Activity: Splitting and Lumping

Introduction: Today the class will be exploring the concept of 'lumpers vs. splitters' through the analysis of four hominin crania. Students will play the part of the paleoanthropologist and will help determine whether all four specimens should be grouped together as one genus or separately as two different genera.

Before Getting Started:

- Have students review the first three topics covered in the teaching materials associated with Module 2.
- Make sure students have access to 3D prints/3D pdfs of *Paranthropus aethiopicus*, *Paranthropus boisei, Australopithecus africanus,* and *Australopithecus sediba*. If these prints/pdfs are labeled, please blind them using the following labels:
  Paranthropus aethiopicus = A
  Paranthropus boisei = B
  Australopithecus africanus = C
  Australopithecus sediba = D
- Print out the lab worksheets associated with this activity and make sure that one is available to every student.

Answers to Introductory Questions:

1. What is a phylogeny?

A diagram that depicts the lines of evolutionary descent of different species, organisms, or genes from a common ancestor or a way that paleontologists show the connections between different organisms and how they relate to one another.

2. Why do paleoanthropologists use phylogenies?

In order to better understand how we as humans evolved over time, it is important to understand our relationships with other hominins. Phylogenies help demonstrate this relationship.

3. What types of characteristics do paleoanthropologists look at when they are grouping different hominin fossils? (Hint: Think about what they look like).

Paleoanthropologists tend to focus on morphological differences (i.e. differences in shape) when they are grouping different fossils. Aspects like the shape and size of the skull, how large the teeth are, etc. can all help paleoanthropologists group the fossils into their various designations.

4. Why might two paleoanthropologists come up two different phylogenies despite looking at the same fossils?

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Two paleoanthropologists may come up with different phylogenies by looking at the same fossils because a lot of the interpretation of these fossils in subjective. The two paleoanthropologists may consider the value of a trait differently or could have different opinions of inter- vs. intragroup variation.

Answers to Part 1: Visual Assessment

Trait	A	B	C*	D
Is the face flat/dished or more rounded like modern humans?	Flat/dished face	Flat/dished face	More rounded like modern human	More rounded like modern human
Are the cheekbones big and flat or small and rounded?	Big and flat	Big and flat	Small and rounded	Small and rounded
Is the brow ridge prominent or reduced?	Prominent brow ridge	Prominent brow ridge	Reduced brow ridge	Reduced brow ridge
Is there post-orbital constriction present?	Yes (it is pinched behind the orbits)	Yes (it is pinched behind the orbits)	Slightly	Slightly
How large are the teeth?	N/A	Very large	Small	Medium
Is the skull more prognathic or orthognathic?	Prognathic (protruding midface)	Prognathic (protruding midface)	Orthognathic	Orthognathic
Is there a sagittal crest?	Sagittal crest present (flange at top of skull)	Sagittal crest present (flange at top of skull)	No	No
Is the cranium gracile or robust?	Robust	Robust	Gracile	Gracile

If you are using loner set 1 or 2 you will be looking at a more incomplete *Paranthropus boisei*. The .stl file/3D pdf of *Paranthropus boisei* currently on the

HETMP website feature a more complete specimen. This lab can be done with the more incomplete specimen, however, it may be beneficial to supplement the fragmentary *Paranthropus boisei* cranium with the newer 3D pdf.

1. Do any of the specimens share multiple traits in common? Which ones?

Specimens A and B share many traits in common. Specimens C and D also share many traits in common.

2. Paleoanthropologists often ascertain the 'relatedness' of different species based on how many traits they share in common. If that is the case, which of the specimens do you think are more likely to be more closely related to one another?

A and B will be more related to each other than they are to C and D. C and D will be more related to each other than they are to A and B.

Answers to Part 2: Splitters and Lumpers

1. Based on the criteria above, how would you group the specimens above? (Are they all different enough to warrant separate groups? Should they all be grouped together? Are there some groups that can be made within the set of four specimens?). Explain your justification

Correct answers include grouping all found specimens together in one group or grouping A and B together in one group while grouping C and D in another group.

2. Based on your answer to the previous question, would you be considered a lumper or a splitter? Why?

If they have one group then they would be considered a lumper. If they have two groups then they would be considered a splitter.

3. Many paleoanthropologists would group specimens A and B together and specimens C and D together. Which traits do you think that they would use to make this grouping?

Any of the traits in the above chart would work for this answer.

Answers to Part 3: Comparative Morphology and Adaptation

1. Based on the chart above, which of the four specimens have a prominent sagittal crest?

Specimens A and B have a sagittal crest.

2. Based on the information above, which of the specimens would have had more powerful chewing?

Specimens A and B because they would have been able to have larger chewing muscles.

3. Now look at the teeth of all of the specimens. Are they similar or different? (You can consult the chart above).

Specimens A and B have larger teeth.

4. Does the answer to question 3 make sense in relation to the answer to question 2? Why or why not?

It would make sense that larger chewing muscle attachment sites would be paired with larger teeth.

5. Two of the specimens given to you eat predominantly grasses, leaves, and fruits, while the other two predominately practiced hard/tough object feeding (grasses, sedges, tubers, etc.). Based on the morphology of the crania you analyzed, which specimens do you think had which diet?

Specimens A and B were hard object feeders while specimens C and D were not.

Final Questions:

1. Based on everything you have learned today, how would you group the four specimens? Did your answer change or stay the same from Part 2?

Answers will vary. Be sure that students can appropriately justify their taxonomy.

2. The postcranial skeletons (everything other than the skull) of these specimens are nearly indistinguishable. Does this impact your answer to the previous question? Why or why not?

Again, answers will vary. Students should be able to get a sense from this question that paleoanthropology is not an exact science and that there is a fair amount of interpretation. Is the cranial morphology more important than that of the postcrania? Are these specimens still different enough to warrant their own genera?

3. What are some of the challenges that paleoanthropologists might face in making these decisions?

Few number of fossils, they are usually fragmented, room for interpretation, etc.