Rachel L. Jacobs & Andrea L. Baden
Stony Brook University

Madagascar’s Subfossils
What is a subfossil?
- Remains that are not completely mineralized
Western science first learned of giant mammals on Madagascar in the 17th century: Étienne de Flacourt

- “Vorompatrana”: elephant bird?
- “Tretretretre”: giant lemur?
  - “large, frightening, and solitary beast with a short and curly coat, rounded ear pinnae, flat face, long digits, and a short tail”
- “Mangarsahoc “ or “Song’aomby”: pygmy hippopotamus
  - “cow that isn’t a cow”
Subfossils

- First subfossils reported in a Western journal was in the 1800s: Alfred Grandidier
  - Ambohisatrana (Ambolisatra)
  - *Aepyornis, Hippopotamus, Paleopropithecus*
Subfossils

- Subfossil sites
  - Northern, western, southern Madagascar
  - Only as far back as 26,000 years ago
Elephant birds

- Palaeognathae
  - Ratitea
    - *Aepyornis* (1-4 species)
    - *Mullerornis* (3 species)
Elephant birds

- *Aepyornis maximus*
  - 4 meters tall (13 feet)
  - 400 kg (880 lbs)
  - Largest eggs known: 7 liters volume
Elephant birds

- **Aepyornis maximus**
  - 1,000-5,000 ya
  - Possible European sightings from 17th to 19th century
    - “A large bird which haunts the Ampatres and lays eggs like the ostriches; so that the people of these places may not take it, it seeks the most lonely places.”
Pygmy hippopotamus

- *Hippopotamus*
  - 3 species
  - Only ungulates on Madagascar
  - Cut marks on bones dating to 2,300 ya
  - Potential sightings up to 1976
Giant fossa

- Eupleridae
  - Cryptoprocta spelea
  - Only extinct Carnivoran known from Madagascar
Giant fossa

- *Cryptoprocta spelea*
  - First remains described in 1902
  - 30 kg (66 lbs)
    - >3 x the size of living fossa
  - Likely fed on some of the large extinct lemurs
## Subfossil lemur diversity

- **2,000 – 500 ya (300 ya)**

<table>
<thead>
<tr>
<th>Family</th>
<th># species</th>
<th>Body mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paleopropithecidae</td>
<td>8</td>
<td>9-200</td>
</tr>
<tr>
<td>Archaeolemuridae</td>
<td>3</td>
<td>13-27</td>
</tr>
<tr>
<td>Megaladapidae</td>
<td>3</td>
<td>38-76</td>
</tr>
<tr>
<td><em>Pachylemur</em></td>
<td>2</td>
<td>10-13</td>
</tr>
<tr>
<td><em>Daubentonia</em></td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
<td></td>
</tr>
</tbody>
</table>
Sloth lemurs

- Paleopropithecidae
  - *Mesopropithecus*
  - *Babakotia*
  - *Paleopropithecus*
  - *Archaeoindris*
Mesopropithecus
- 3 species
- 9-11 kg (20-25 lbs)
- Leaves, fruit, seeds
- Curved fingers
- Slow climber
Sloth lemurs

- **Babakotia**
  - 1 species
  - 15-18 kg (33-40 lbs)
  - Leaves, fruit, seeds, hard objects
  - Curved fingers
  - Slow climber
  - Suspensory
Sloth lemurs

- *Paleopropithecus*
  - 3 species
  - 25-55 kg (33-121 lbs)
  - Leaves, fruit, seeds
  - Hook-like hands and feet
  - Reduced hind foot
  - Highly suspensory
Sloth lemurs

- *Archaeoindris*
  - 1 species
  - 190-210 kg (420-460 lbs)
  - Leaves, fruit, seeds
  - Humerus longer than femur
  - Climbing and suspensory behavior
Sloth lemurs
Sloth lemurs
Paleopropithecidae

- 10-200 kg
- Highly folivorous
- Long arms relative to legs
- Slow vertical climbing and suspensory behavior
Monkey lemurs

- Archaeolemuridae
  - Archaeolemur
  - Hadropithecus
Monkey lemur

- *Archaeolemur*
  - 2 species
  - 11-16 kg (24-35 lbs)
  - Arms and legs similar in length
  - Arboreal and terrestrial quadruped
Monkey lemurs

- *Archaeolemur*
  - Robust skull and jaw
  - Large masticatory muscles
  - Broad spatulate incisors
  - Hard-object feeders
Monkey lemurs

- *Hadropithecus*
  - 1 species
  - 23 kg (50 lbs)
  - Arms and legs similar in length
  - Arboreal and terrestrial quadruped
Monkey lemurs

- *Hadropithecus*
  - Robust skull and jaw
  - Large masticatory muscles
  - Smaller incisors
  - Narrow gape
  - May have specialized on tubers
Monkey lemurs

- Archaeolemuridae
  - 11-23 kg: larger than any living species
  - Diets composed of hard objects/tubers
  - Arms and legs similar in length
  - At least some terrestrial behavior
Koala lemurs

- Megaladapidae
  - Megaladapis
Megaladapis

- 3 species
- 38-76 kg (84-168 lbs)
- Long arms relative to legs
- Enormous hands and feet
- Vertical clinger and climber
Koala lemurs

- *Megaladapis*
  - Crests on molars
  - No upper incisors
  - Long snout
  - Leafy diet
Koala lemurs
Subfossil lemurids

- *Pachylemur*
  - 2 species
  - 10-13 kg (22-29 lbs)
Subfossil lemurids

- *Pachylemur*
  - Resembles *Varecia*
  - Arms and legs similar in length
  - Slow arboreal quadruped
  - Less leaping
Subfossil lemurids

- *Pachylemur*
  - Dentally similar to *Varecia*
  - Fruit diet
Subfossil aye-ayes

- *Daubentonia robusta*
  - 13 kg (29 lbs)
Subfossil aye-ayes
Adaptive radiation of lemurs
Adaptive radiation of lemurs
Adaptive radiations

“...the diversification of species originating from a common ancestor to fill a wide variety of ecological niches. It occurs when a species gives rise...to numerous kinds of descendants that remain sympatric within a small geographic area...”
Adaptive radiations

“...the coexisting species tend to diverge in their use of ecological resources in order to reduce interspecific competition.”

e.g., Galapagos finches (Ecuador)
Lemur evolution

- Madagascar isolated: 80 mya
- Primates appear (in Eurasia & N. America): 65-55 mya
- Molecular clocks estimate lemurs arrived: 40-65 mya
- Madagascar isolates BEFORE the evolution of primates, how did they get there??
Rafting event?

- Cyclones
- Water currents
- Floating vegetal masses
  - e.g., worm lizards
Madagascar 65 mya

- Paleontological work in NW Madagascar
  - Deposits dating to the Late Cretaceous (65 mya)
Mahajanga Basin Project

Berivotra Study Area
Madagascar 65 mya

- *Majungasaurus crenatissimus*
  - Large theropod dinosaur
  - Ferocious carnivore
  - Top predator
Madagascar 65 mya

- *Majungasaurus crenatissimus*
  - Serrated teeth
Madagascar 65 mya

- *Majungasaurus crenatissimus*
  - Cannibal
Madagascar 65 mya

- *Masiakasaurus knopfleri*
  - Small theropod dinosaur
  - 1.8 m (6 ft)
  - Procumbent front teeth for grasping/spearing prey
Madagascar 65 mya

- *Rahonavis ostrami*
  - Bird-like dinosaur
  - Large claw on the second toe
Madagascar 65 mya

- *Simosuchus clarki*
  - < 1 m (2.5 ft)
  - Short snout
  - Short tail
  - Heavily armored (osteoderms)
Madagascar 65 mya

- Simosuchus clarki
  - Multicusped teeth
  - Herbivorous diet
Madagascar 65 mya

- *Beelzebufo ampinga*
  - 4 kg (8.8 lbs): larger than any living frog
**Madagascar 65 mya**

- *Beelzebufo ampinga*
  - 4 kg (8.8 lbs): larger than any living frog
  - May have eaten small dinosaurs
The fossil gap

65 million years

26,000 years