Looking for a Missing Link

Scientific American
Pp 4-19

Interpretive tools:
Principles of biology, ecology & culture

Evolutionary baggage:
Unpack ourselves to understand our past

Traditional classification

gorilla  chimp  bonobo  human

Traits of Last Common Ancestor?

Ramapithecus!

Biped = first hominid?!
15-8 mya

<table>
<thead>
<tr>
<th></th>
<th>Broad shoulders</th>
<th>Broad shoulders</th>
<th>Broad shoulders</th>
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<th>Broad shoulders</th>
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<tbody>
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<td>No tail</td>
<td>No tail</td>
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</tr>
<tr>
<td>hairy</td>
<td>hairy</td>
<td>hairy</td>
<td>hairy</td>
<td>hairy</td>
<td>less hairy</td>
</tr>
<tr>
<td>Large canine</td>
<td>large canine</td>
<td>Large canine</td>
<td>Large canine</td>
<td>Large canine</td>
<td>Small canine</td>
</tr>
<tr>
<td>Brain 300-500cc</td>
<td>Brain 300-500cc</td>
<td>Brain 300-500cc</td>
<td>Brain 300-500cc</td>
<td>Brain 1300-1500cc</td>
<td>Brain 1300-1500cc</td>
</tr>
<tr>
<td>Brachiator</td>
<td>Knuckle walk</td>
<td>Knuckle walk</td>
<td>Knuckle walk &amp; biped</td>
<td>Biped</td>
<td>Biped</td>
</tr>
<tr>
<td>Crushing molars</td>
<td>Crushing molars</td>
<td>Crushing molars</td>
<td>Crushing molars</td>
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<tr>
<td>Tools?</td>
<td>No tools</td>
<td>Tool user</td>
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<td>Tool user</td>
<td>Tool user</td>
</tr>
</tbody>
</table>

Groups?
Genotype!

Phenotype problematic = ambiguous evidence of inheritance
- E.g. convergent traits
Genetic relationship:
Molecular systematics
- Family trees based on genetic comparisons
  - Protein comparisons
  - DNA-DNA hybridization
  - Heating temperature for hybrid strands of DNA is proportional to % genetic base mismatches
  - Chromosome sequencing
  - Mitochondrial DNA sequencing

Genetic distance

<table>
<thead>
<tr>
<th></th>
<th>Bonobo</th>
<th>Chimp</th>
<th>Gorilla</th>
<th>Orangutan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonobo</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chimp</td>
<td>0.7%</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gorilla</td>
<td>2.3%</td>
<td>2.3%</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Orangutan</td>
<td>3.6%</td>
<td>3.6%</td>
<td>3.6%</td>
<td>-</td>
</tr>
<tr>
<td>Human</td>
<td>1.6%</td>
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<td>2.3%</td>
<td></td>
</tr>
</tbody>
</table>

Genetic distance

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<tr>
<th></th>
<th>Bonobo</th>
<th>Chimp</th>
<th>Gorilla</th>
<th>Orangutan</th>
<th>Humans</th>
<th>Primates</th>
<th>Felines</th>
<th>Canines</th>
<th>Birds</th>
<th>Amphibia</th>
<th>Reptalia</th>
<th>Invertebrates</th>
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</thead>
<tbody>
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<td>Bonobo</td>
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</tr>
<tr>
<td>Humans</td>
<td>1.6%</td>
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<td>2.3%</td>
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Trees based on MtDNA
**Genotype & Phenotype**

Molecular systematics
- Human genome project
- Chimp genome project
  - Individual differences in genes may code for critical Amino Acid differences, coding for different proteins
  - E.g. immune system genes
  - E.g. early brain development
  - Smell, hearing
  - Long bone growth
  - Hairiness
  - Digestion

**Calibrating DNA splits**

When? How old is missing link?

Proconsul ~ 22 mya

**DNA prediction:**
How old should “Missing Link” between chimps and humans be?

<table>
<thead>
<tr>
<th>DNA similarity</th>
<th>Age (mya) 1</th>
<th>Age (mya) 2</th>
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</thead>
<tbody>
<tr>
<td>4.8%</td>
<td>22 million</td>
<td>7.2%</td>
</tr>
<tr>
<td>1.6%</td>
<td>X million</td>
<td>1.6%</td>
</tr>
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</table>

7.33 mya
4.89 mya

**Ramapithecus!**

Biped = first hominid ?!
15-8 mya

**DNA mismatch?**

Ramapithecus ~ 10 mya?
**Ramapithecus**

First hominid?
- Older than expected

What to do?
- Find more fossils!

**Sivapithecus**

A big ape!

Ancestor of Orangutan

**2 Siwaliks hominids?**

One ape species!

DNA = branching pattern

<table>
<thead>
<tr>
<th>Species</th>
<th>Extinct (mya)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proconsul</td>
<td>~ 22</td>
</tr>
<tr>
<td>Sivapithecus</td>
<td>~ 10</td>
</tr>
<tr>
<td>Human</td>
<td>5-7</td>
</tr>
<tr>
<td>Chimpanzee</td>
<td></td>
</tr>
<tr>
<td>Gorilla</td>
<td></td>
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<tr>
<td>Orangutan</td>
<td></td>
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<tr>
<td>Gibbon</td>
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<tr>
<td>OW Monkey</td>
<td></td>
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</tbody>
</table>

Sexual dimorphism

DNA = branching pattern
a “missing link”?  

Search for missing link:  

When?  
– Probably 5-7 million years ago  
  - Based on DNA + fossils  

Where?  
– Africa  
  - Based on DNA + comparative anatomy  

Feet first?  
small-brained biped

Walking the Walk:  
interpreting fossils  

Comparative anatomy  
Bio-mechanics  

Chimps on 2 legs
Danger of Collapse

Unstable!

Bipedal challenge

How to keep your balance on one foot?
- Avoid collapse to unsupported side

Hip muscles

Muscle contracts

Leg swings back

Leg swings out
Bipedal challenge

How to keep your balance on one foot?

– Avoid collapse to unsupported side