Sequence Analysis '17 lecture 21

- Tree of Life

OneZoom  
tolweb
Lineaus Classification system as I learned it c.1976

- kingdom
- phylum
- class
- order
- family
- genus
- species
All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs - extinct.
OneZoom
onezoom.org

"Google-map for phylogeny"

Interactive Fractal Info-Graphic (IFIG)

Exercise 13: explore Tree of Life

- www.onezoom.org
- Start from the root of the tree
  - Find homo sapiens. Back out.
  - When do the following first appear (mya)
    - two eyes
    - jaw
    - four limbs
    - five fingers
    - no tail
Species characteristic may be correlated with ancestry, or not.

- **Paraphyletic** -- a classification that does not contain all of the descendents. “Reptile” is does not include birds which descended from reptiles.

- **Monophyletic** -- a classification that includes all descendents of a common ancestor.
Polytomy versus dichotomy

- **dichotomic**
  - Branch order unknown

- **polytomic**
  - Branch order unknown
HW6
HW7
Term Project
Atlantic bluefin tuna: *thunnus thynnus*

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Phylum</th>
<th>Class</th>
<th>Order</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANIMALIA</td>
<td>CHORDATA</td>
<td>ACTINOPTERYGII</td>
<td>PERCIFORMES</td>
<td>SCOMBRIDAE</td>
<td>THUNNUS</td>
<td>THYNNUS</td>
</tr>
<tr>
<td>animal</td>
<td>notochord</td>
<td>ray-finned fishes</td>
<td>perch-like</td>
<td>mackerels</td>
<td>tuna</td>
<td>bluefin</td>
</tr>
</tbody>
</table>

Critically Endangered ([IUCN 2.3](http://www.iucnredlist.org/search))
Tuna MSA
Mitochondrial cytochrome B (DNA) -- one of the most widely sequenced genes

Are there enough differences here?
The classification “bluefin” is paraphyletic, since the common ancestor of N. Atlantic Bluefin and Pacific Bluefin includes a non-bluefin tuns, the albacore.

**Unrooted trees. Bootstrapped on subtree.**
Does the consensus tree match species characteristics?
## Tuna features

<table>
<thead>
<tr>
<th>feature</th>
<th>tree result</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>size and shape</td>
<td>monophyletic</td>
<td>1</td>
</tr>
<tr>
<td>tropical versus sub-tropical</td>
<td>paraphyletic</td>
<td></td>
</tr>
<tr>
<td>number of gill rakers</td>
<td>monophyletic</td>
<td></td>
</tr>
<tr>
<td>number of dorsal spines</td>
<td>monophyletic</td>
<td></td>
</tr>
<tr>
<td>existence/number of anal spines</td>
<td>monophyletic</td>
<td></td>
</tr>
<tr>
<td>coloring</td>
<td>paraphyletic</td>
<td>1</td>
</tr>
<tr>
<td>body shape</td>
<td>monophyletic</td>
<td></td>
</tr>
<tr>
<td>caudal keels/shape</td>
<td>monophyletic</td>
<td></td>
</tr>
<tr>
<td>pelagic versus coastal</td>
<td>monophyletic</td>
<td></td>
</tr>
</tbody>
</table>
Turn on options bar. Show polytomies. Unconnected species are polytomic.

Term project step 1: find a polytomy.
Study the species…

**Boulenger’s caecilian**

“blind ones”, limbless, serpentine amphibians

Eukaryota
Metazoa
Bilateria
Chordata
Craniata
Vertebrata
Gnathostomata
Teleostomi
Tetrapoda
Amphibia
Gymnophiona
Herpetidae
Boulengerula

Not a worm. Has a tiny skull.

Drawing of extinct ancestor Eocaecilia micropodia.
Images of Boulengerula

Images help.
Align the sequences.

Informative sequences and columns

DIYVG
NIYVG
DVYID
DVFVS
DVFIS
Make a PhyML tree. Compare it to the OneZoom tree.

PhyML tree

OneZoom tree

splits: nt,cuf, ntf,cu

splits: tu,cfn, tun,cf

0 similarity!
Compare your trees using maximum parsimony.
Try nearest neighbor interchange.

Total mutations=7

Total mutations=9
Try nearest neighbor interchange.

Total mutations=7

Total mutations=8
Genus Boulengerula – Boulenger's Caecilians

Make sense of the tree given species differences, if possible!

<table>
<thead>
<tr>
<th>species</th>
<th>region</th>
<th>habitat</th>
<th>features</th>
</tr>
</thead>
<tbody>
<tr>
<td>taitana</td>
<td>Kenya*</td>
<td>degraded former forest*</td>
<td>endangered</td>
</tr>
<tr>
<td>uluguruensis</td>
<td>Tanzania</td>
<td>moist lowland forests</td>
<td></td>
</tr>
<tr>
<td>fischeri</td>
<td>Rwanda</td>
<td>moist montane forests</td>
<td></td>
</tr>
<tr>
<td>chagawensis</td>
<td>Kenya, Malawi</td>
<td>tropical dry forests</td>
<td></td>
</tr>
<tr>
<td>niedeni</td>
<td>Kenya*</td>
<td>agricultural areas*</td>
<td>Critically endangered</td>
</tr>
</tbody>
</table>

*monophyletic characteristics

http://research.amnh.org/vz/herpetology/amphibia