The extraordinary extinct animals and ecosystems of Madagascar

Steve Goodman

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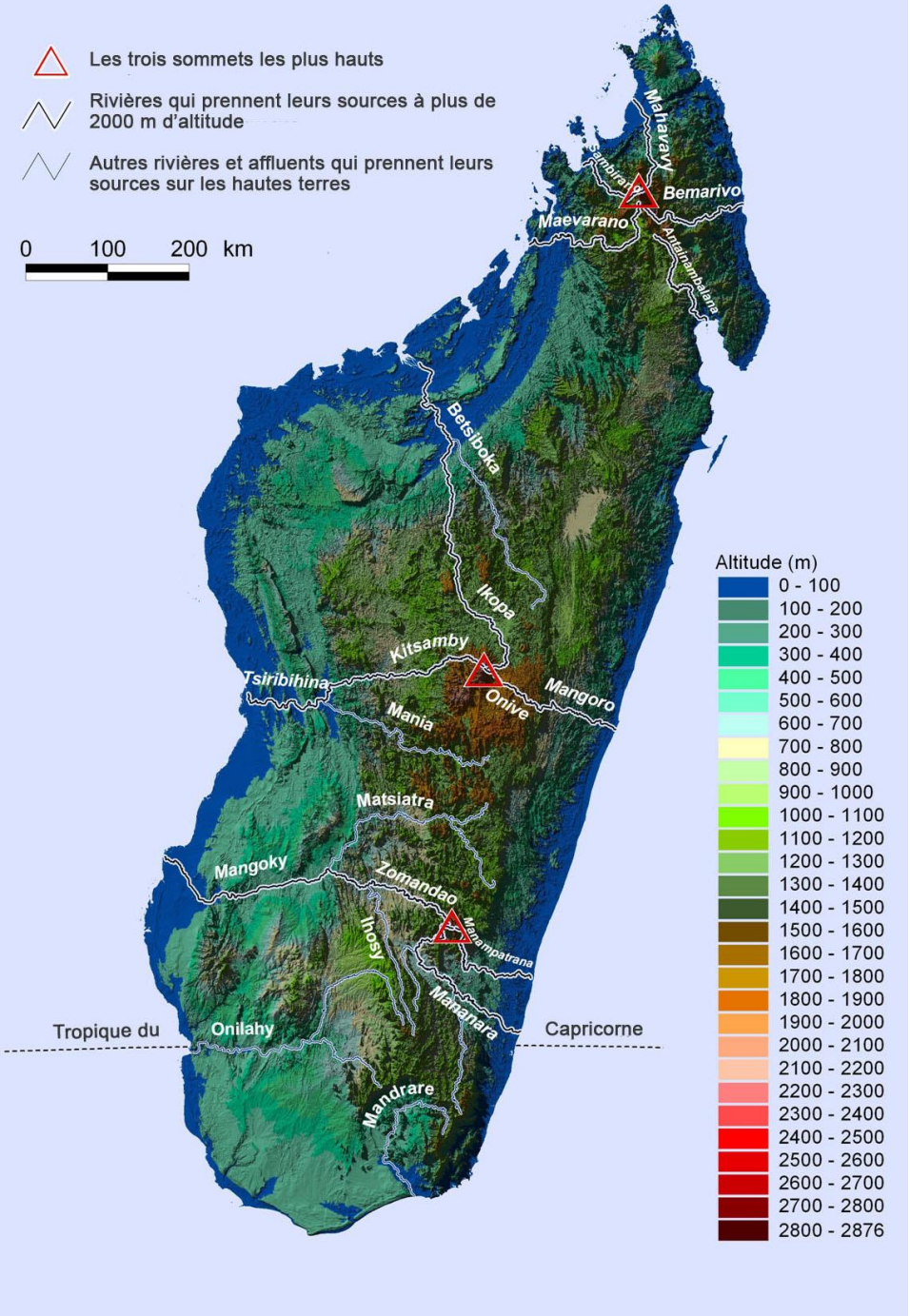
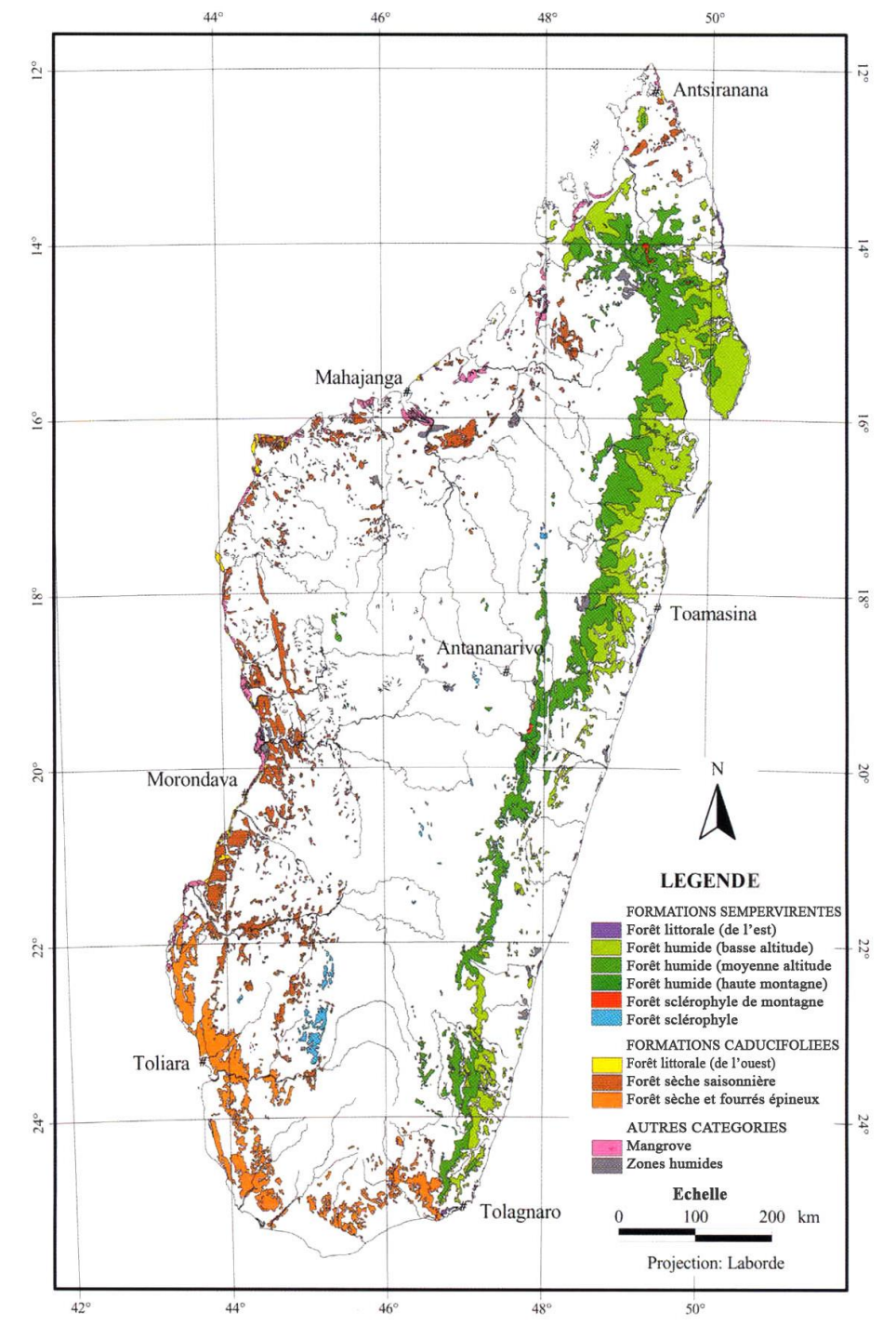
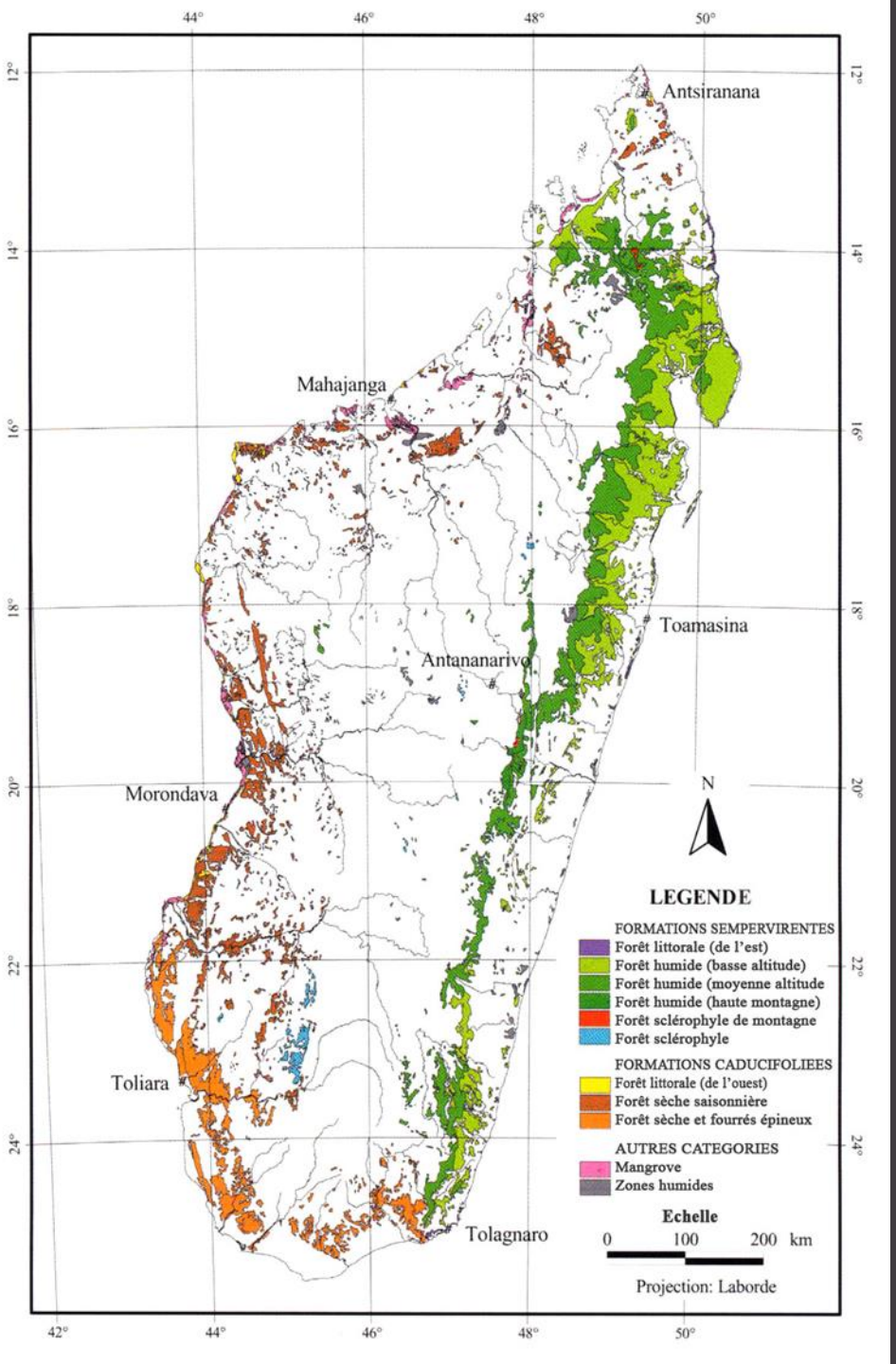
General themes

- During the course of the last millennia, a number of notable changes have taken place to the ecosystems of Madagascar.

- Different factors, ranging from natural climate shifts to human interventions, can explain these changes.


Les trois sommets les plus hauts
Rivières qui prennent leurs sources à plus de 2000 m d'altitude
Autres rivières et affluents qui prennent leurs sources sur les hautes terres
0 100 200 km
Mahavavy
Sambirano
Bemarivo
Maevarano
Antsiranambaliana
Betsiboka
Ikopa
Kitsamby
Tsiribihina
Onive
Mangoro
Mania
Matsiatra
Mangoky
Zomandao
Mananjampatrana
Ihosy
Mananara
Onilahy
Mandrare
Tropique du
Capricorne
Altitude (m)
0 - 100
100 - 200
200 - 300
300 - 400
400 - 500
500 - 600
600 - 700
700 - 800
800 - 900
900 - 1000
1000 - 1100
1100 - 1200
1200 - 1300
1300 - 1400
1400 - 1500
1500 - 1600
1600 - 1700
1700 - 1800
1800 - 1900
1900 - 2000
2000 - 2100
2100 - 2200
2200 - 2300
2300 - 2400
2400 - 2500
2500 - 2600
2600 - 2700
2700 - 2800
2800 - 2876


44°
46°
48°
50°
12°
14°
16°
18°
20°
22°
24°
Antsiranana
Mahajanga
Toamasina
Antananarivo
Morondava
Toliara
Tolagnaro
N
LEGENDE
FORMATIONS SEMPERVIRENTES
Forêt littorale (de l'est)
Forêt humide (basse altitude)
Forêt humide (moyenne altitude
Forêt humide (haute montagne)
Forêt sclérophyle de montagne
Forêt sclérophyle
FORMATIONS CADUCIFOLIEES
Forêt littorale (de l'ouest)
Forêt sèche saisonnière
Forêt sèche et fourrés épineux
AUTRES CATEGORIES
Mangrove
Zones humides
Echelle
0 100 200 km
Projection: Laborde


44°
46°
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42°
Antsiranana
Mahajanga
Toamasina
Antananarivo
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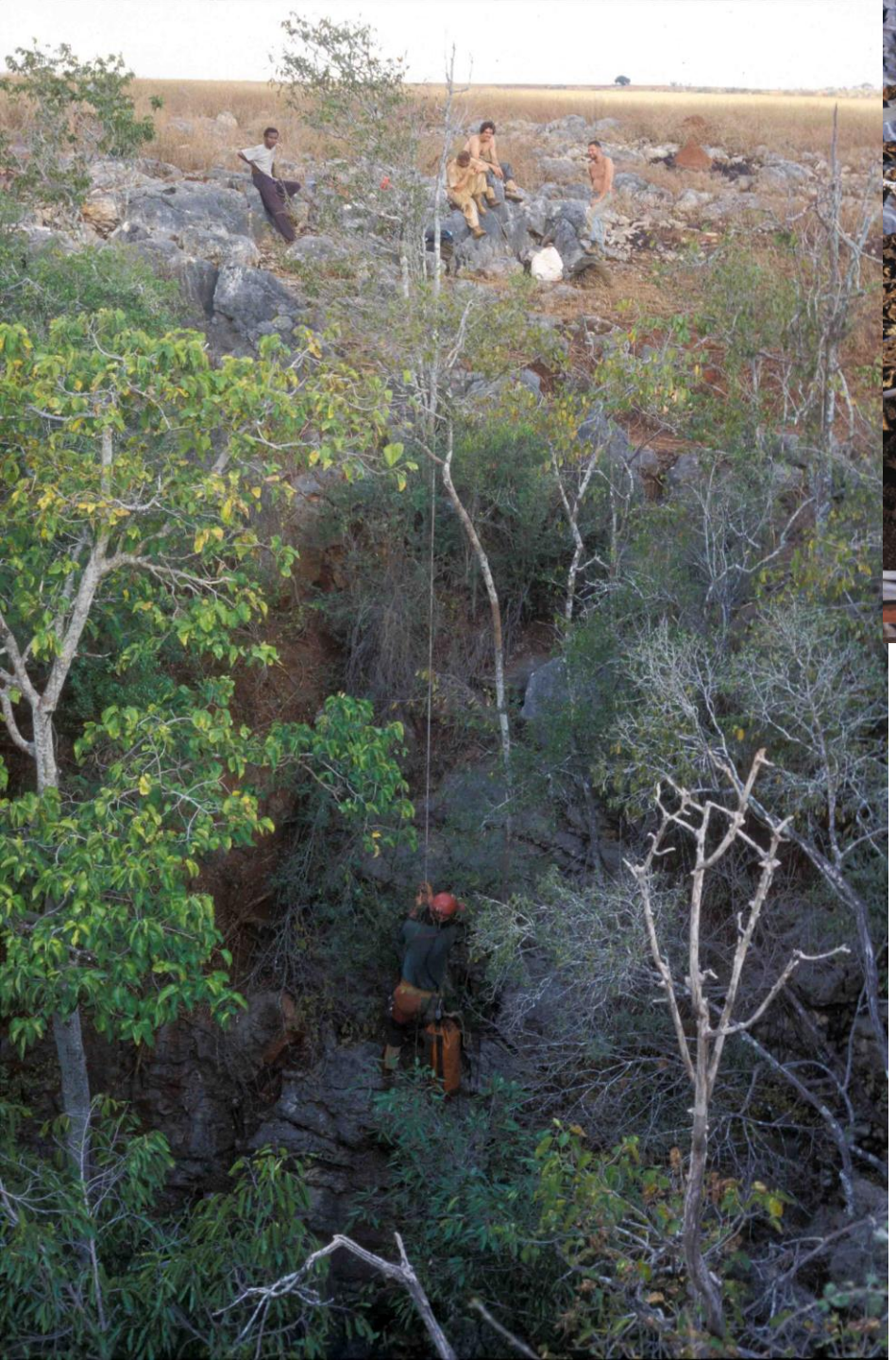
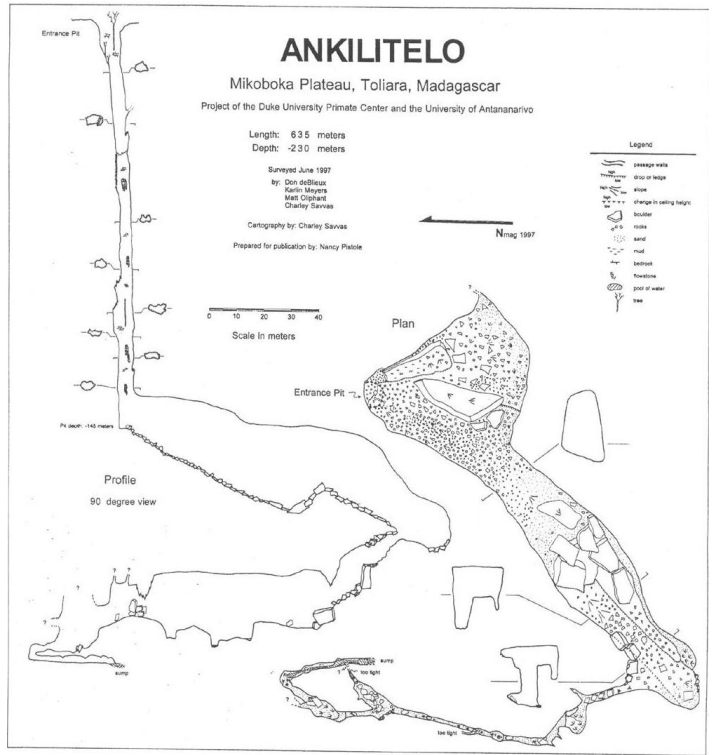
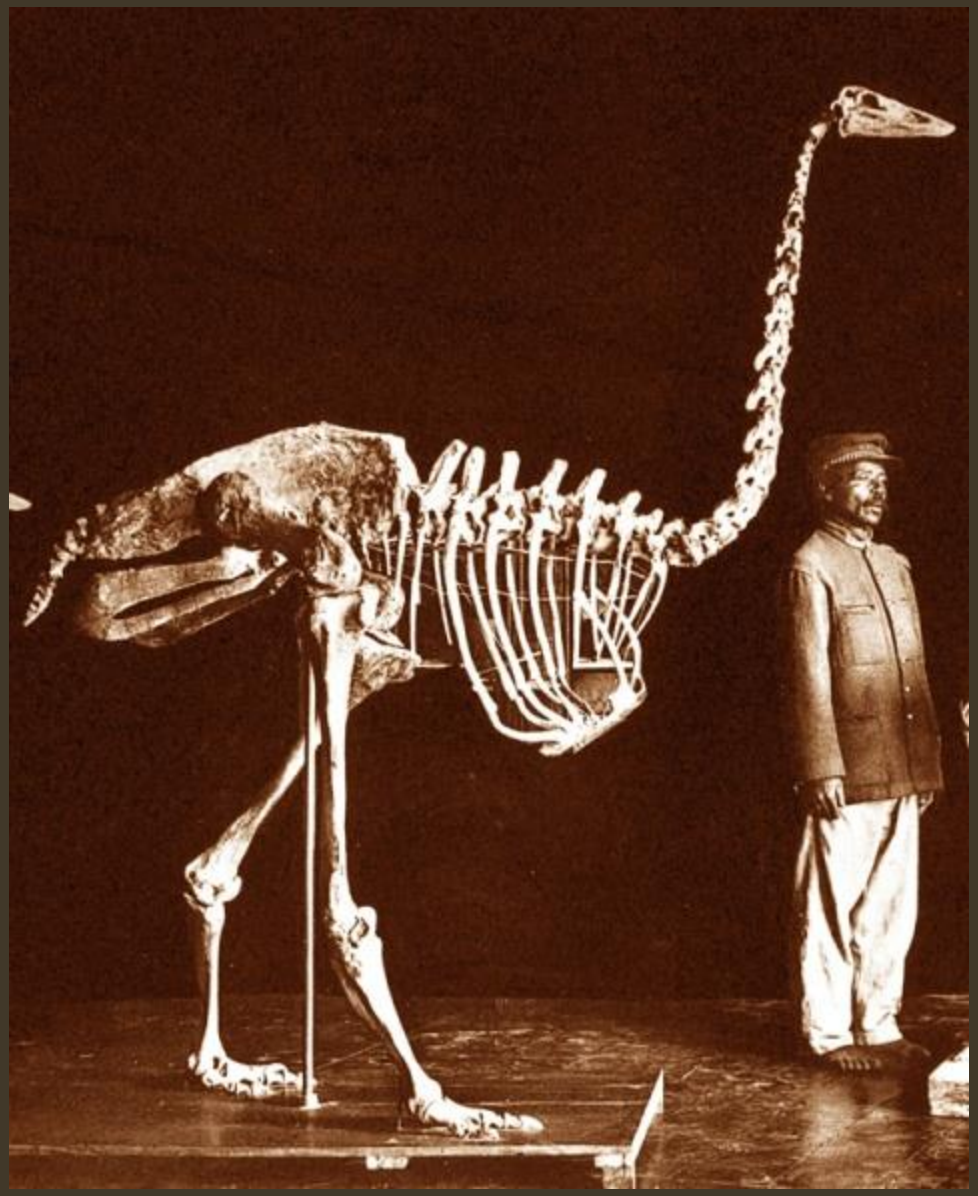
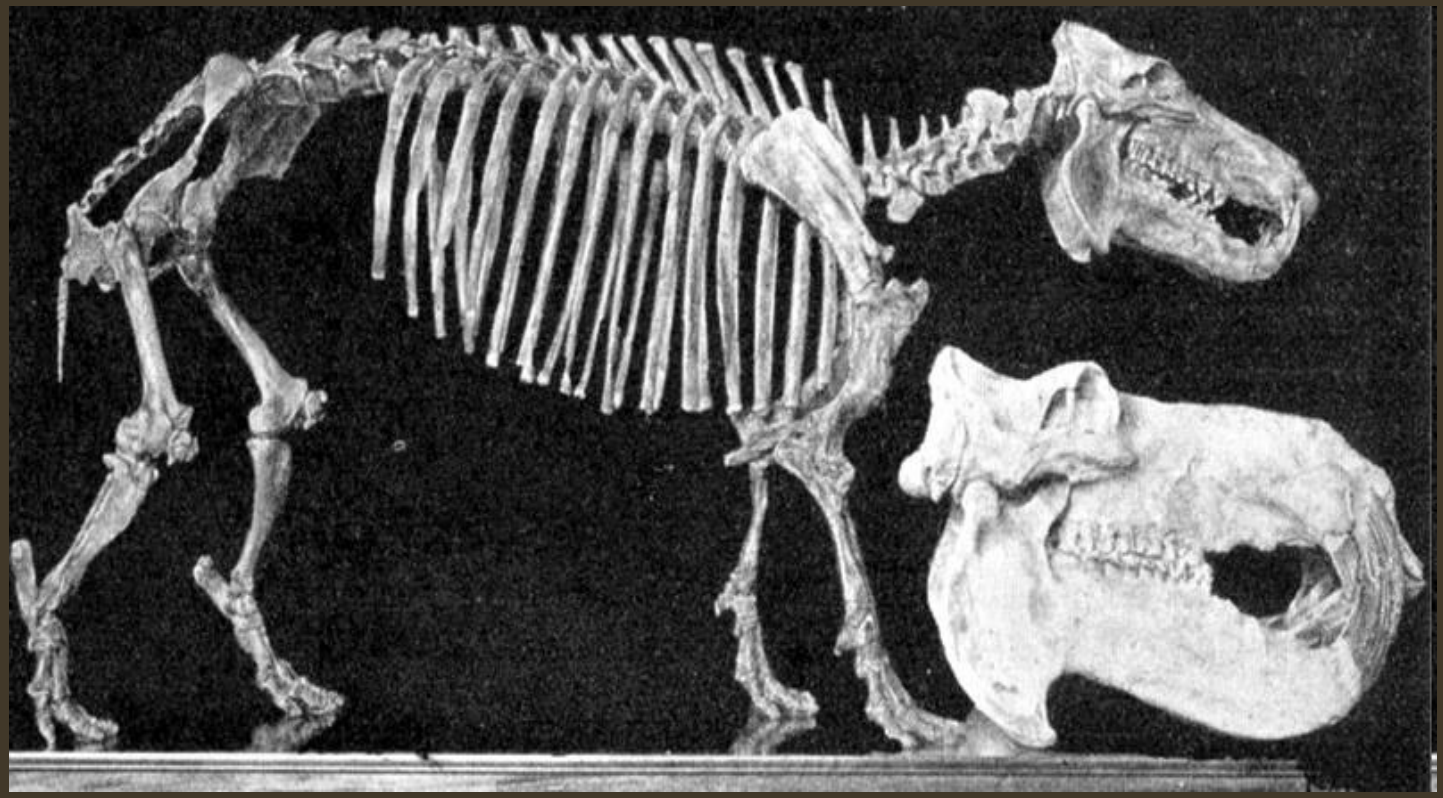
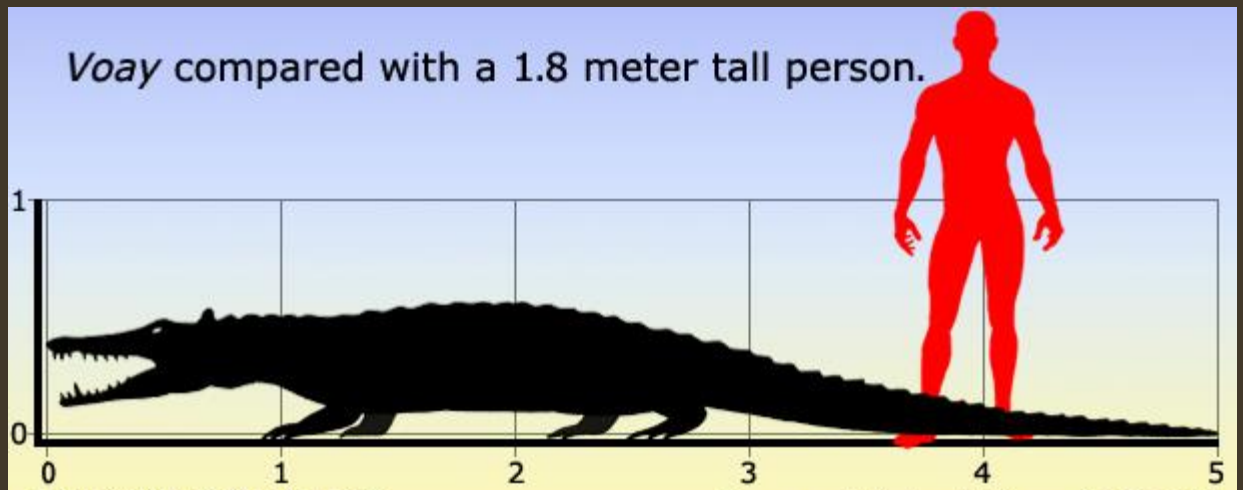
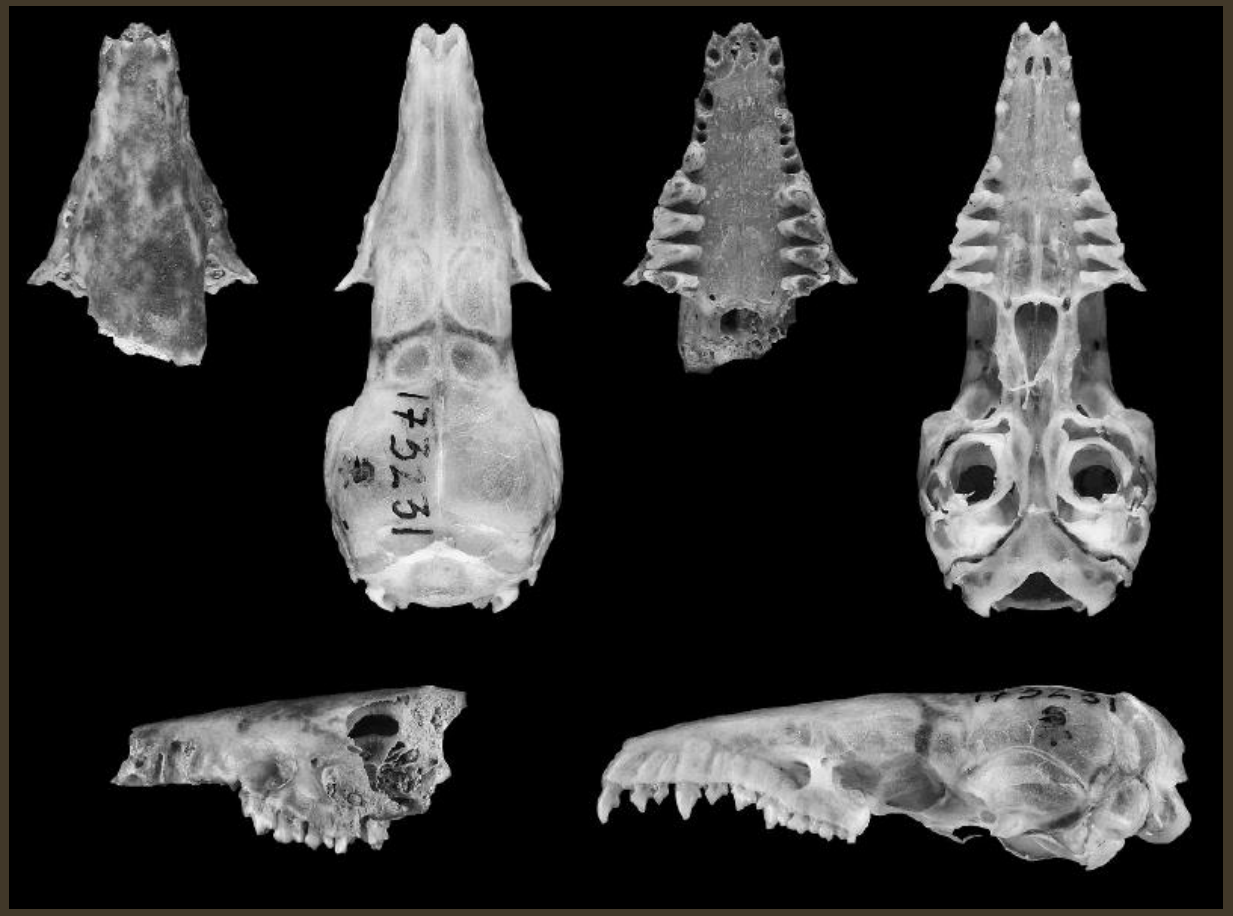



ANKILITELO
Mikoboka Plateau, Toliara, Madagascar
Project of the Duke University Primate Center and the University of Antananarivo
Length: 635 meters
Depth: -230 meters
Surveyed June 1997
by: Don deBlieux
Karlin Meyers
Matt Oliphant
Charley Savvas
Cartography by: Charley Savvas
Prepared for publication by: Nancy Pistole
Nmag 1997
Legend
passage walls
drop or ledge
slope
change in ceiling height
boulder
rocks
sand
mud
bedrock
flowstone
pool of water
tree
0 10 20 30 40
Scale in meters
Plan
Entrance Pit
Entrance Pit
Pit depth: -145 meters
Profile
90 degree view
sump
too tight
sump
too tight



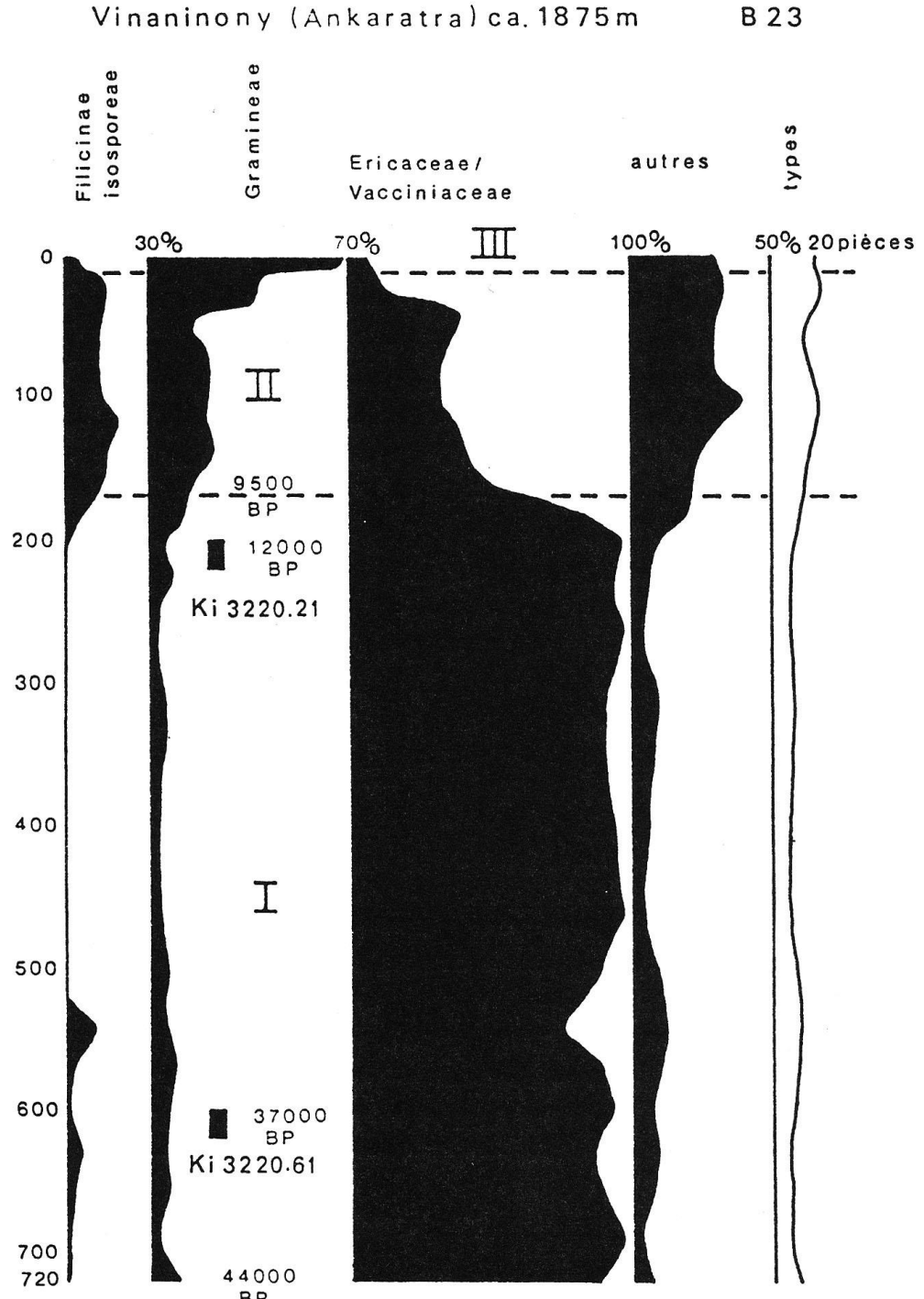


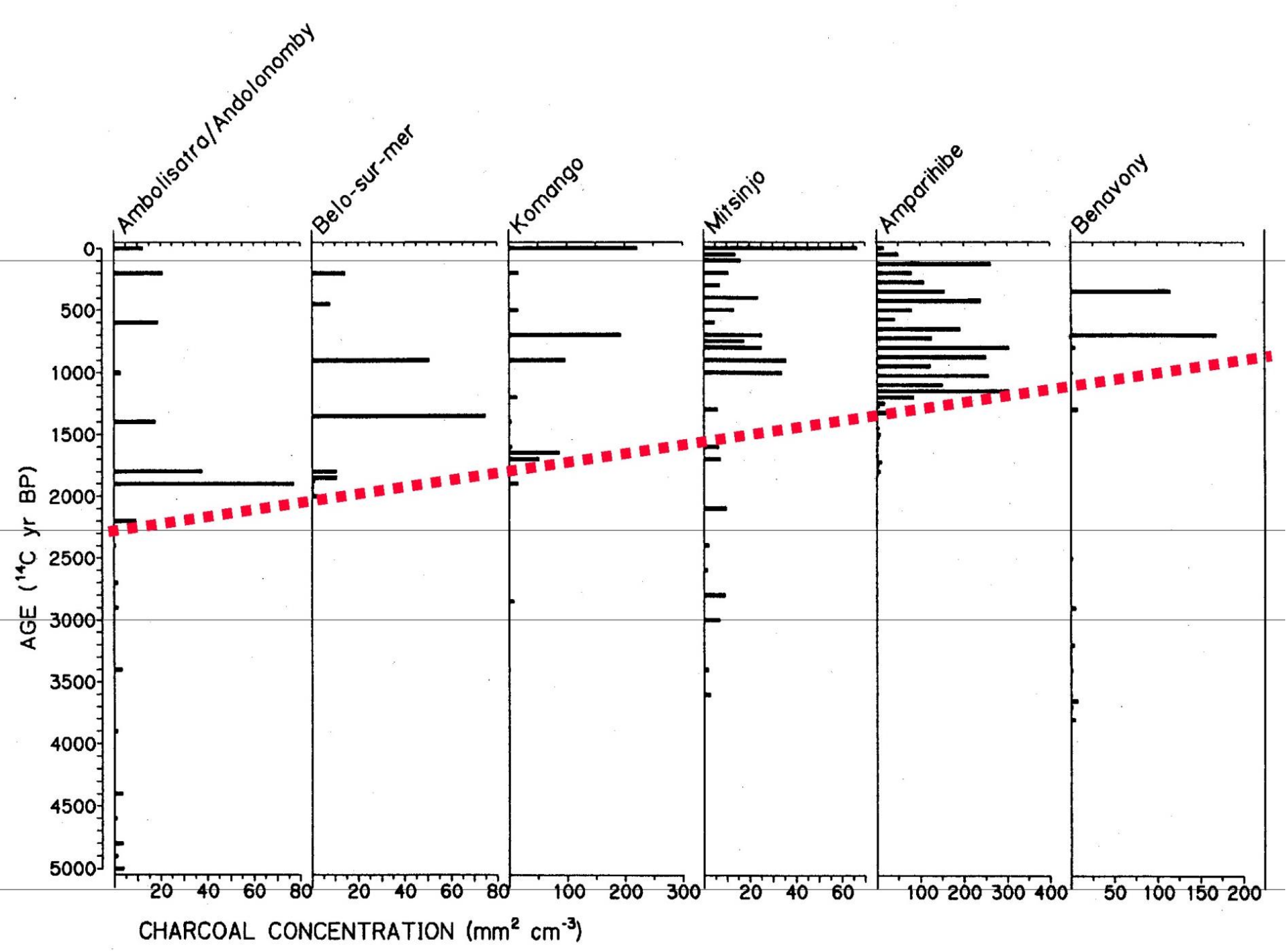

Voay compared with a 1.8 meter tall person.
1
0
0
1
2
3
4
5

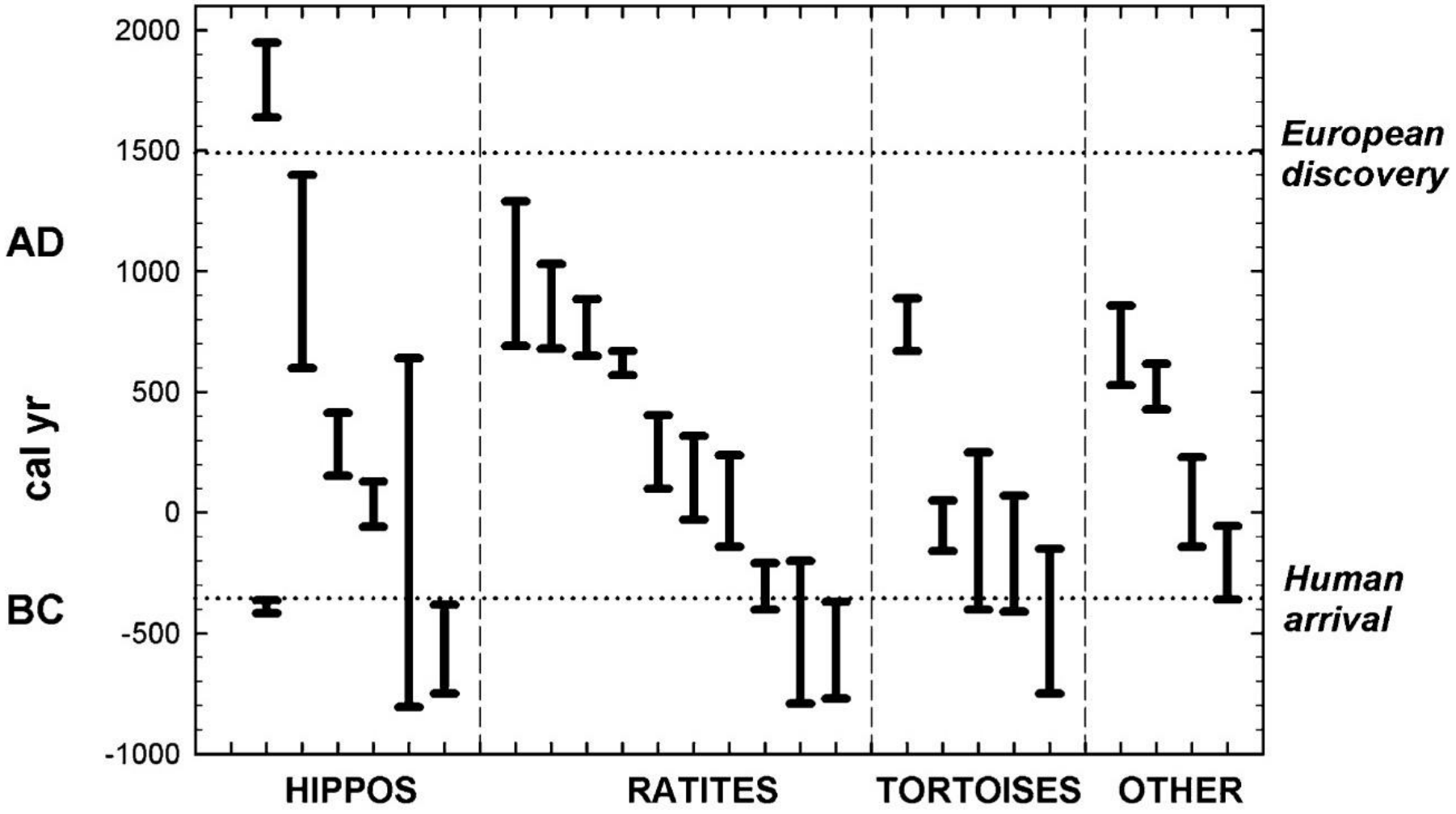

17571

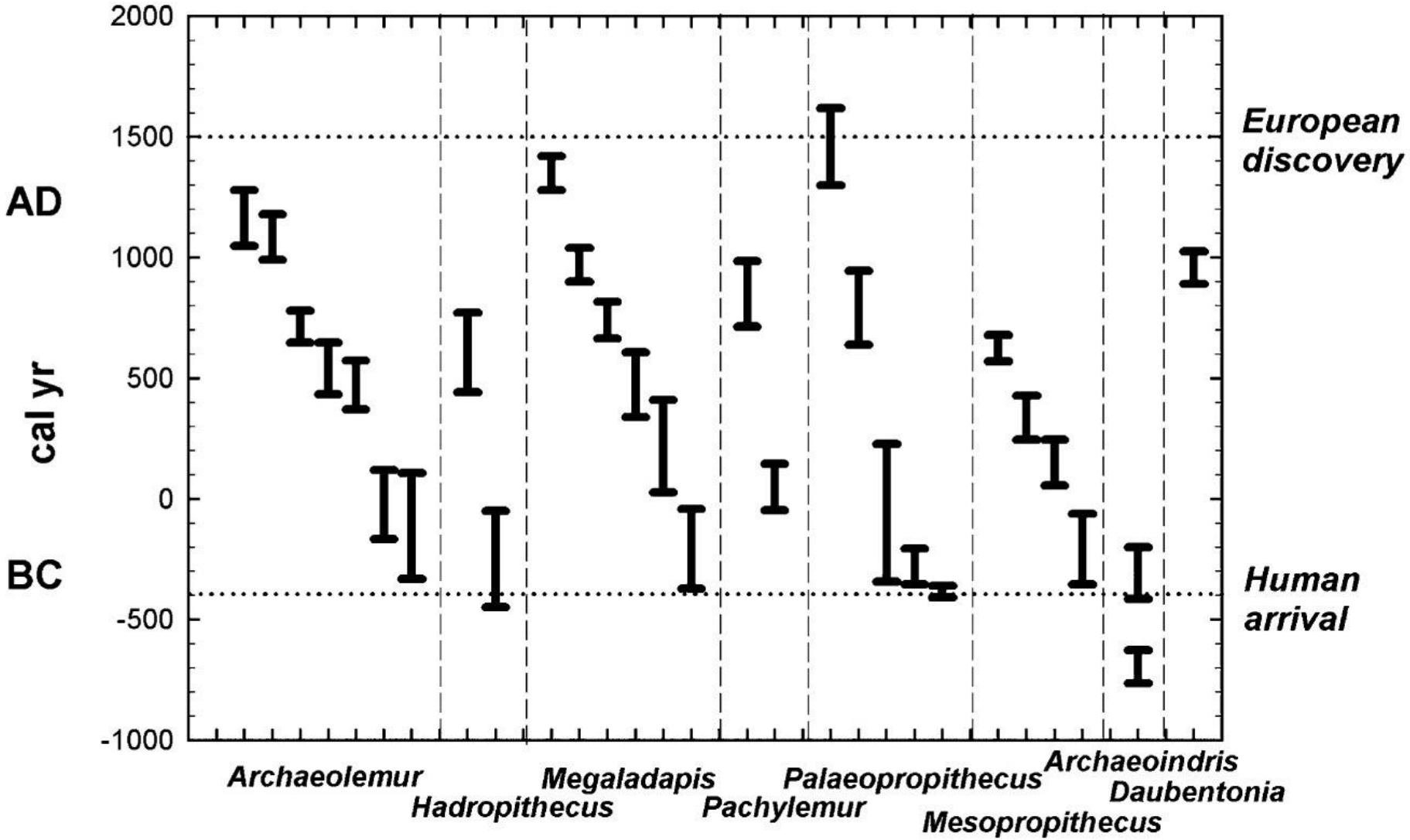
Changes in the bird and non-flying mammals since the Quaternary (last 15,000 years)

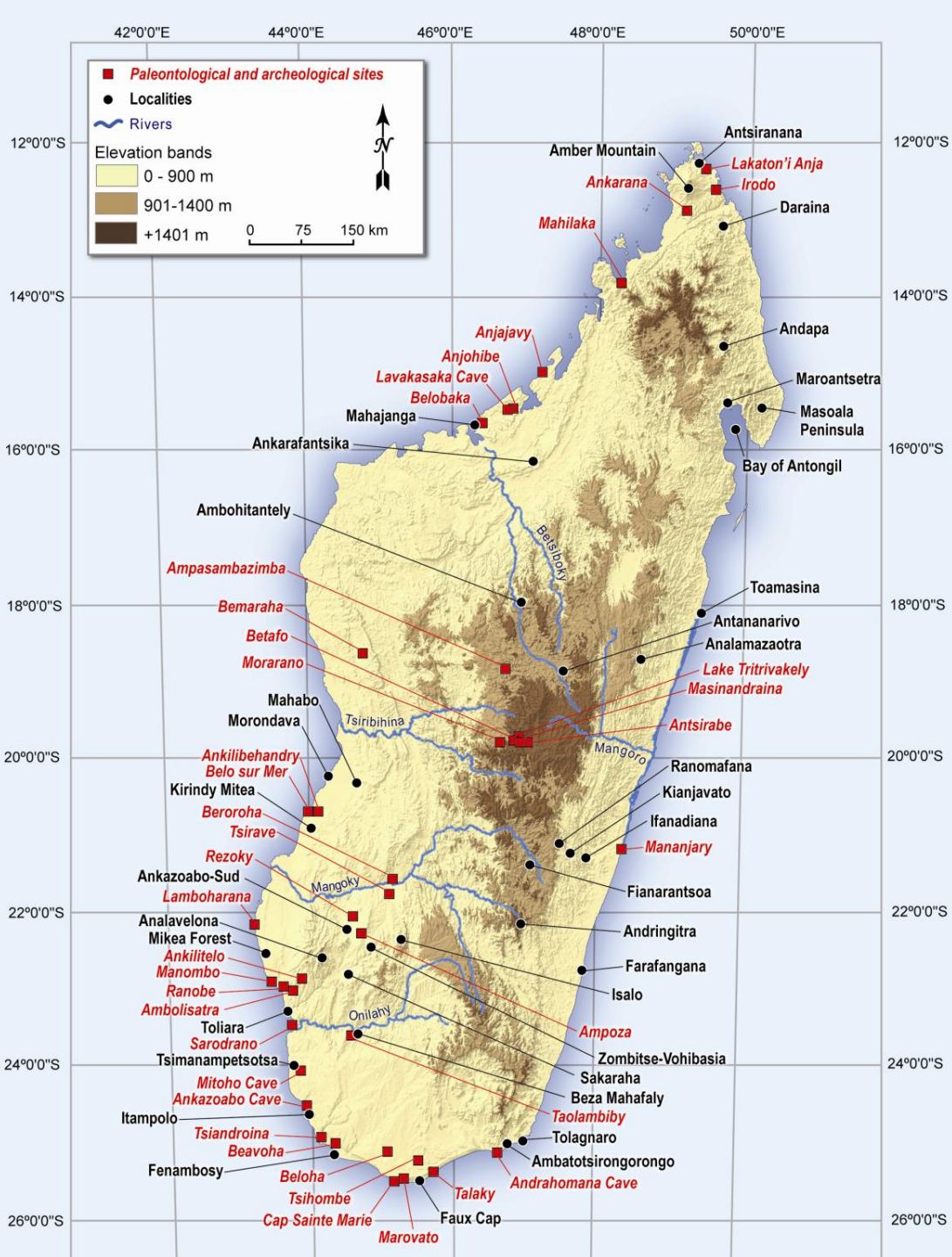
Group	Number of living species	Number of extinct species	% extinction
Birds (nesting species)	209	20	9.6 %
Terrestrial mammals	195	26	13.3 %

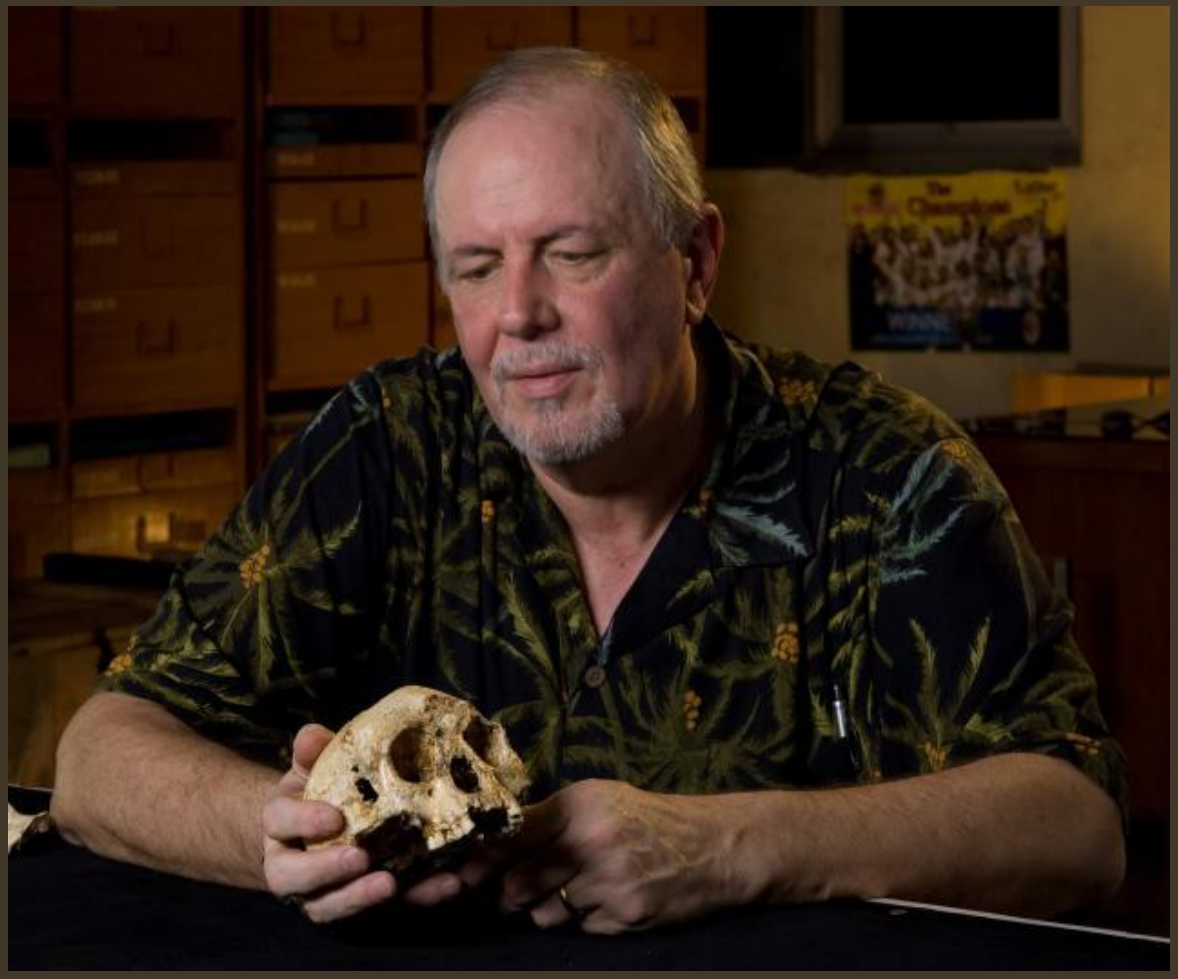

Vinaninony (Ankaratra) ca. 1875m
B 23
Filicinae isosporeae
Gramineae
Ericaceae / Vacciniaceae
autres
types
30%
70%
III
100%
50%
20 pièces
0
100
200
300
400
500
600
700
720
II
9500 BP
12000 BP
Ki 3220.21
I
37000 BP
Ki 3220.61
44000 BP

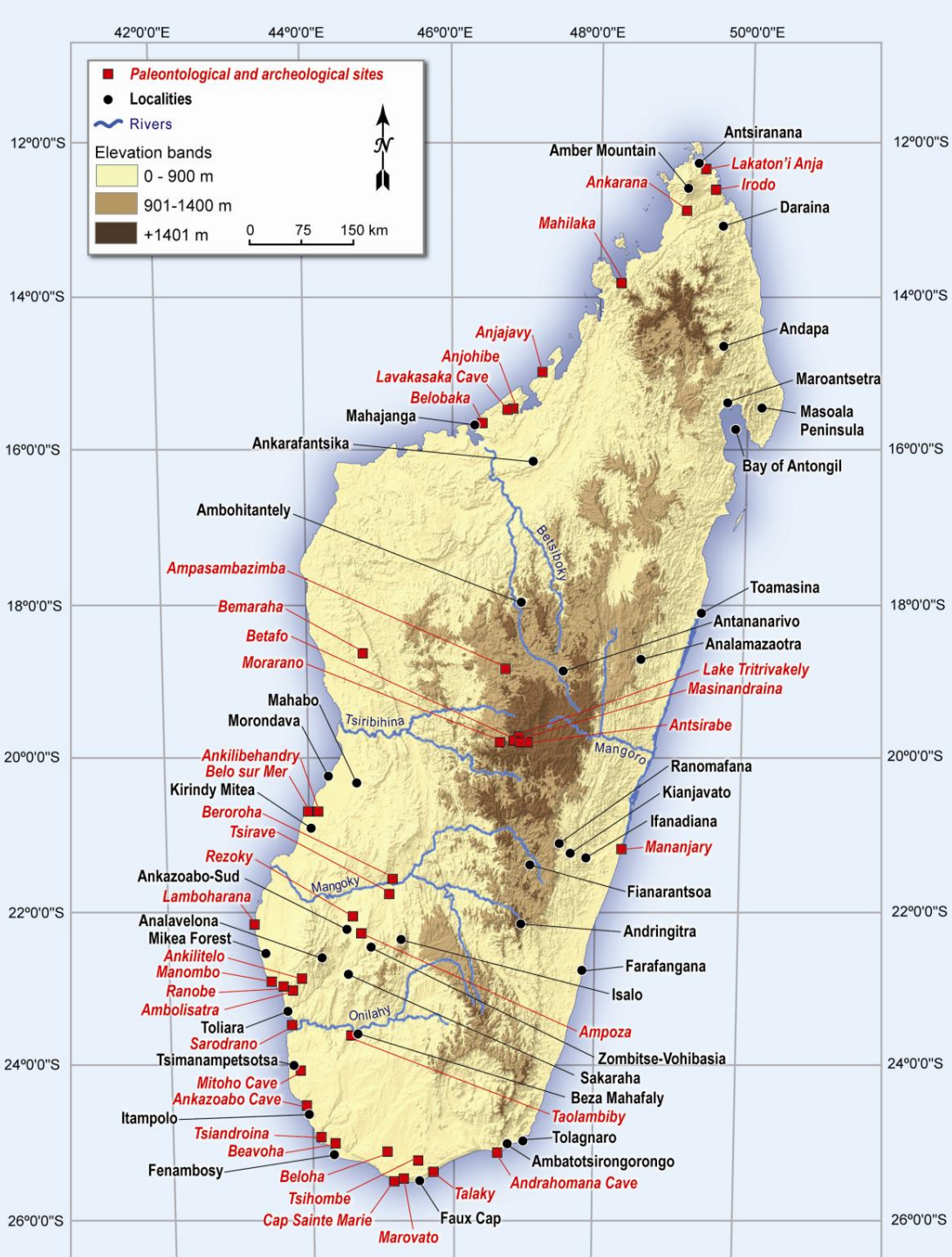

Ambolisatra/Andolonomby
Belo-sur-mer
Komango
Mitsinjo
Amparihibe
Benavony
AGE (^{14}C yr BP)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
20 40 60 80
20 40 60 80
100 200 300
20 40 60
100 200 300 400
50 100 150 200
CHARCOAL CONCENTRATION (mm^2 cm^{-3})


2000
1500
1000
500
0
-500
-1000
AD
cal yr
BC
European discovery
Human arrival
HIPPOS
RATITES
TORTOISES
OTHER


2000
1500
1000
500
0
-500
-1000
AD
cal yr
BC
European discovery
Human arrival
Archaeolemur
Hadropithecus
Megaladapis
Pachylemur
Palaeopropithecus
Mesopropithecus
Archaeoindris
Daubentonia


Paleontological and archeological sites
Localities
Rivers
Elevation bands
0 - 900 m
901-1400 m
+1401 m
0 75 150 km
N
42°0'0"E
44°0'0"E
46°0'0"E
48°0'0"E
50°0'0"E
12°0'0"S
14°0'0"S
16°0'0"S
18°0'0"S
20°0'0"S
22°0'0"S
24°0'0"S
26°0'0"S
Antsiranana
Amber Mountain
Lakaton'i Anja
Irodo
Ankarana
Daraina
Mahilaka
Andapa
Anjajavy
Anjohibe
Lavakasaka Cave
Belobaka
Maroantsetra
Masoala Peninsula
Mahajanga
Ankarafantsika
Bay of Antongil
Ambohitantely
Betsiboky
Ampasambazimba
Toamasina
Bemaraha
Antananarivo
Betafo
Analamazaotra
Morarano
Lake Tritrivakely
Masinandraina
Mahabo
Tsiribihina
Morondava
Antsirabe
Mangoro
Ankilibehandry
Belo sur Mer
Ranomafana
Kirindy Mitea
Kianjavato
Beroroha
Ifanadiana
Tsirave
Mananjary
Rezoky
Ankazoabo-Sud
Mangoky
Fianarantsoa
Lamboharana
Analavelona
Andringitra
Mikea Forest
Ankilitelo
Farafangana
Manombo
Isalo
Ranobe
Ambolisatra
Onilahy
Toliara
Ampoza
Sarodrano
Zombitse-Vohibasia
Tsimanampetsotsa
Sakaraha
Mitoho Cave
Beza Mahafaly
Ankazoabo Cave
Taolambiby
Itampolo
Tsiandroina
Tolagnaro
Beavoha
Ambatotsirongorongo
Fenambosy
Andrahomana Cave
Beloha
Talaky
Tsihombe
Faux Cap
Cap Sainte Marie
Marovato

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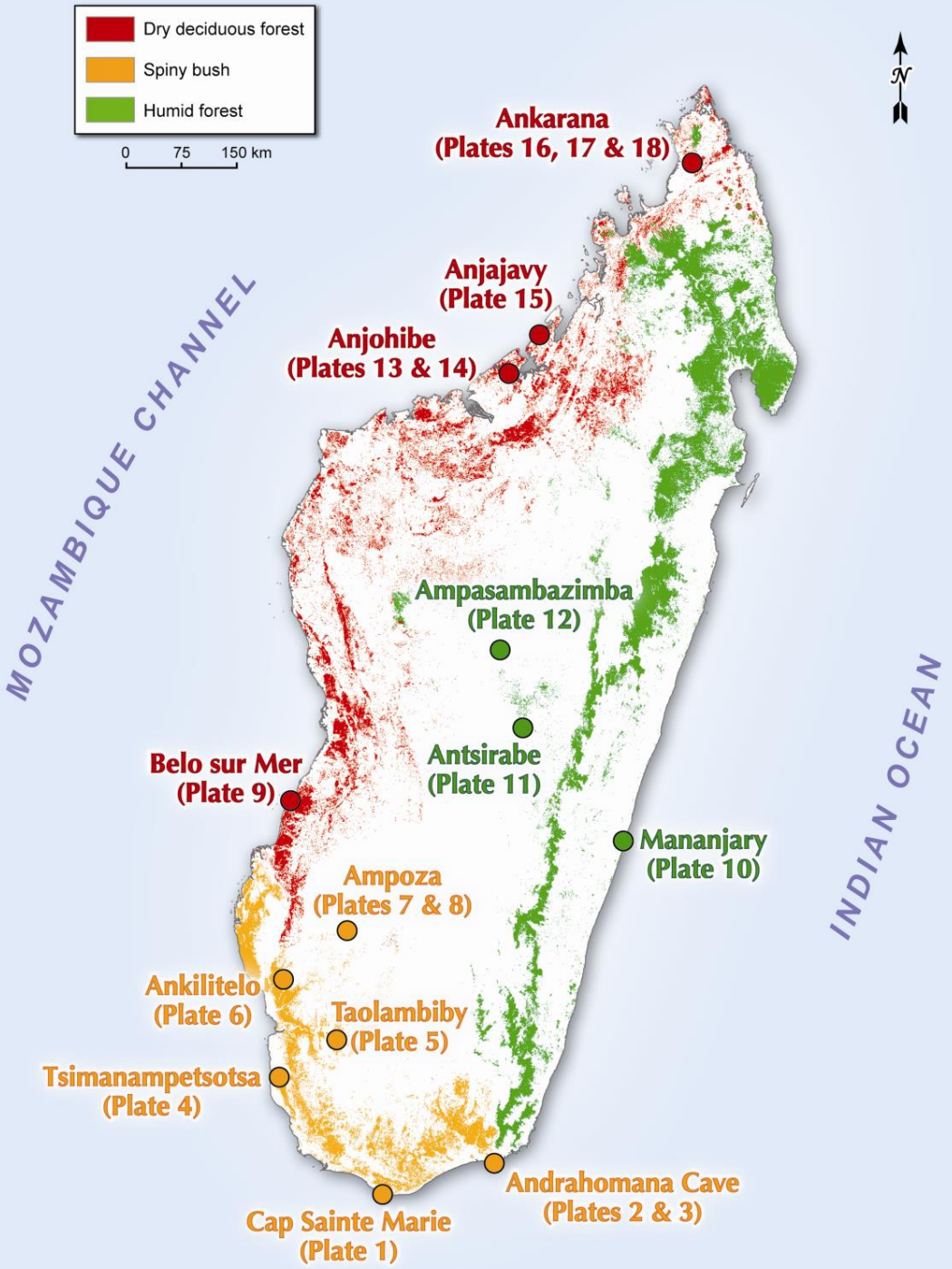
Andrahomana Cave
Beloha
Talaky
Tsihombe
Faux Cap
Cap Sainte Marie
Marovato


Dry deciduous forest
Spiny bush
Humid forest
0 75 150 km
N
Ankarana
(Plates 16, 17 & 18)
Anjajavy
(Plate 15)
Anjohibe
(Plates 13 & 14)
MOZAMBIQUE CHANNEL
Ampasambazimba
(Plate 12)
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(Plate 9)
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(Plates 7 & 8)
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(Plate 6)
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(Plate 5)
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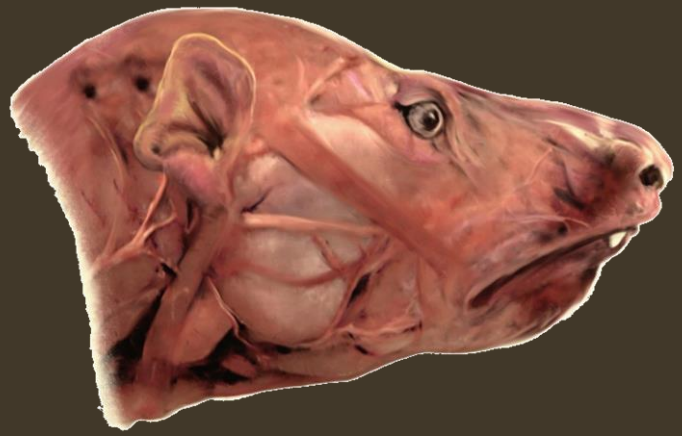
(Plate 4)
Andrahomana Cave
(Plates 2 & 3)
Cap Sainte Marie
(Plate 1)

ASSOCIATION VAHATRA
GUIDES SUR LA DIVERSITE BIOLOGIQUE DE MADAGASCAR

LES ANIMAUX ET ECOSYSTEMES DE L'HOLOCENE DISPARUS DE MADAGASCAR

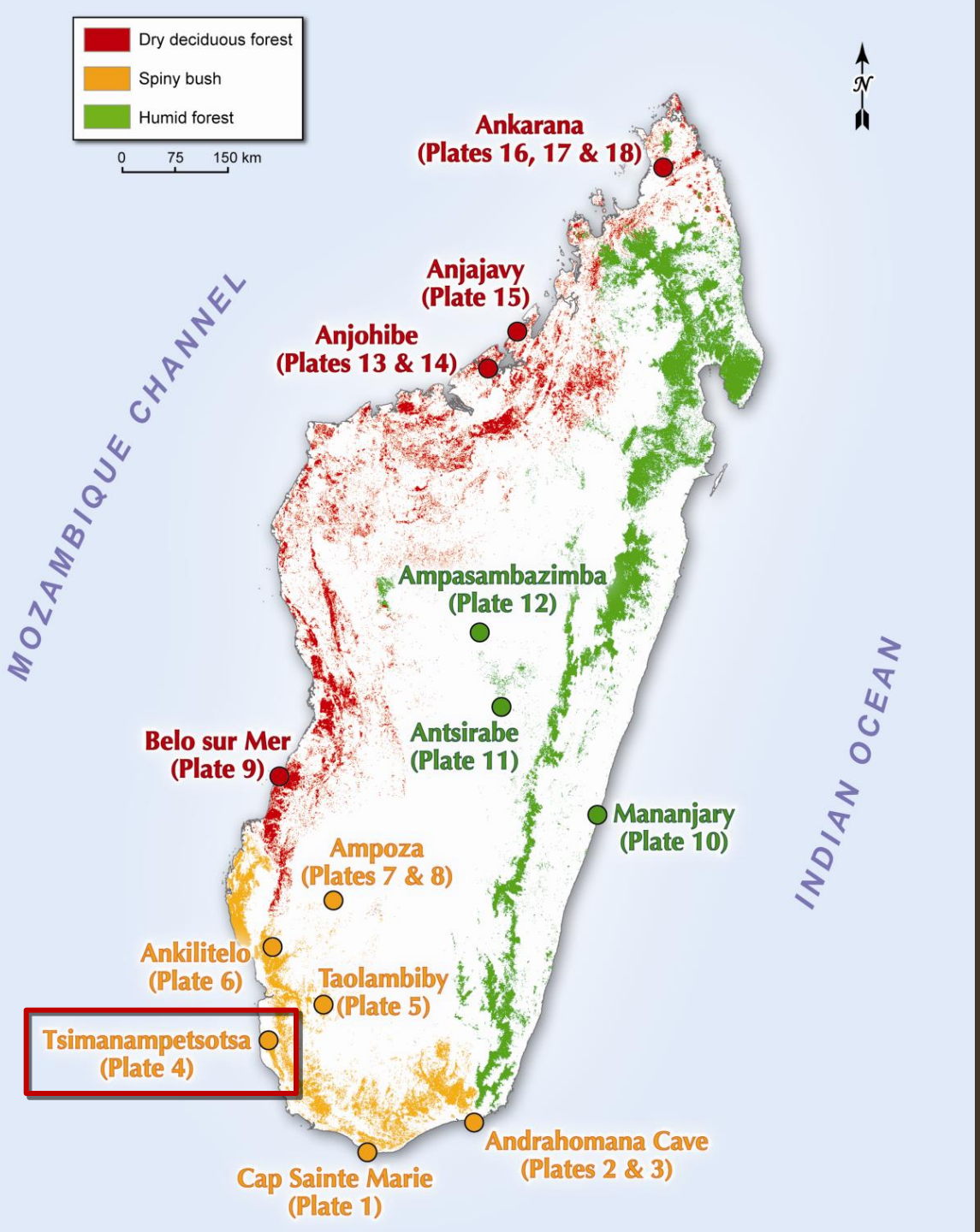
STEVEN M. GOODMAN & WILLIAM L. JUNGERS

ILLUSTRATIONS DE VELIZAR SIMEONOVSKI




VAS 2011

Some case examples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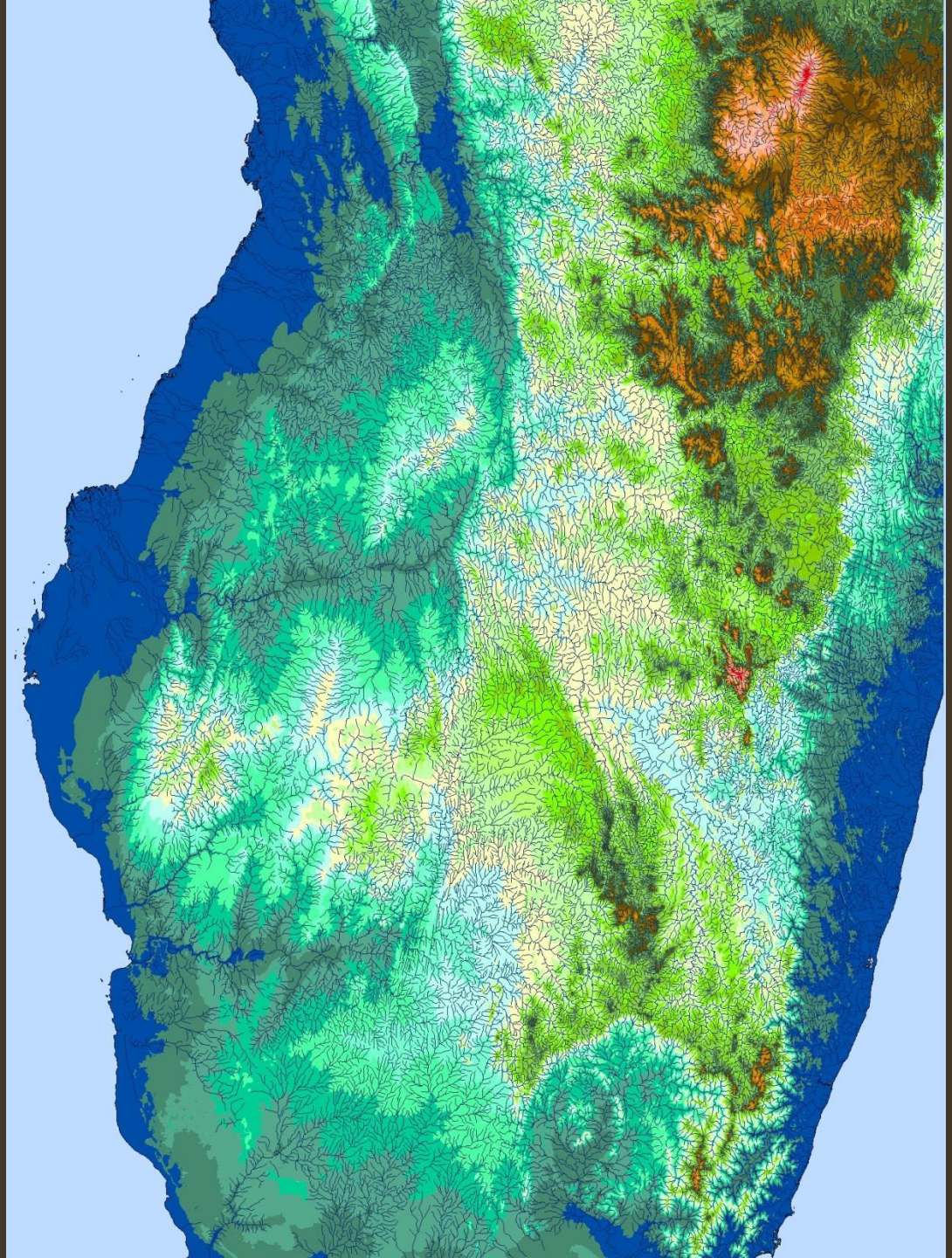

Tsimanampetsotsa

- Radiocarbon dates for :

  †*Cryptoprocta spelea* – 1865 ybp,

  †*Mesopropithecus globiceps* – 2148 ybp,

  †*Palaeopropithecus ingens* – 1450-1148, ybp

  †*Hippopotamus lemereli* – 980 ybp.

- Archeology – region never populated, even until today.
- Still considerable natural forests.
- **CAUSE**: natural climatic change (very recent).


Dry deciduous forest
Spiny bush
Humid forest
0 75 150 km
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1929 White Expedition to Ampoza

1993 Goodman/Yoder Expedition to Ampoza


0
150 km
0
50
100 mi

Population genetics:
1) Little variation in remaining population and went through clear recent bottleneck

Ampoza

- Radiocarbon dates for :

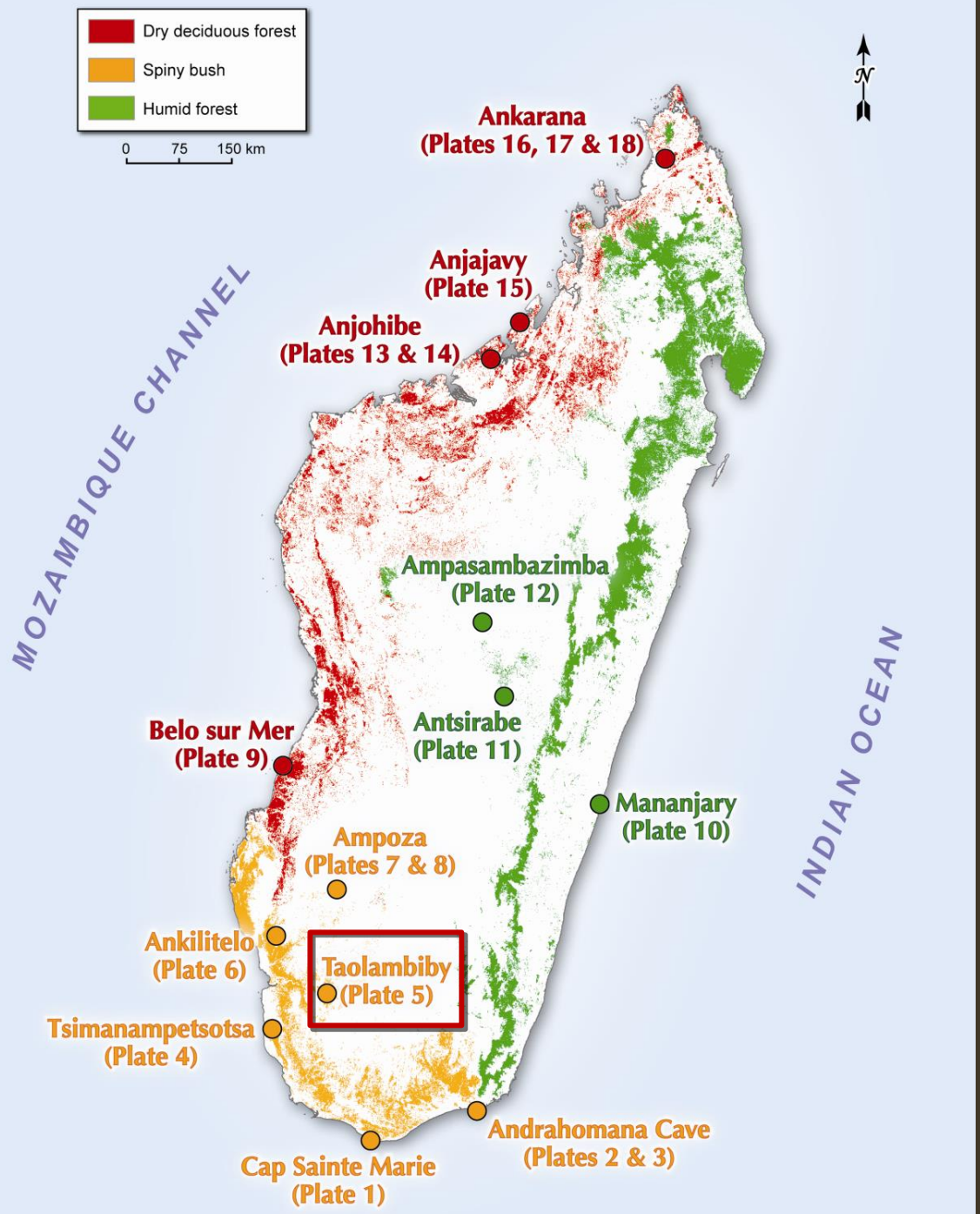
  †*Hippopotamus lemerlei* from 2760 to 2370 ybp.

  †*Palaeopropithecus ingens* at 2285 ybp.

  †*Dipsochelys abrupta* at 2035 ybp.

  †*Hypogeomys antimena* at 1350 ybp.

- Archeology – first human evidence in the region is 13th century.
- **CAUSE** : natural climate change, perhaps accentuated by human activities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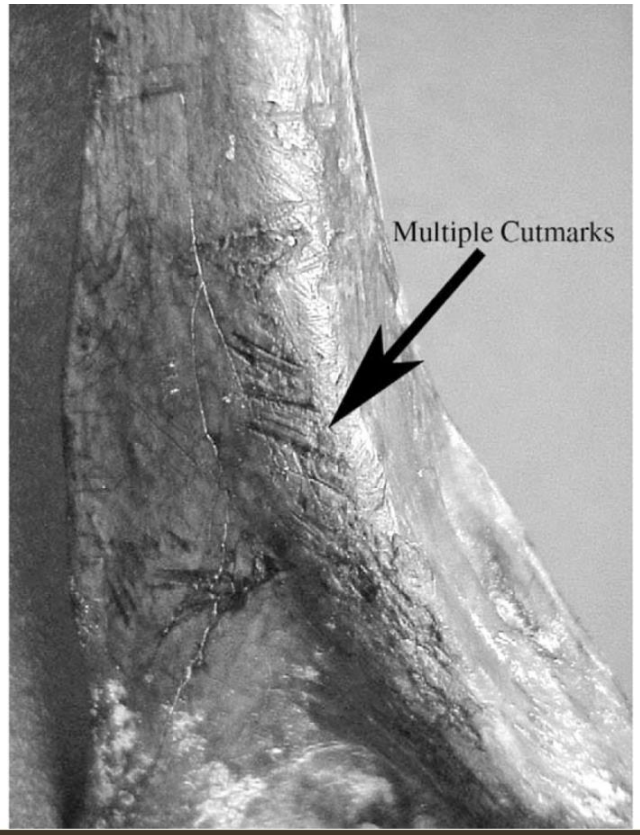
Radiocarbon dating

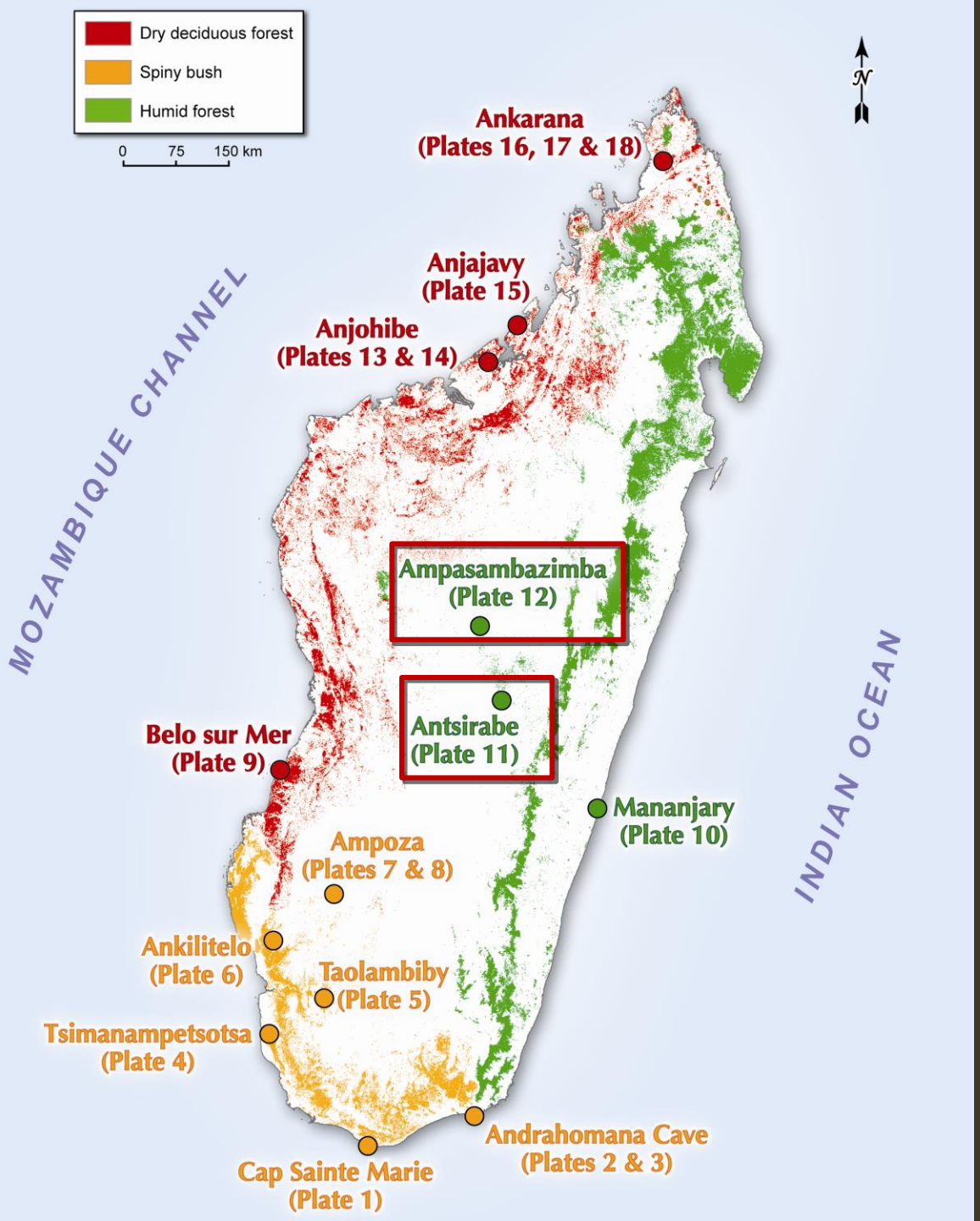
The oldest radiocarbon date published from Madagascar in a human context is from an extinct lemur (*Palaeopropithecus*) with clear knife marks and calibrated to 2325 ybp.



Signs of knife cut-marks

Amongst the recovered bone remains of lemurs:

1. 40% of the specimens of †*Palaeopropithecus*,
2. 33% of †*Pachylemur*, and
3. 29% of *Propithecus.*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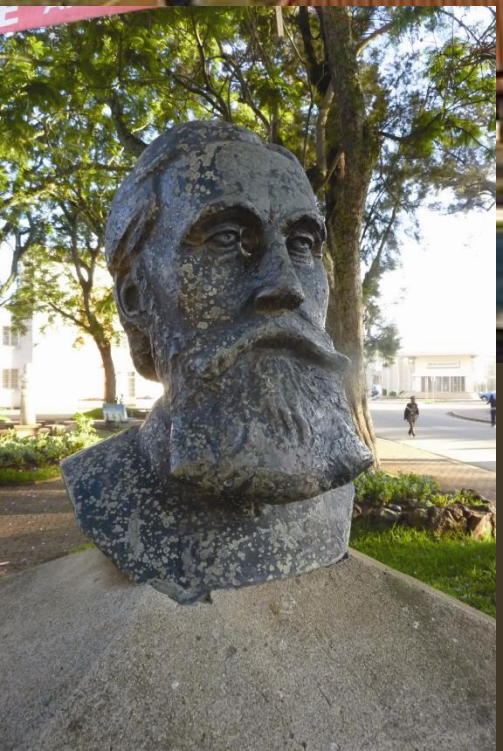
Ampasambazimba

- Of the 18 species of lemurs known from the site, eight are extinct.
- 40 radiocarbon dates are known from the site, most falling between 7000 to 2000 ybp.

- The most recent date from an extinct lemur (*Megaladapis*) is 1035 ybp.
- The earliest archeological evidence of people in the region is 1400 ybp.
- **CAUSE**: mixture of natural and human modifications.



Antsirabe region

- Four species of extinct lemurs are known from regional subfossil sites.
- 16 species of birds - 38% are extinct.
- Radiocarbon dates of giant extinct elephant birds - 4496 ybp.
- Radiocarbon dates of extinct dwarf hippos – 1800-1215 ybp.
- **CAUSE**: good evidence of climate change to about 3500 ybp, people arrive, and accentuate natural factors.

Conclusions

1) Madagascar has experienced considerable climatic changes in the past 15,000 years (natural),

2) There is some evidence that the island has exceptionally variable climates (natural),

Conclusions

3) Over the past millennia there have been rather dramatic changes to the ecosystems and land animals of Madagascar.

- In certain areas of the island, these changes are best explained by natural climatic shifts.
- In other areas, human modification of natural habitats resulted in important changes.
- Finally, at other sites a mixture of these factors best explain the ecological changes.