

EVOLUTIONARY CHANGES IN PRIMATES

30

30-15

When paleontologists discover fossils, they determine whether they have discovered fossils of recent or early organisms. They then determine the kinds of organisms the fossils represent. If a skull were discovered and determined to be a primate skull, the next step would be to 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. Because 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 will

- examine gorilla, early human, and modern human skull diagrams.
- measure or observe and record specific skull structures and features.
- evaluate evolutionary changes that have occurred in these organisms.

Materials

metric ruler
protractor

Procedure

Part A. Skull Characteristics

Brain Area Compared To Face Area

The rectangles over the skulls in Figure 30-1 represent the area of the brain (upper rectangle) and face (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.

- Record in lines one and two of Table 30-1 the brain and face areas for the gorilla, *Paranthropus*, and modern human skulls.

A comparison can be made as to whether the brain area is larger or smaller than the face area.

- Compare the brain and face areas and complete lines 3, 4, and 5 of Table 30-1.

Cranial Capacity

- Measure the diameter in centimeters of the circle in each skull. The diameter is the distance across the exact center of each circle.

- Multiply the cranial diameters by 200 cm^3 . This gives the cranial capacity (brain volume) in cubic centimeters.

- Record the cranial capacity for each skull in line 6 of Table 30-1.

NOTE: This method of measuring cranial capacity differs from the method used when an intact skull is available.

Jaw Angle (Prognathism)

In front of each skull are two heavy 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.

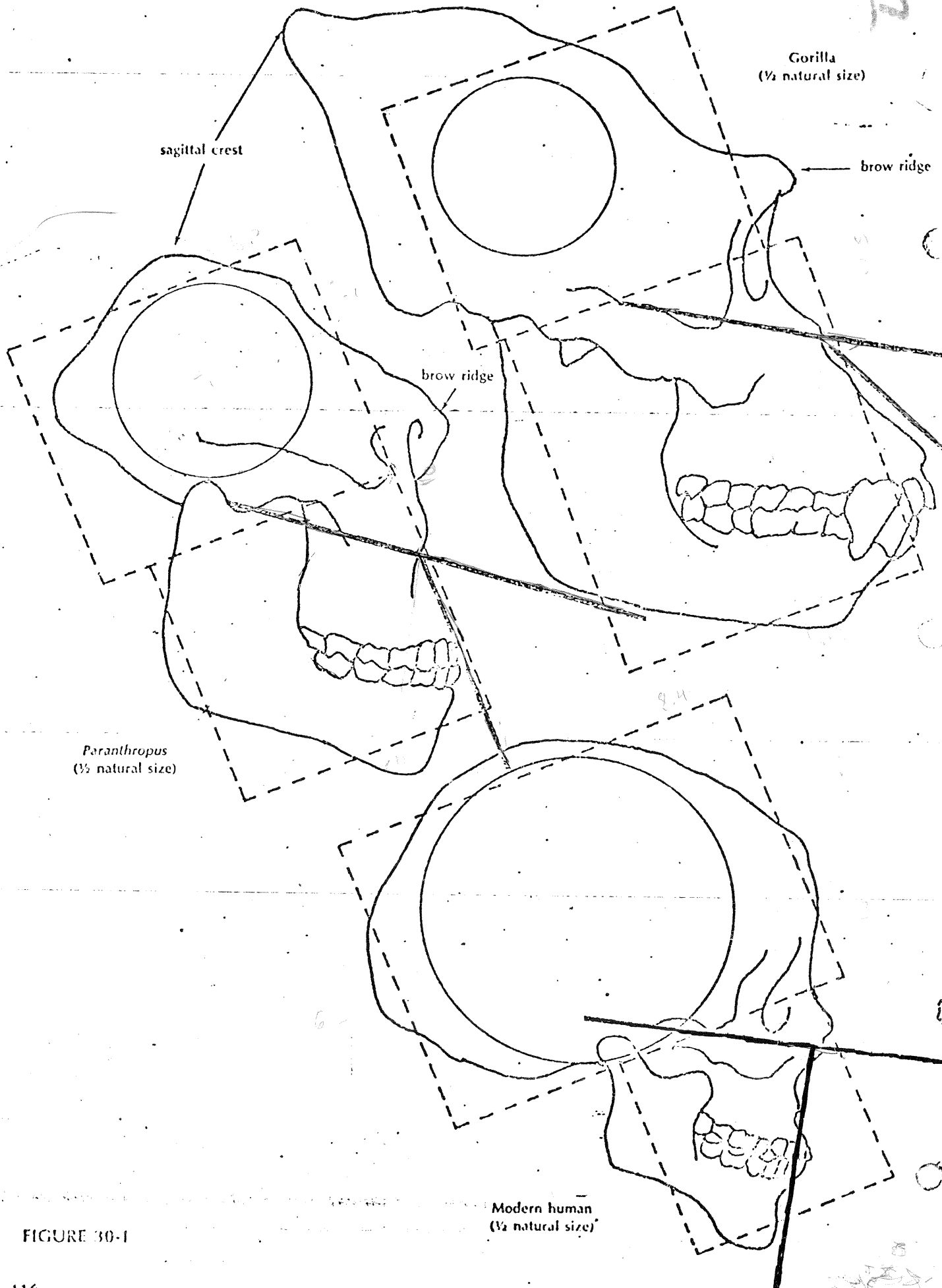


FIGURE 30-1

Modern human
(1/2 natural size)

- With a protractor, measure the outside angle formed by the two lines in each skull (the angle toward the right).

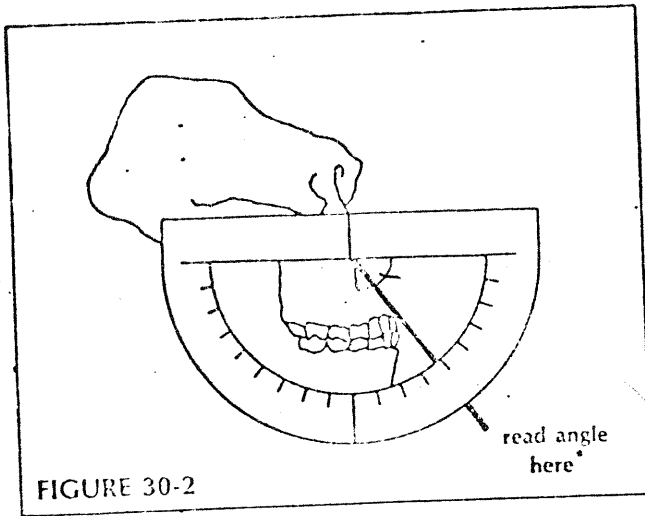


FIGURE 30-2

- Place the protractor onto each skull as shown in Figure 30-2. Read the angle by using the outside scale on the protractor. The angle is read where the lower skull line crosses the protractor.

- Record the angles in line 7 of Table 30-1. An angle of less than 90° means that the lower jaw sticks out in front of the nose. An angle of 90° means that the lower jaw does not stick out in front of the nose. Complete line 8 of Table 30-1.

Sagittal Crest

A bony ridge running across the top of a skull for muscle attachment is called a sagittal crest.

- Indicate in line 9 of Table 30-1 whether a sagittal crest is absent or present in each skull. Refer to Figure 30-1.

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 line 10 of Table 30-1 whether or not a brow ridge is present.

Numbers and Types of Teeth

Use the diagrams on page 116 for this part of the investigation.

- Count and record the number of teeth for each lower jaw in line 11 of Table 30-1.

- Count the number of each tooth type for each lower jaw. "M" on Figure 30-3 is for molar, "P" is for premolar, "C" is for canine, and "I" is for incisor.

- Record in lines 12 to 15 of Table 30-1 the tooth type totals.

Lower Jaw Shape

The distance across the jaw backs compared to the distance across the jaw fronts can be used to determine jaw shapes of the three organisms in Figure 30-3 on page 119.

- Measure in centimeters the distance across each jaw from one dot to the other on the back molar teeth.

- Measure the distance across each jaw using the dots on the front pre-molar teeth.

- Record the distances for each jaw in lines 16 and 17 of Table 30-1. The distance across the back and front of a lower jaw will help to determine if the jaw is U- or V-shaped.

If the distance across the back of the jaw is the same as the distance across the front of the jaw, the jaw has a U shape. If the distance across the back is greater than the distance across the front, the jaw has a V shape. Complete lines 18, 19, and 20 of Table 30-1.

Part B. Interpretation of Data

The following information will help you evaluate your recorded data and answer the questions in the Analysis.

Brain Area Compared to Face Area

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

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.

Jaw Angle

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

TABLE 30-1. COMPARISON OF GORILLA, *PARANTHROPUS*, AND MODERN HUMAN SKULLS

	GORILLA	<i>PARANTHROPUS</i>	MODERN HUMAN
1. Face area			
2. Brain area			
3. Is brain area smaller than face area?			
4. Is brain area larger than face area?			
5. Is brain area 3 times larger than face area?			
6. Cranial capacity in cm ³			
7. Jaw angle			
8. Does lower jaw stick out in front of nose?			
9. Sagittal crest present			
10. Brow ridge present			
11. Number of teeth in lower jaw			
12. Number of molars in lower jaw			
13. Number of premolars in lower jar			
14. Number of canines in lower jaw			
15. Number of incisors in lower jaw			
16. Distance across back of jaw			
17. Distance across front of jaw			
18. Is distance across front and back of jaw the same?			
19. Is lower jaw U-shaped?			
20. Is lower jaw V-shaped?			

Sagittal Crest

This bony ridge is associated with heavy temporal muscles used to move the lower jaws. As the lower jaw gets smaller, so does the sagittal crest.

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 humans. *Paranthropus* is used here to illustrate many traits believed to have been associated with early

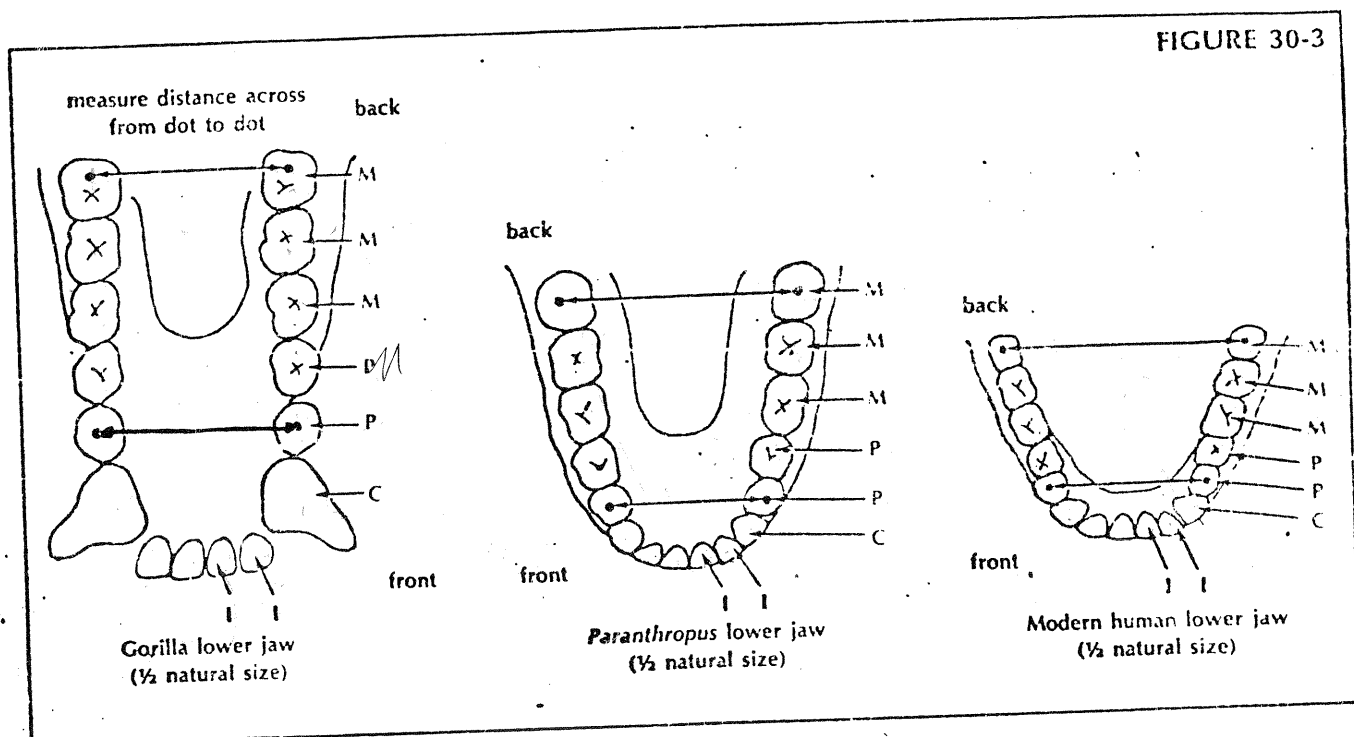
humans. All three animals probably evolved from some common primate ancestor. Use *Paranthropus* traits only as a means of distinguishing among modern humans, early humans, and gorillas.

Numbers and Types of Teeth

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

Lower Jaw Shape

Gorillas have a jaw in which both sides are parallel to one another. They have a U-shaped jaw. Modern humans have a V-shaped jaw.



Analysis

- (a) What change in brain area has occurred when gorilla is compared to modern humans? _____

(b) What change in face area has occurred when gorilla is compared to modern humans? _____

(c) Which animal in this investigation shows the largest brain area and smallest face area? _____

2. How does the cranial capacity of *Paranthropus* compare to that of the

(a) gorilla? _____

(b) modern human? _____

3. How do the lower jaws of these three animals compare in regard to

(a) number of teeth? _____

(b) number of molars? _____

(c) number of premolars? _____

(d) number of canines? _____

(e) number of incisors? _____

(f) jaw shape? _____

4. How many traits are similar when comparing

(a) gorilla to *Paranthropus*? _____

(b) *Paranthropus* to modern human? _____

(c) gorilla to modern human? _____

5. Based on your answer to question 4, does a modern human seem to be closer in evolutionary

development to gorilla or *Paranthropus*? _____

6. Based on your answer to question 4, does *Paranthropus* seem to be rather close in evolutionary

development to both gorilla and modern human? _____

7. Suppose you find a distorted fossil jawbone and note that there are 16 teeth in it. Explain why this information may or may not be helpful in determining whether the fossil is from a modern or early

human or gorilla. _____

8. Suppose you find a distorted jawbone with most of the teeth missing. The canine teeth, however, are present and appear to be quite large. Which animal might this jaw be from? _____

Explain. _____

9. Suppose you find only the top portion of a skull. No sagittal crest seems to be present, nor is there any evidence that one may have ever been present. Which animal might this skull be from? _____

Explain. _____

10. Suppose you find a skull with 22 teeth. Might this skull be from a primate? _____

Explain. _____