Evolutionary Changes in Primates

As paleontologists discover fossils, they must determine whether they have discovered fossils of recent or early organisms. Upon discovery of a skull, a paleontologist must determine what kind of organism it is. Once he has determined if is a primate skull, he must determine whether it is of an ape or a human. Because evolutionary change has occurred in both groups, the skull could be of early or modern ape or early or modern human. Since humans and apes evolved along separate lines, certain physical characteristics can be used in an attempt to classify the fossil skull as belonging to either ape (early or modern), early human, or modern human. Techniques similar to the ones used in this investigation are used by anthropologists, paleontologists, and archeologists.

In this investigation, you are to examine skull diagrams of a gorilla, an early human, and a modern human. You are to measure or evaluate evolutionary changes that have occurred in the organisms.

Part A: Skull Characteristics and Relationships

1. Ratio of Face Area to Brain Area

Rectangles over the skulls in Figure 1 represent the area of the brain (upper rectangle) and face area (lower rectangle) of each skull. Determine the area of each rectangle by measuring the length and width in centimeters and multiplying the two measurements together. In Table 1, record the face and brain areas of the three skulls.

Determine the ratio of face area to brain area of each skull by dividing the brain area by the face area. Carry the divisions to two decimal places. Always use face area as one in the ratio. For example, a skull with a face area of 120 and a brain area of 50 has a face area to brain area ratio of 1 to 0.41. Record the ratios in the proper column of the table.

<table>
<thead>
<tr>
<th>Face area</th>
<th>120</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain area</td>
<td>50</td>
<td>0.41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Face area</th>
<th>120</th>
</tr>
</thead>
</table>

Ratio of Face Area to Brain Area = 1 to .41
Figure 2
2. Cranial Capacity

Measure the diameter of the circle in each skull in centimeters. Multiply the cranial diameters by 200. This gives a value equivalent to the cranial capacity (brain volume) in cubic centimeters (cm³). Record the cranial capacity of each skull in the table.

3. Jaw angle (Prognathism)

In front of each skull are two lines, one running parallel to the slope of the upper jaw and one running through the nose. These two lines are to be used for measuring how far the jaw protrudes forward. With a protractor, measure the outside angle formed by the two lines in each skull. Measure the angle toward the right. For example, the jaw angle in Figure 2 is 45°. Record the angles in the proper column of the table.

4. Lower Jaw Shape

The ratio between the distance across the jaw backs compared to the distance across the jaw fronts can be used to compare jaw shapes of the 3 jaws in Figure 3. Measure the distance across each jaw from one dot to the other on the back teeth. Measure the distance across each jaw using the dots on the front teeth. Record in the table the distances (in cm) for each jaw.

Determine the ratio between the distance across the back of the jaw to the distance across the front of the jaw for each skull. Use the distance across the back of the jaw as one in the ratios. Record the ratios in the proper column of the table.

Figure 2

Figure 3
5. Numbers and Types of Teeth

Count the number of teeth in each lower jaw in Figure 3. Count the number of each tooth type in each lower jaw. Record in the table the total number of teeth in each lower jaw and the number of each type. Use “M” for molar, “P” for premolar, “C” for canine, and “T” for incisor.

6. Sagittal Crest

A bony ridge running across the top of a skull for muscle attachment is called a sagittal crest. Indicate in the table whether a sagittal crest is absent or present in each skull.

7. Brow ridge (Supraorbital Ridge)

Directly above the eye sockets is a thick bony ridge. This ridge may be absent or present in a skull. Indicate in the table whether or not a brow ridge is present in each skull.

Part B: Interpretation of Data

Use the following information to help you evaluate your recorded data and answer the questions in Formulating Generalizations.

1. Ratio of Face Area to Brain Area

A reduction in face area compared to brain area is a trait of modern humans.

2. Cranial Capacity

An increase in brain size as measured by cranial capacity is characteristic of more complex organisms. Modern humans have the largest cranial capacity of all closely related primates.

3. Jaw Angle

Jaw angle increase toward 90° is a trait of modern humans. Less of a protruding jaw angle is characteristic of more complex organisms.
4. Lower Jaw Shape

Gorillas have a jaw in which both sides are parallel to one another. The have a ratio of 1:1 for back to front distance. Modern humans have more V-shaped jaw with a ratio of back to front distance of greater than 1:1.

5. Number and Types of Teeth

Adult modern humans, Paranthropus, and gorillas all have similar patterns in terms of numbers and types of teeth.

6. Sagittal Crest

This bony ridge is associated with heavy temporal muscles used to move the lower jaws. Reduction in size of the lower jaw in modern humans has resulted in a corresponding reduction in the size of this ridge.

7. Brow Ridge

Loss of this ridge is a trait of modern humans.

**NOTE:** Most anthropologists believe that Paranthropus evolved along with gorillas and humans. It cannot and should not be assumed that the progression of evolutionary change was from gorilla to Paranthropus to modern human. Paranthropus is used here to illustrate many traits believed to have been associated with early humans. All three animals probably evolved from some common primate ancestor. Use Paranthropus traits only as a means of distinguishing among modern humans, early humans, and gorillas.