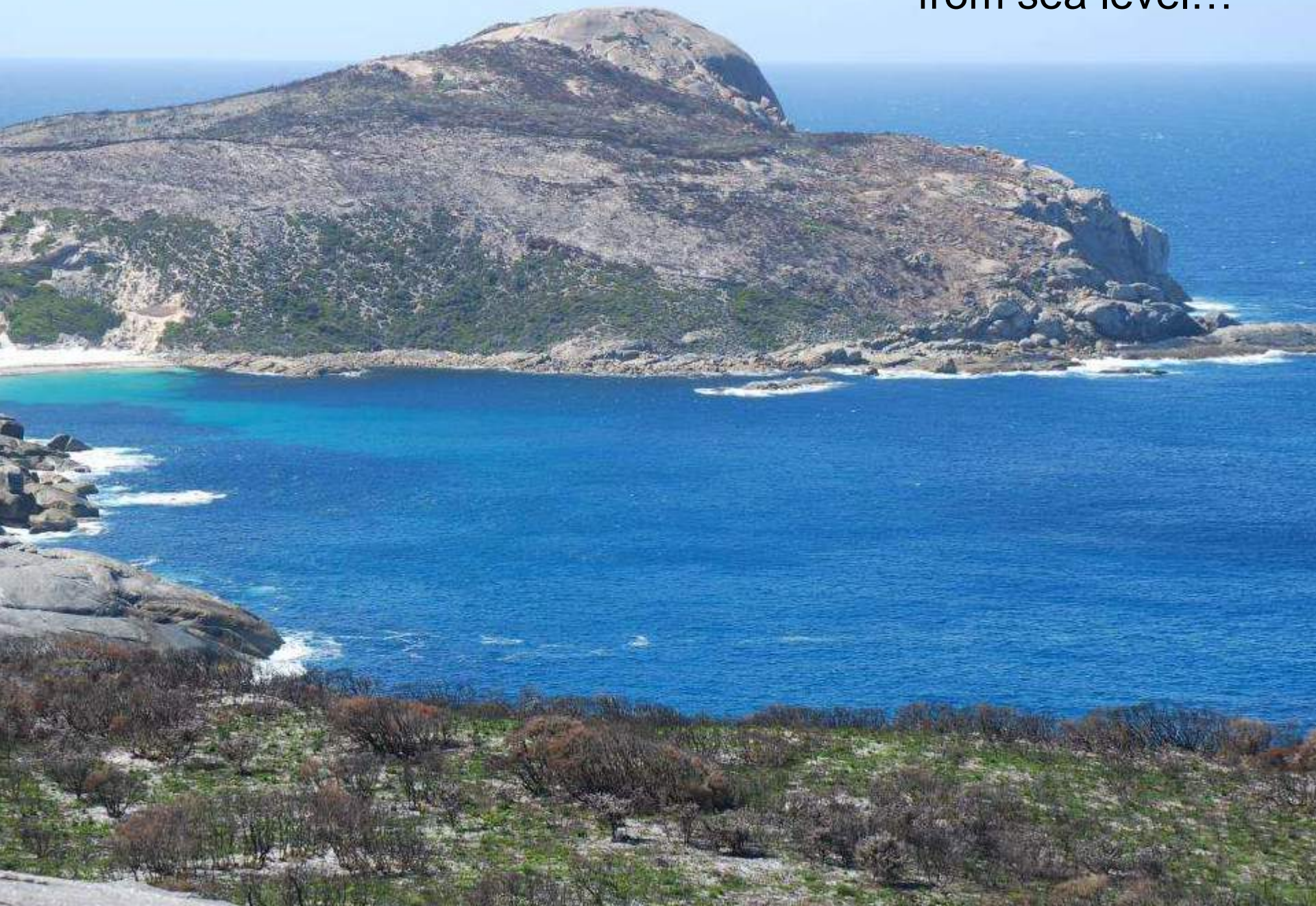


from square meters



to square kilometers

from sea level...



Mt. Kinabalu, Borneo, Sabah



Granitic and gneissic inselbergs

- Habitat types



Lichens and cyanobacteria on inselbergs



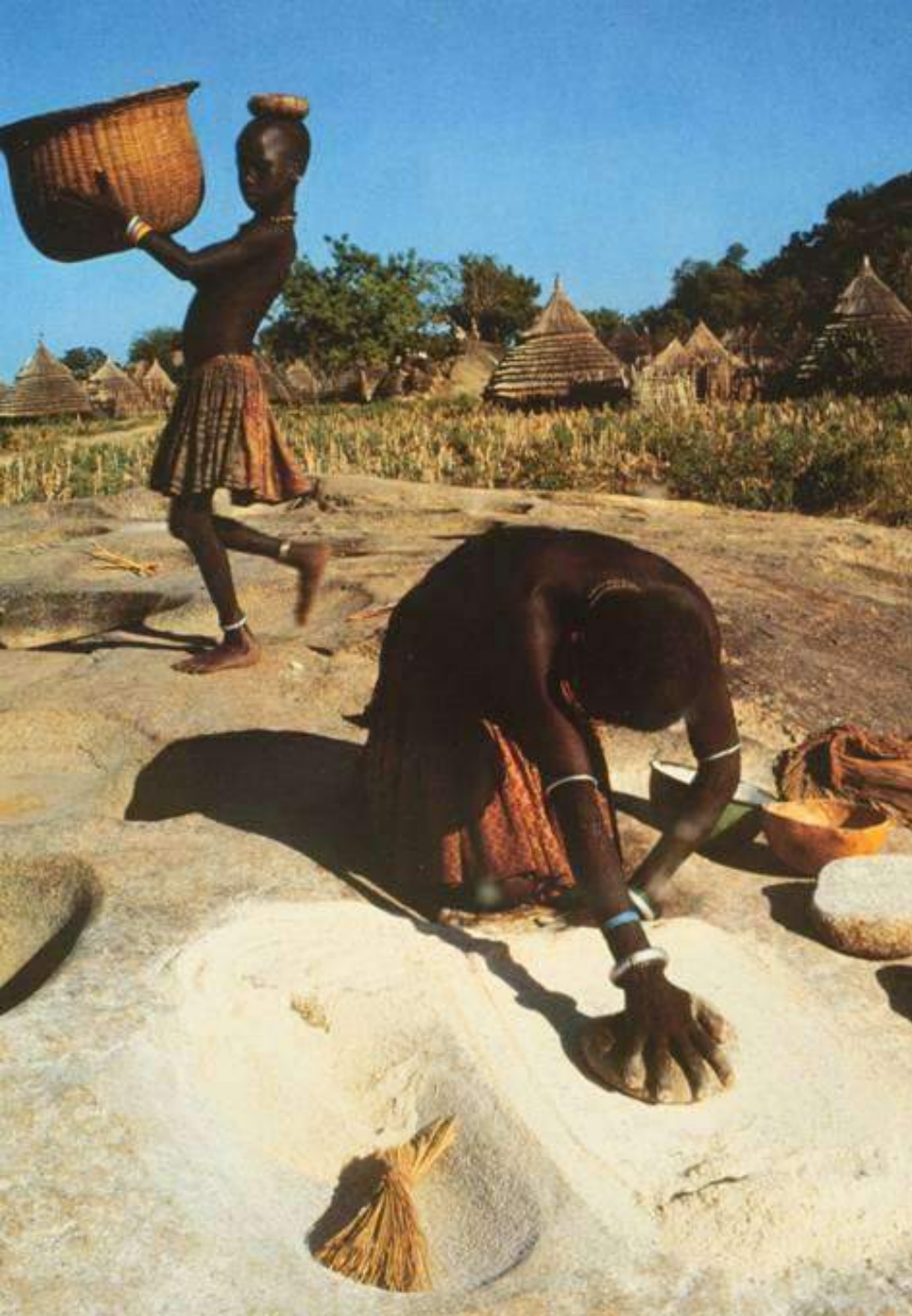
Seasonally water-filled rock pools



Seasonally water-filled rock pools



Dopatrium longidens (Scrophulariaceae)



Rock pools
– „grinding holes“

tropical Africa

- Spatial species turnover in rock pools: stochasticity



Ephemeral flush vegetation



Ecological attributes of ephemeral flush vegetation

- Highly seasonal plant community
- Small habitat size
- Annuals dominating
- Small size of plants
- High species richness
- Shallow substrate
- Lack of nutrients
- High percentage of carnivorous plants





Utricularia menziesii

Evolution and systematics of carnivorous plants

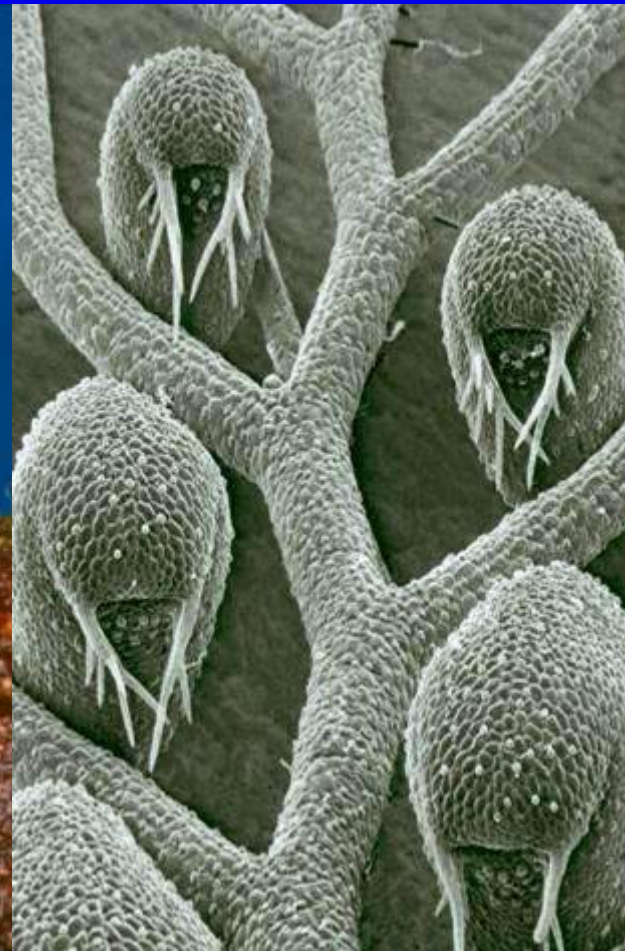
- **Lamiales/Lentibulariaceae: *Utricularia***, subcosmopolitan



ca. 15% aquatic

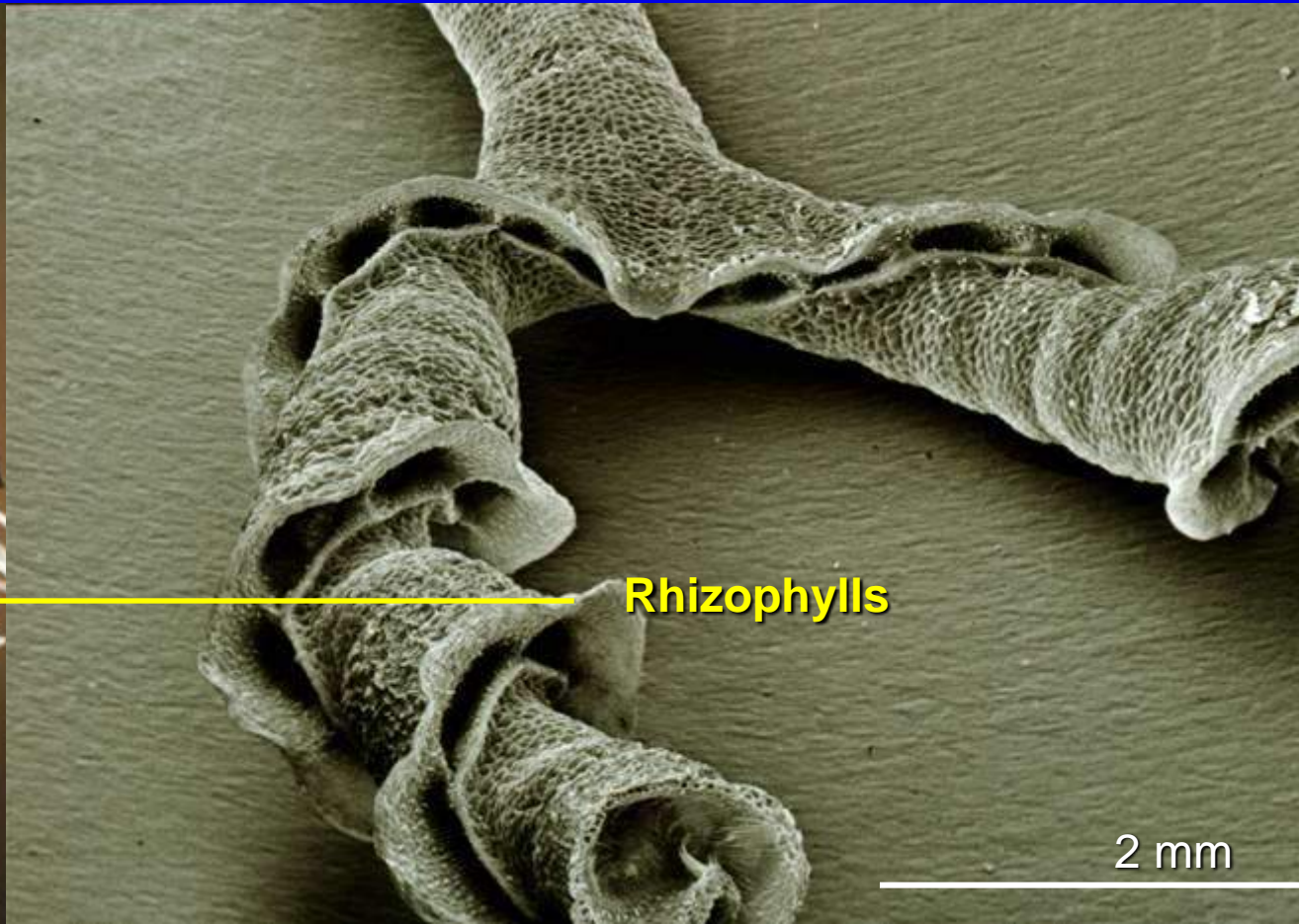


ca. 85% terrestrial



Phylogeny of Lentibulariaceae

Lamiales/Lentibulariaceae: *Genlisea*, Neotropics, Africa, Madagascar



Rhizophylls

2 mm

Smallest angiosperm genomes



Arabidopsis thaliana 157 Mbp



Genlisea margaretae 63 Mbp
Greilhuber et al. 2006

Smallest Angiosperm Genomes Found in Lentibulariaceae, with Chromosomes of Bacterial Size

J. Greilhuber, T. Borsch, K. Müller, A. Worberg, S. Porembski, W. Barthlott (2006)

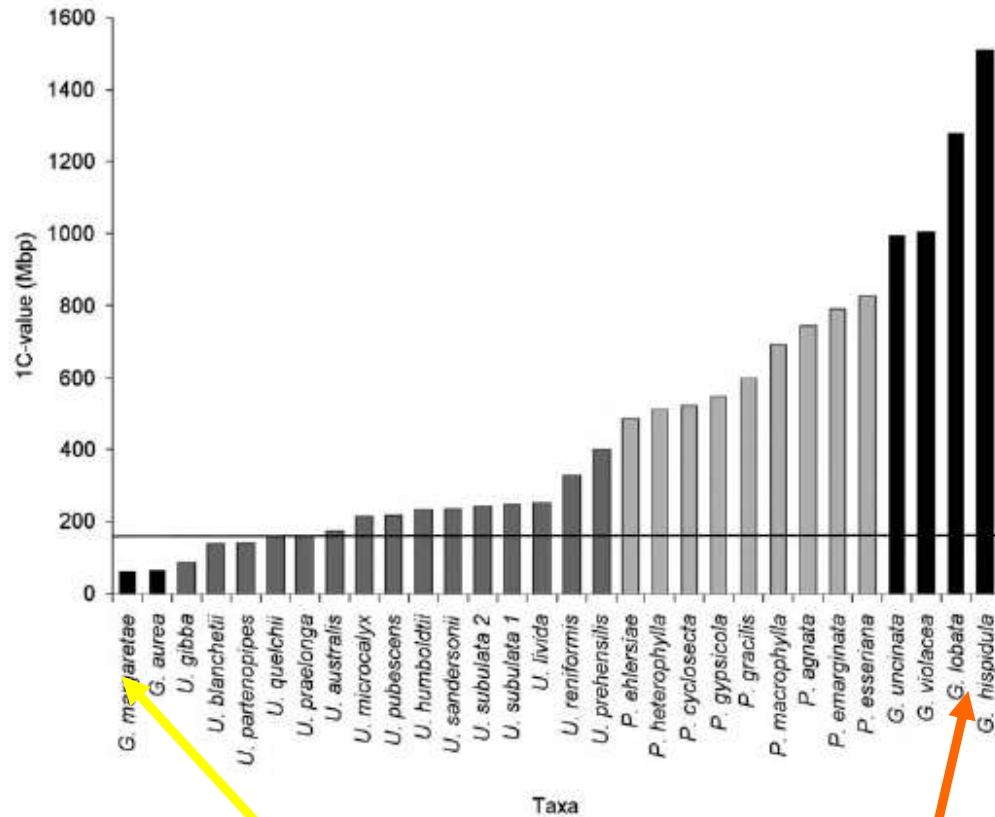
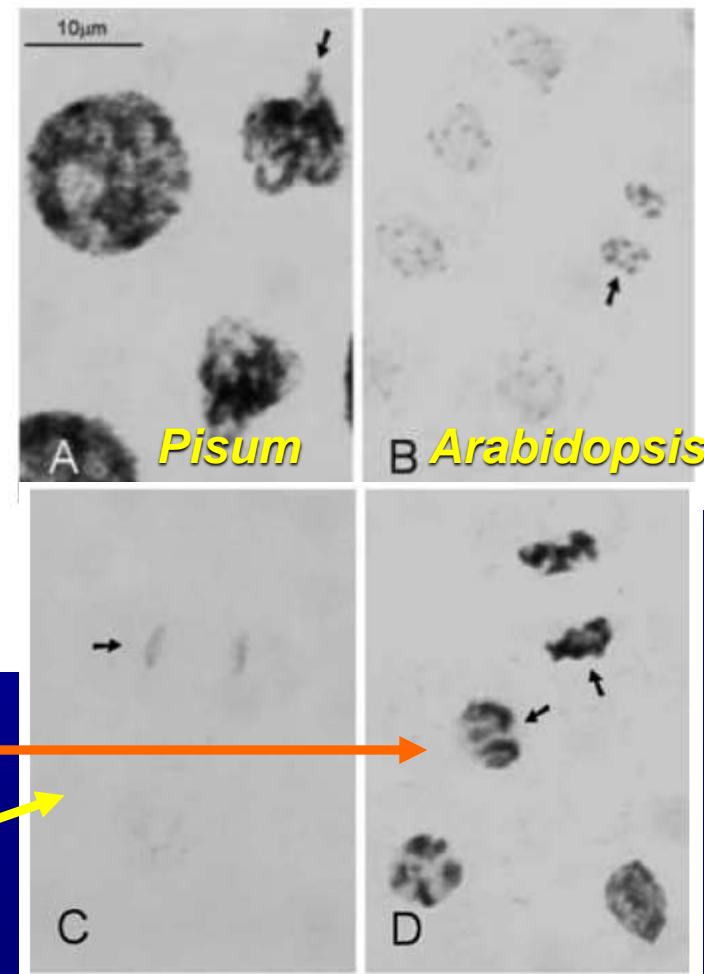


Fig. 1 DNA 1C-values in accessions of *Genlisea*, *Utricularia*, and *Pinguicula* (Bonn collection), ordered according to size. The horizontal line indicates the 1C-value of *Arabidopsis thaliana*.



Genlisea lobata

Genlisea margaritae

Parallel evolution of desiccation-tolerant arborescent monocotyledons

- **Cyperaceae** and **Velloziaceae**: mat-forming in tropical Africa and South America



Afrotrilepis pilosa



Coleochloa



Trilepis



Pleurostima

Desiccation-tolerant vascular plants

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



Desiccation tolerant vascular plants

- Adaptations to unpredictable water scarcity



dry → **wet** → **dry**

Microdracoides squamosus

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



dry → **wet** → **dry**

Myrothamnus moschatus

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, Boryaceae, Gesneriaceae, Linderniaceae, Myrothamnaceae, Bromeliaceae (?)



-Desiccation-tolerant, arborescent monocots
convergent evolution of the tree habit



Borya



Microdracoides



Xerophyta

General facts about inselbergs

- globally distributed, old terrestrial habitat islands
- c. 15.000 – 20.000 species of vascular plants
- many species locally restricted (endemics)
- possession of specific adaptive traits
- almost no gymnosperms, ferns, „derived“ angiosperms



trop. Africa: species number low, β -diversity low







Study sites of inselbergs in Madagascar

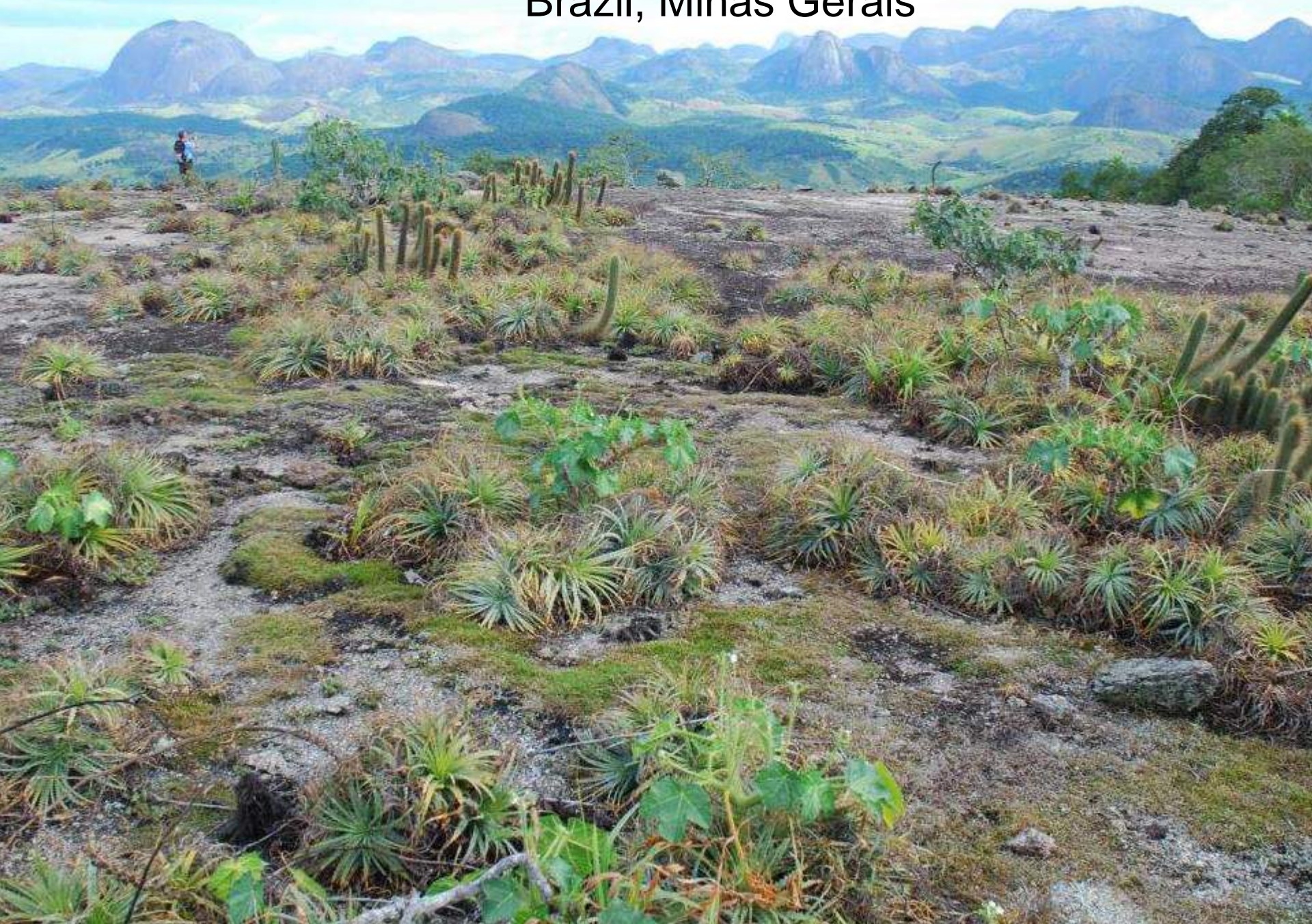
c. 900 spp. (8% of total flora)

high beta diversity!





Brazil, Minas Gerais





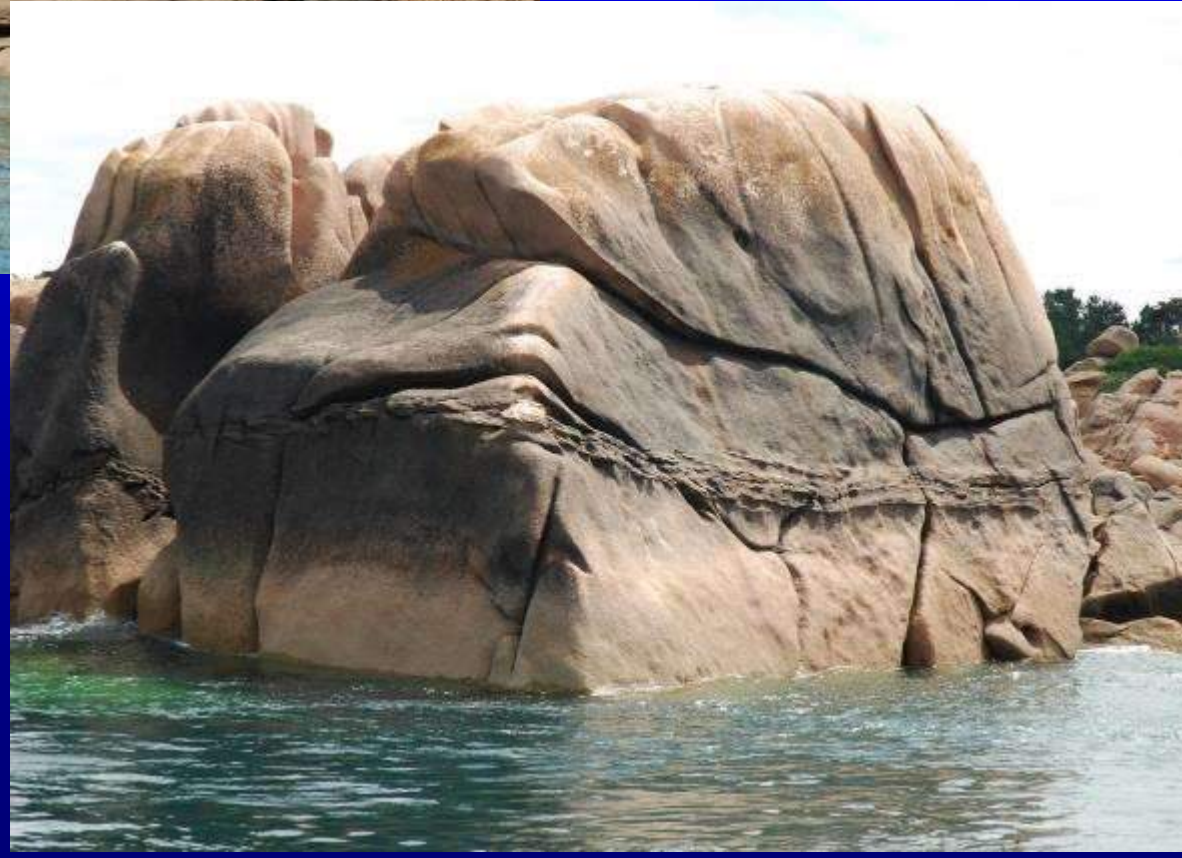
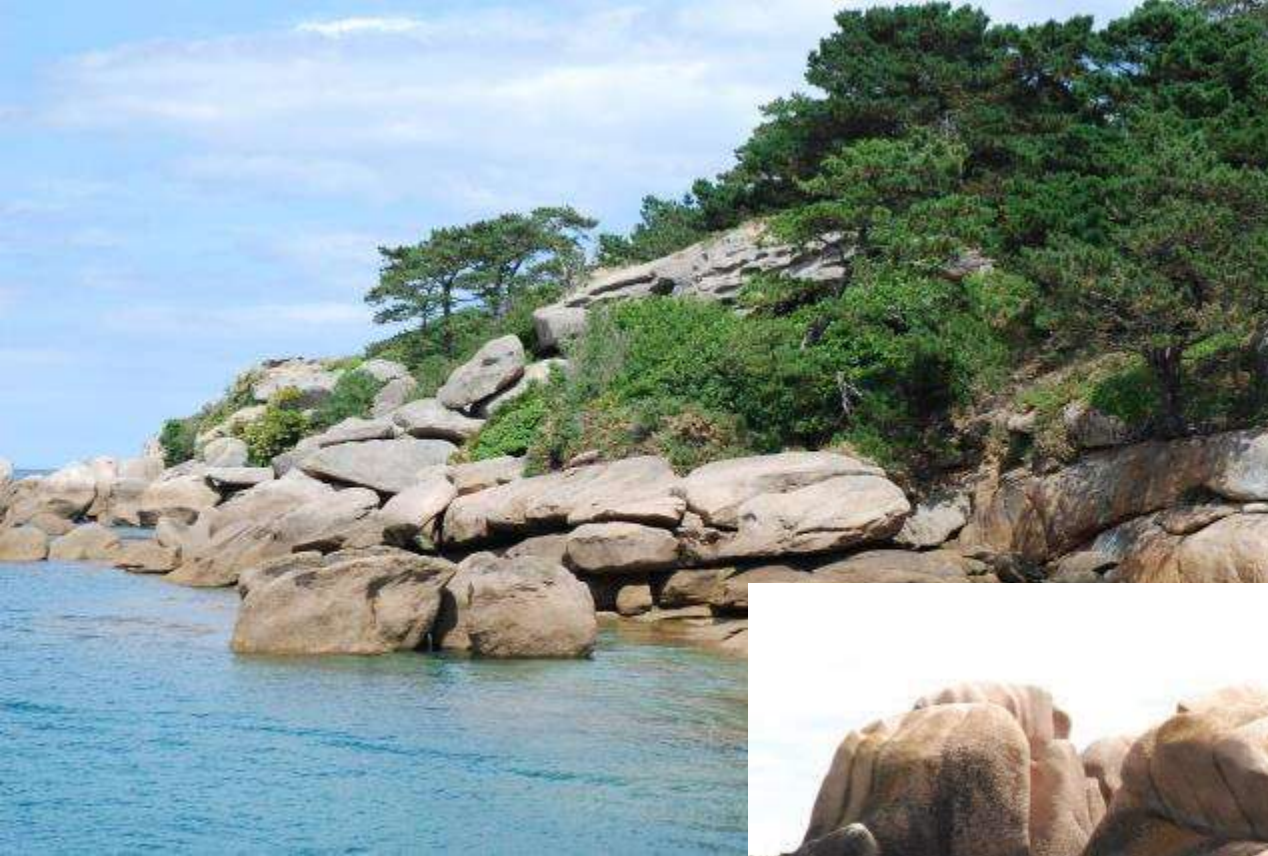
Species richness on inselbergs can be high in tropical and temperate regions

Australia



USA





precambrian
granites
(e.g. Brittany)

Megaliths at the Atlantic Fringe



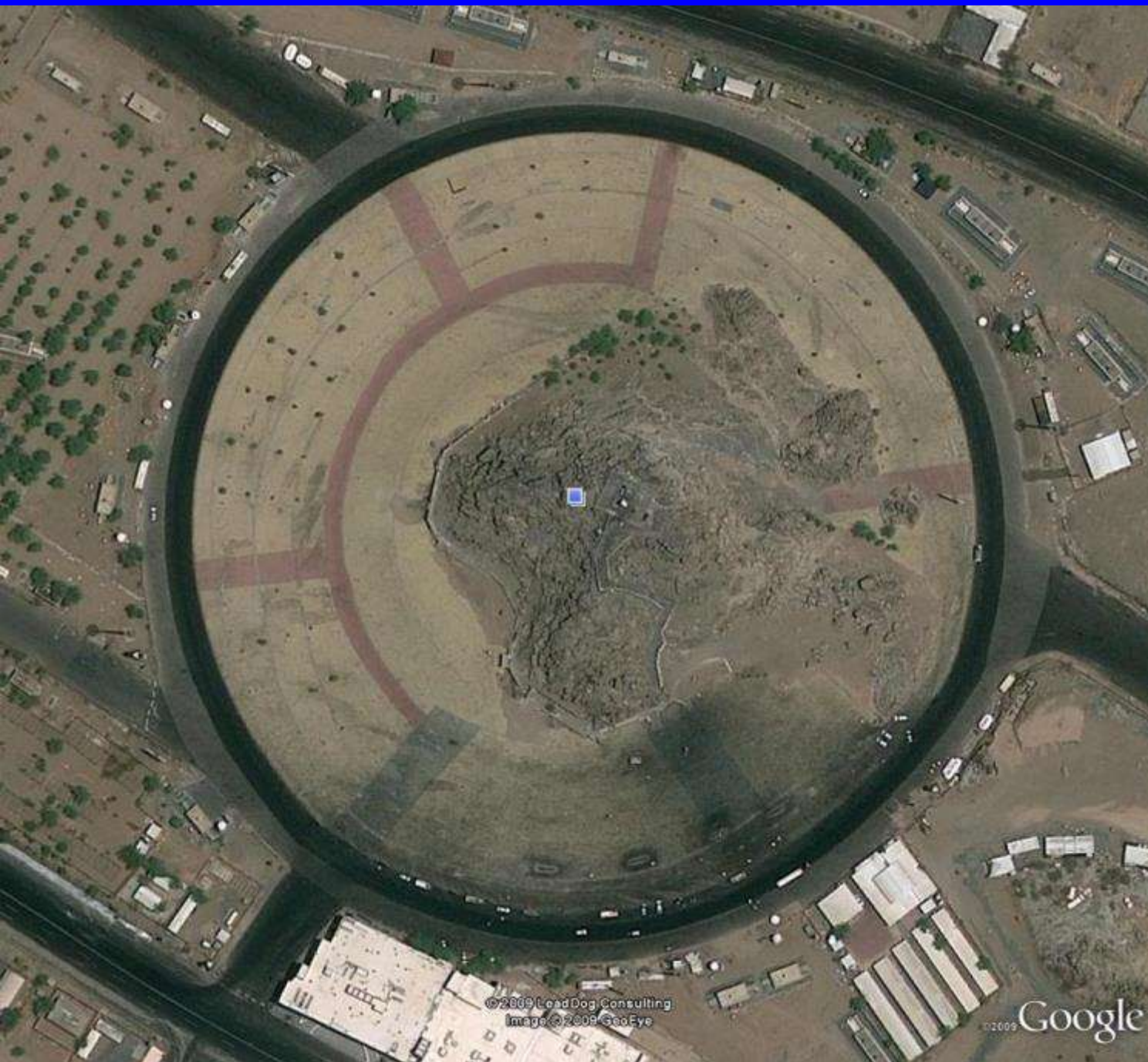
It has been suggested that the great megalithic monuments found on the Atlantic fringes of Europe – such as the alignments at Carnac, Brittany; chambered tombs like West Kennet, Avon with its spectacular façade and ultimately the tradition which resulted in the great trilithons at Stonehenge come from a particular sociocultural mix of the indigenous Mesolithic people and the arrival of people with a tradition of farming. Certainly these monuments attest a complex relationship between peoples and places – and it can be argued that they remind us that the “Neolithic Revolution” was as much a shift in ideas and attitudes as it was a change in ecology and economy.



The Amazonian Stonehenge

Amapa, Brazil

Mecca
Mt. Arafat





Hadsch
Mt. Arafat
Mecca



Jable Rehmat, Arafat
Photography by Resa Gilani



tombs, Angola





Quantifying human pressure
on inselbergs

Inselbergs in Megacities:

- Atlanta
- Bangalore
- Mecca
- Rio de Janeiro
- Yaoundé
- Albany





Granite Quarry Barre, VT

The World's Largest

[Display Map](#)



Experience Rock of Ages - quarry, factory and cut-in-stone activity.



Tour active granite quarry nearly 600 feet deep Narrated shuttle tours to the quarry operate the Friday of Memorial Day weekend until mid-October. (Closed July 4th) Small fee

Watch artisans in the factory polish and sculpt world-famous Barre granite

Our factory is available for self-guided tours of the artisans Monday through Friday 8:00-3:30. The factory is closed all holidays and associated days; e.g., the factory is closed Thanksgiving and the Friday thereafter. The factory is generally also closed the first two weeks of January. Free admission

Stop in at our Visitors Center and view our video, explore our exhibits, browse our gift shop and bowl on the outdoor granite lane. mid-May through October (Closed July 4th) Free admission

cut-in-stone activity is a BLAST! Squeeze the trigger, feel the throb of abrasive and air pulsing at 110 psi as you cut in stone. Make a great memory as you make a stone souvenir with your own hands - a terrific family activity.

Mid-June through mid-October, Monday through Saturday. (Closed July 4 th) Small fee

For details, dates and times of operation see the [Rock of Ages Tour Center](#) or call toll free 866-748-6877 or locally at 476-3119.



Granite quarries



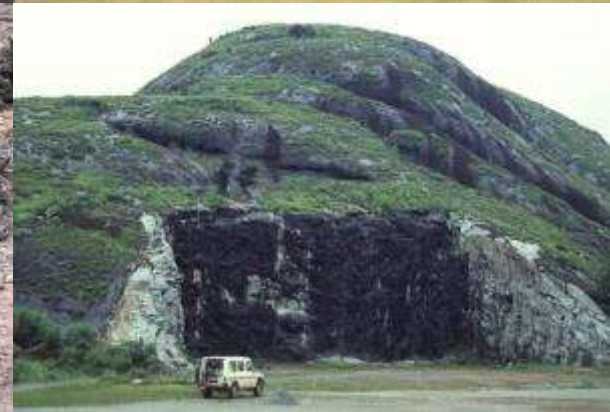
Microdracoides squamosus: a species at risk



Invasive species on inselbergs



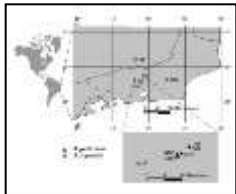
- Habitat fragmentation increases the percentage of exotic weeds on inselbergs
- Inselbergs are evolutionary springboards of invasive species



Rapid Global Destruction of Rock Outcrops

Population differentiation and species cohesion in two closely related plants adapted to neotropical high-altitude 'inselbergs', *Alcantarea imperialis* and *Alcantarea geniculata* (Bromeliaceae)

T. BARBARÁ,* G. MARTINELLI,† M. F. FAY,* S. J. MAYO† and C. LEXER*



Photos T. Barbara



‘Gene flow in [*A. imperialis*] is considerably lower than expected ... too low to prevent differentiation due to drift ... the ability of pollinating bats to promote gene exchange between inselbergs is smaller than previously assumed.’

General facts about inselbergs

- globally distributed old terrestrial habitat islands
- c. 15.000 – 20.000 species of vascular plants
- many species locally restricted (endemics)
- possession of specific adaptive traits
- almost no gymnosperms, ferns, „derived“ angiosperms









Tropical rock outcrops

- Granite/gneiss inselbergs
- Sandstone table mountains
- Quartzitic outcrops
- Ferricretes (ironstone)





1991

**Monitoring:
Remarkable constancy
(*Cyperus submicrolepis*,
Ivory Coast)**

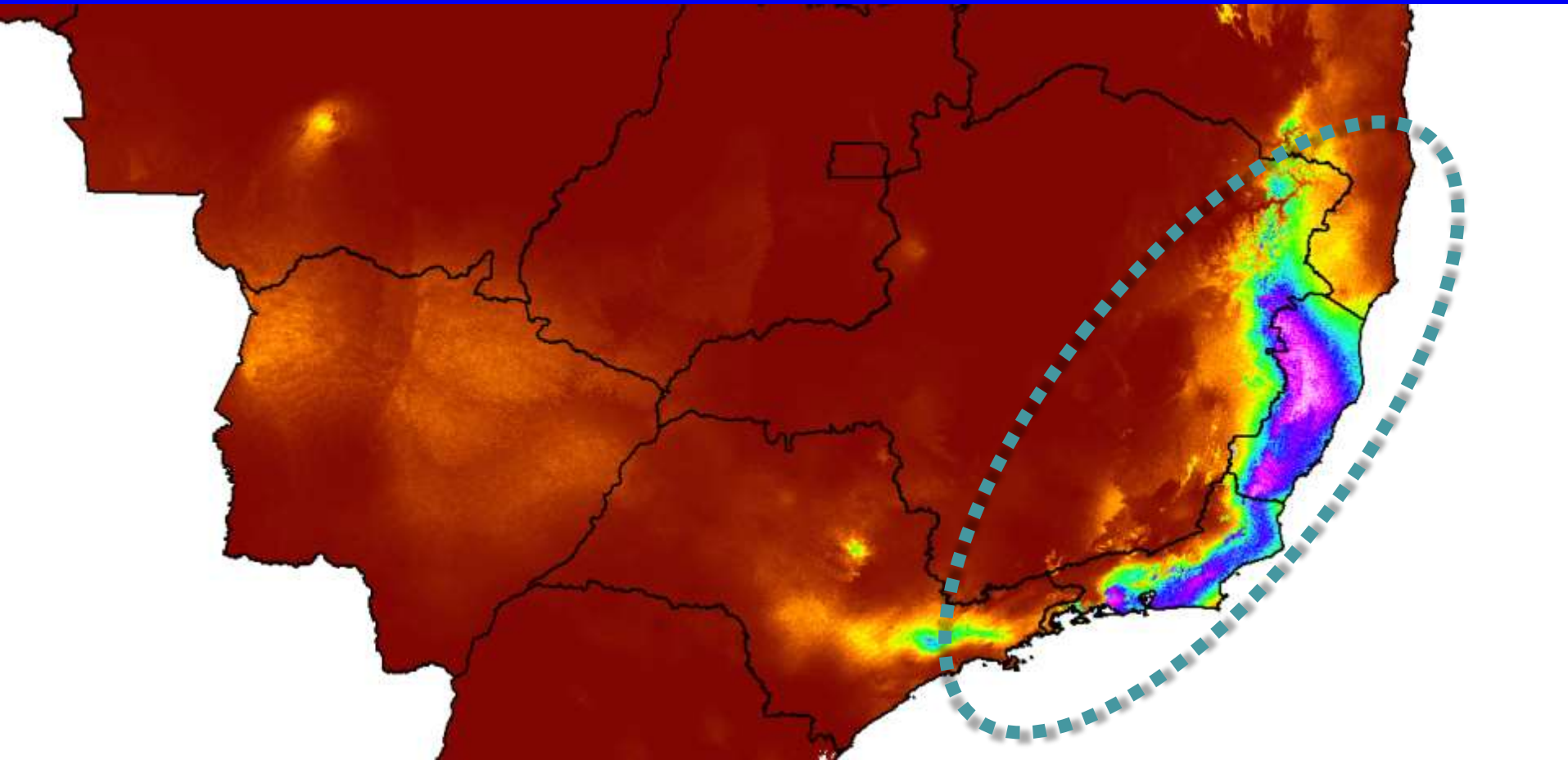


2009

**Establish permanent
plots!!!**

Bromeliads: ↑ endemic species on inselbergs

Potential area of occurrence: Southeastern Brazil

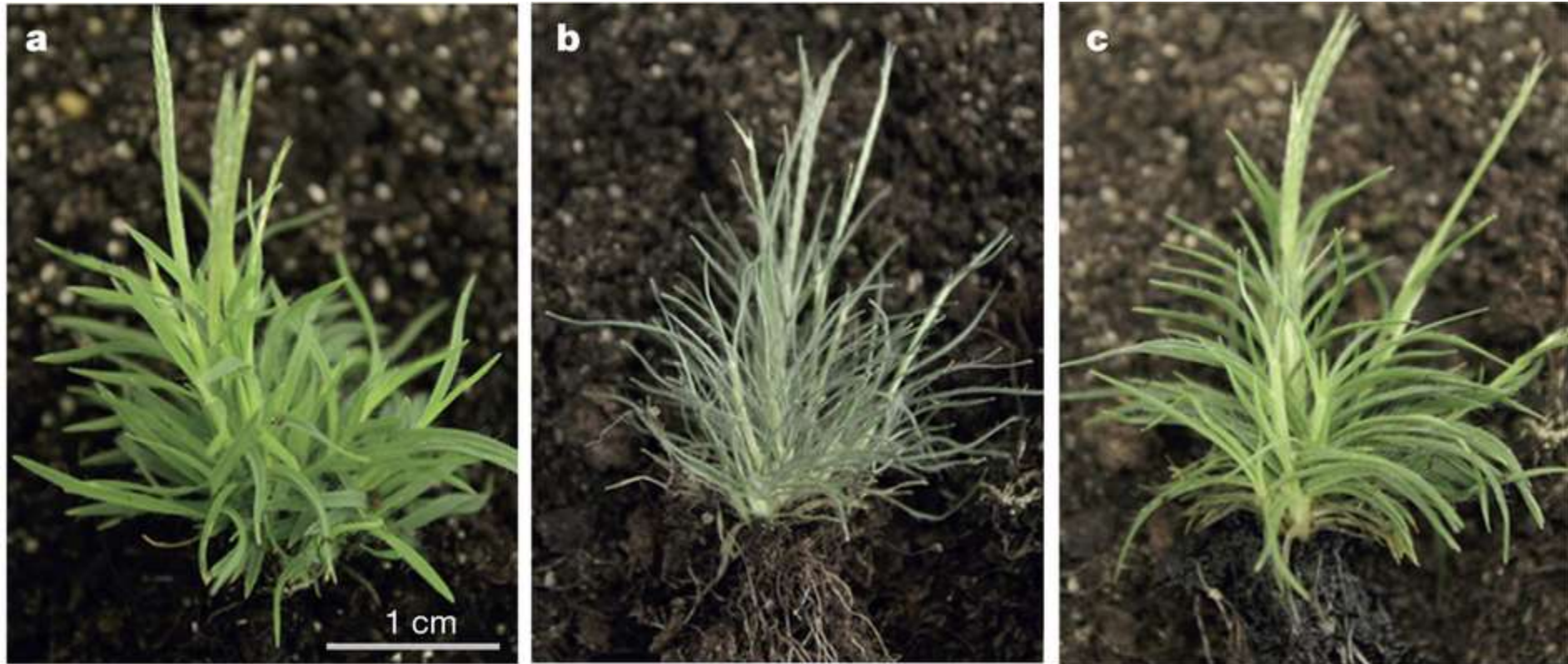


Unpubl. data

Sugar Loaf Biodiversity Center

The smallest known grass genome: 244 Mb, VanBuren et al. 2015

Desiccation tolerance in the resurrection grass *Oropetium thomaeum*.



a, Well watered. b, Desiccated (relative water content <5%) after 9 days of drought stress. c, Condition 24 h post-hydration (relative water content >70%).