An Overview of the Primates

OUTLINE

Introduction
Primate Characteristics
Primate Adaptations
Evolutionary Factors
Geographical Distribution and Habitats
Diet and Teeth
Locomotion
Primate Classification
A Survey of the Living Primates
Lemurs and Lorises
Tarsiers
Anthropoids (Monkeys, Apes, and Humans)
Hominoids (Apes and Humans)
Humans
Endangered Primates
The Bushmeat Crisis
Mountain Gorillas at Great Risk
Focus Questions

What are the major characteristics of primates?

Why are humans considered primates?

Introduction

Chimpanzees aren’t monkeys. Neither are gorillas and orangutans. They’re apes, and even though most people think they’re basically the same, they aren’t. Yet, how many times have you seen a greeting card or advertisement with a picture of a chimpanzee and a phrase that goes something like, “Don’t monkey around”? Or maybe you’ve seen people at zoos making fun of captive primates. While these things might seem trivial, they aren’t, because they show how little most people know about our closest relatives. This is unfortunate, because by better understanding these relatives, we can learn a great deal about ourselves. Also, we need this knowledge if we want to save the many primate species that are now critically endangered.

One way to better understand any organism is to compare its anatomy and behavior with the anatomy and behavior of other, closely related species. This comparative approach helps explain how and why physiological and behavioral systems evolved as adaptive responses to various selective pressures throughout the course of evolution. This statement applies to human beings just as it does to any other species. So if we want to identify the components that have shaped the evolution of our species, a good starting point is to compare ourselves with our closest living relatives, the approximately 230 species of nonhuman primates (prosimians, monkeys, and apes). (Groves, 2001b, suggests that there may be as many as 350 primate species.)

This chapter describes the physical characteristics that define the order Primates; gives a brief overview of the major groups of living primates; and introduces some methods of comparing living primates through genetic data. (For a comparison of human and nonhuman skeletons, see Appendix A.) But before we go any further, we again want to call attention to a few common misunderstandings about evolutionary processes.

Evolution isn’t a goal-directed process. Therefore, the fact that lemurs and lorises evolved before anthropoids doesn’t mean that they “progressed,” or “advanced,” to become anthropoids. Living primate species aren’t in any way “superior” to their predecessors or to one another. Consequently, discussions of major groupings of contemporary nonhuman primates don’t imply that any of these groups is superior or inferior to any other group. Each lineage or species has come to possess unique qualities that make it better suited to a particular habitat and lifestyle. Given that all living organisms are “successful” results of the evolutionary process, it’s best to completely avoid using such loaded terms as superior and inferior. Finally, you shouldn’t make the mistake of thinking that contemporary primates (including humans) necessarily represent the final stage or apex of a lineage. Actually, the only species that represent final evolutionary stages of particular lineages are the ones that become extinct.

Primate Characteristics

All primates share many characteristics with other mammals. Some of these basic mammalian traits are body hair; a relatively long gestation period followed by live birth; mammary glands (thus the term mammal); different types of teeth (incisors, canines,
Primate Characteristics

premolars, and molars); the ability to maintain a constant internal body temperature through physiological means, or *endothermy*; increased brain size; and a considerable capacity for learning and behavioral flexibility. Therefore, to differentiate primates, as a group, from other mammals, we need to describe those characteristics that, taken together, set primates apart.

Identifying single traits that define the primate order isn’t easy because compared to many mammals, primates have remained quite *generalized*. That is, primates have retained many ancestral mammalian traits that some other mammals have lost over time. In response to particular selective pressures, many mammalian groups have become increasingly *specialized*, or derived. For example, through the course of evolution, horses and cattle have undergone a reduction of the number of digits (fingers and toes) from the ancestral pattern of five to one and two, respectively. Moreover, these species have developed hard, protective coverings over their feet in the form of hooves (Fig. 6-1a). This limb structure is adaptive in prey species, whose survival depends on speed and stability, but it restricts them to only one type of locomotion. Moreover, limb function is limited entirely to support and movement, while the ability to manipulate objects is completely lost.

Primates can’t be defined by one or even a few traits they share in common because they aren’t so specialized. Therefore, anthropologists have drawn attention to a group of characteristics that, taken together, more or less typify the entire primate order. But these are a set of *general* tendencies that aren’t equally expressed in all primates. In addition, while some of these traits are unique to primates, many others are retained primitive mammalian characteristics shared with other mammals. So the following list is meant to give an overall structural and behavioral picture of the primates in general, and it emphasizes the characteristics that tend to set primates apart from other mammals. Concentrating on certain ancestral mammalian traits along with more specific derived ones has been the traditional approach of *primatologists*, and it’s still used today. In their limbs and locomotion, teeth and diet, senses, brain, and behaviors, primates reflect a common evolutionary history with adaptations to similar environmental challenges, mostly as highly social, arboreal animals.

**Figure 6-1**
(a) A horse’s front foot, homologous with a human hand, has undergone reduction from five digits to one. (b) While raccoons are capable of considerable manual dexterity and can readily pick up small objects with one hand, they have no opposable thumb. (c) Many monkeys are able to grasp objects with an opposable thumb, while others have very reduced thumbs. (d) Humans are capable of a “precision grip.” (e) Chimpanzees, with their reduced thumbs, are also capable of a precision grip, but they frequently use a modified form.

*specialized* Evolved for a particular function; usually refers to a specific trait (e.g., incisor teeth), but may also refer to the entire way of life of an organism.

*primatologists* Scientists who study the evolution, anatomy, and behavior of nonhuman primates. Those who study behavior in noncaptive animals are usually trained as physical anthropologists.
An Overview of the Primates

A. Limbs and locomotion
1. A tendency toward erect posture (especially in the upper body). Present to some degree in almost all primates, this tendency is variously associated with sitting, leaping, standing, and, occasionally, bipedal walking.
2. A flexible, generalized limb structure, which allows most primates to practice a number of locomotor behaviors. Primates have retained some bones (for example, the clavicle, or collarbone) and certain abilities (like rotation of the forearm) that have been lost in some more specialized mammals. Various aspects of hip and shoulder anatomy also provide primates with a wide range of limb movement and function (for example, walking on four or sometimes two limbs, climbing, and hanging by the hands or feet from tree branches. Thus, by maintaining a generalized locomotor anatomy, primates aren’t restricted to one form of movement, such as quadrupedalism.
3. Hands and feet with a high degree of prehensility (grasping ability). All primates use their hands, and frequently their feet, to grasp and manipulate objects (Fig. 6-1b through e). This is variably expressed and is enhanced by a number of characteristics, including:
   a. Retention of five digits on hands and feet. This characteristic varies somewhat throughout the order, with some species showing reduction or absence of the thumb or second digit (first finger).
   b. An opposable thumb and, in most species, a divergent and partially opposable big toe. Most primates are capable of moving the thumb so that it comes in contact (in some fashion) with the second digit or the palm of the hand (see Fig. 6-1c through 6-1e).
   c. Nails instead of claws. This characteristic is seen in all primates except some New World monkeys. All prosimians also have a claw on one digit.
   d. Tactile pads enriched with sensory nerve fibers at the ends of digits. This enhances the sense of touch.

B. Diet and teeth
1. Lack of dietary specialization. This is typical of most primates, who tend to eat a wide assortment of food items. In general, primates are omnivorous.
2. A generalized dentition. The teeth aren’t specialized for processing only one type of food, a pattern related to the lack of dietary specialization.

C. The senses and the brain. Primates, especially diurnal ones, rely heavily on vision and less on the sense of smell. This emphasis is reflected in evolutionary changes in the skull, eyes, and brain.
1. Color vision. This is a characteristic of all diurnal primates. Nocturnal primates don’t have color vision.
2. Depth perception. Stereoscopic vision, or the ability to perceive objects in three dimensions, is made possible through a variety of mechanisms, including:
   a. Eyes positioned toward the front of the face (not to the sides). This provides for overlapping visual fields, or binocular vision (Fig. 6-2).
   b. Visual information from each eye transmitted to visual centers in both hemispheres of the brain. In nonprimate mammals, most optic nerve fibers cross to the opposite hemisphere through a structure at the base of the brain. In primates, about 40 percent of the fibers remain on the same side, so that each hemisphere receives information from both eyes (see Fig. 6-2).
   c. Visual information organized into three-dimensional images by specialized structures in the brain itself. The capacity for stereoscopic vision depends on overlapping visual fields and on each hemisphere of the brain receiving visual information from both eyes.
3. Decreased reliance on the sense of smell (olfaction). This trend is expressed in an overall reduction in the size of olfactory structures in the brain (see next page).

prehensility  Grasping with the hands and, in many primates, also the feet.

omnivorous  Having a diet consisting of many kinds of foods, such as plant materials (seeds, fruits, leaves), meat, and insects.

diurnal  Active during the day.

nocturnal  Active during the night.

stereoscopic vision  The condition whereby visual images are, to varying degrees, superimposed on one another. This provides for depth perception, or the perception of the external environment in three dimensions. Stereoscopic vision is partly a function of structures in the brain.

binocular vision  Vision characterized by overlapping visual fields provided for by forward-facing eyes. Binocular vision is essential to depth perception.

hemispheres  The two halves of the cerebrum that are connected by a dense mass of fibers. (The cerebrum is the large rounded outer portion of the brain.)
Corresponding reduction of the entire olfactory apparatus has also resulted in decreased size of the snout. In some species, such as baboons, the large muzzle isn’t related to olfaction, but to the presence of large teeth, especially the canines (Fig. 6-3).

4. Expansion and increased complexity of the brain. This is a general trend among placental mammals, but it’s especially true of primates (Fig. 6-4). In primates, this
expansion is most evident in the visual and association areas of the neocortex (portions of the brain where information from different sensory modalities is integrated).

D. Maturation, learning, and behavior
1. A more efficient means of fetal nourishment, longer periods of gestation, reduced numbers of offspring (with single births the norm), delayed maturation, and longer life span.
2. A greater dependence on flexible, learned behavior. This trend is correlated with delayed maturation and longer periods of infant and childhood dependency on at least one parent. As a result of both these trends, parental investment in each offspring is increased, so that although fewer offspring are born, they receive more intense rearing.
3. The tendency to live in social groups and the permanent association of adult males with the group. Except for some nocturnal species, primates tend to associate with other individuals. The permanent association of adult males with the group is uncommon in most mammals but widespread in primates.
4. The tendency toward diurnal activity patterns. This is seen in most primates; only one New World monkey species and some prosimians are nocturnal.

Primate Adaptations

In this section, we’ll consider how primate anatomical traits evolved as adaptations to environmental circumstances. It’s important to remember that the term environmental circumstances refers to several interrelated variables, including climate, diet, habitat (such as woodland, grassland, forest), and predation.

EVOLUTIONARY FACTORS

Traditionally, the suite of characteristics shared by primates has been explained as the result of adaptation to arboreal living. While other placental mammals were adapting to various ground-dwelling lifestyles and even marine environments, the primates found their adaptive niche in the trees. Some other mammals were also adapting to arboreal living, but while many of them nested in trees, they continued to feed on the
Primate Adaptations

ground. But throughout the course of evolution, primates increasingly found food (leaves, seeds, fruits, nuts, insects, birds’ eggs, and small mammals) in the branches themselves. Over time, this dietary shift enhanced a general trend toward increased omnivory; and this trend in turn led to the retention of the generalized dentition we see in primates today.

This adaptive process is also reflected in how heavily primates rely on vision. In a complex, three-dimensional environment with uncertain footholds, color vision and depth perception are, to say the least, extremely beneficial. Grasping hands and feet also reflect an adaptation to living in the trees. Obviously, grasping hands aren’t essential to climbing, as many animals (such as cats, squirrels, and raccoons) demonstrate quite effectively. Nevertheless, most early primates adopted a technique of grasping branches with prehensile hands and feet (and tails in some species), and grasping abilities were further enhanced with the appearance of flattened nails instead of claws.

It has also been suggested that primates became increasingly more dependent on vision as a result of hunting small prey (Cartmill, 1972, 1992). This explanation is based on the fact that highly visual predators like cats and owls have eyes positioned at the front of the face. Moreover, early primates may not have even been arboreal. Instead, they may have begun to exploit shrubs after the appearance of flowering plants and only later moved into the trees (Sussman, 1991). The appearance of flowering plants certainly opened up entire new econiches and eventually provided foods such as nectar, fruits, berries, and insects, all of which could be exploited by animals that were adapting to a wide variety of foods and a generalized resource base. These hypotheses aren’t mutually exclusive. The complex of primate characteristics might well have begun in nonarboreal settings, but at some point, the primates did take to the trees, and that’s where most of them still live today.

GEOGRAPHICAL DISTRIBUTION AND HABITATS

With just a couple of exceptions, primates are found in tropical or semitropical areas of the New and Old Worlds. In the New World, these areas include southern Mexico, Central America, and parts of South America. Old World primates are found in Africa, India, Southeast Asia (including numerous islands), parts of China, and Japan (Fig. 6-5).

While the majority of primates are mostly arboreal and live in forest or woodland habitats, some Old World monkeys (for example, baboons) have adapted to life on the ground in places where trees are sparsely distributed. Moreover, the African apes (gorillas, chimpanzees, and bonobos) spend a lot of time on the ground in forested and wooded habitats. Nevertheless, no nonhuman primate is adapted to a fully terrestrial lifestyle, so they all spend some time in the trees.

DIET AND TEETH

Omnivory is one example of the overall lack of specialization in primates. Although the majority of primate species tend to emphasize some foods over others, most eat a combination of fruits, nuts, seeds, leaves, other plant materials, and insects. Many also get animal protein from birds and amphibians, and some occasionally kill and eat small mammals, including other primates. Others, such as African colobus monkeys and the leaf-eating monkeys (langurs) of India and Southeast Asia, have become more specialized and mostly feed on leaves. Such a wide array of choices is highly adaptive, even in fairly predictable environments.

Like the majority of other mammals, most primates have four kinds of teeth: incisors and canines for biting and cutting, and premolars and molars for chewing. Biologists use what’s called a dental formula to describe the number of each type of tooth a species
Figure 6-5
Geographical distribution of living nonhuman primates. Much original habitat is now very fragmented.
Primate Adaptations

Baboon species (throughout sub-Saharan Africa)

Bonobo species (throughout sub-Saharan Africa)

Chimpanzees and bonobos (across central Africa)

Mountain and lowland gorillas (western and central Africa)

Gibbons and siamangs (Southeast Asia, islands, and China)

Galagos (bush babies) (throughout sub-Saharan Africa)

Langur species (colobines) (Southeast Asia, and southern China)

Colobus species (throughout sub-Saharan Africa)

Lemurs (Madagascar)

Tarsier species (Mainland and islands of Southeast Asia)

Orangutans (Borneo and Sumatra)

Macaque species (North Africa, India, Southeast Asia, China, and Japan)

Cercopithecus species (throughout sub-Saharan Africa)

Loris species (Africa, India, and Southeast Asia)

Macaque species (North Africa, India, Southeast Asia, China, and Japan)

Lemurs (Madagascar)

Tarsier species (Mainland and islands of Southeast Asia)

Orangutans (Borneo and Sumatra)
An Overview of the Primates

CHAPTER 6

midline An anatomical term referring to a hypothetical line that divides the body into right and left halves.

cusps The bumps on the chewing surfaces of premolar and molar teeth.

morphology The form (shape, size) of anatomical structures; can also refer to the entire organism.

quadrupedal Using all four limbs to support the body during locomotion; the basic mammalian (and primate) form of locomotion.

macaques (muh-kakz) A group of Old World monkeys comprising several species, including theus monkeys. Most macaque species live in India, other parts of Asia, and nearby islands.

brachiation A form of locomotion in which the body is suspended beneath the hands, and support is alternated from one forelimb to the other; arm swinging.

Figure 6-6
The human maxilla (a) illustrates a dental formula of \( \frac{2.1.2.3}{2.1.2.3} \) characteristic of all Old World monkeys, apes, and humans. The Cebus maxilla (b) shows the \( \frac{2.1.3.3}{2.1.3.3} \) dental formula that is typical of most New World monkeys. (Not to scale.)

has in each quadrant of the mouth (Fig. 6-6). For example, all Old World anthropoids (monkeys, apes, and humans) have two incisors, one canine, two premolars, and three molars on each side of the midline in both the upper and lower jaws, for a total of 32 teeth. This is represented as a dental formula of

\[
\begin{align*}
2.1.2.3 & \text{ (upper)} \\
2.1.2.3 & \text{ (lower)}
\end{align*}
\]

The dental formula for a generalized placental mammal is 3.1.4.3 (three incisors, one canine, four premolars, and three molars). But primates have fewer teeth than this ancestral pattern because of an evolutionary trend toward fewer teeth in many mammal groups. Moreover, the number of each type of tooth varies among primate lineages. For example, in most New World monkeys, the dental formula is 2.1.3.3 (two incisors, one canine, three premolars, and three molars). In contrast, humans, apes, and all Old World monkeys all have a dental formula of 2.1.2.3; that is, they have one fewer premolar than most New World monkeys.

The lack of dietary specialization in primates is reflected in the lack of specialization in the size and shape of the teeth, because tooth form is directly related to diet. For example, carnivores typically have premolars and molars with high pointed cusps adapted for tearing meat (refer back to the wolf cranium in Fig. 4-4); but herbivores, such as cattle and horses, have molars with broad, flat surfaces suited to chewing tough grasses and other plant materials. Most primates have premolars and molars with low, rounded cusps, and this kind of molar morphology allows them to process most types of foods. So throughout their evolutionary history, the primates have developed a dentition adapted to a varied diet, and their ability to exploit many foods has contributed to their overall success during the last 50 million years.

LOCOMOTION

Almost all primates are, at least to some degree, quadrupedal, meaning they use all four limbs to support the body during locomotion. However, most primates use more than one form of locomotion, and they’re able to do this because of their generalized anatomy.

Although the majority of quadrupedal primates are arboreal, terrestrial quadrupedalism is fairly common and is typical of some lemurs, baboons, and macaques. The limbs of terrestrial quadrupeds are approximately the same length (Fig. 6-7a), but in arboreal quadrupeds, forelimbs are somewhat shorter (Fig. 6-7b).

Vertical clinging and leaping, another form of locomotion, is characteristic of many prosimians. As the term implies, vertical clingers and leapers support themselves vertically by grasping onto tree trunks with their knees and ankles tightly flexed (Fig. 6-7c). Forceful extension of their long hind limbs allows them to spring powerfully forward or backward.

Brachiation, or arm swinging, is another type of primate locomotion where the body is alternately supported under either forelimb (Fig. 6-7d). Because of anatomical modifications at the shoulder joint, apes and humans are capable of true brachiation. However, only the small gibbons and siamangs of Southeast Asia brachiate almost exclusively.

Species that brachiate tend to have arms that are longer than legs, a short stable lower back, long curved fingers, and shortened thumbs. Because these are traits seen in all the apes, it’s believed that although none of the great apes (orangutans, gorillas, bonobos,
Primate Adaptations

Some New World monkeys (for example, muriquis and spider monkeys) are called semibrachiators, as they practice a combination of leaping with some arm swinging. Also, some New World species enhance arm swinging and other suspensory behaviors by using a prehensile tail, which in effect serves as a grasping fifth hand. It’s important to mention that none of the Old World monkeys have prehensile tails.

Lastly, all the apes (to varying degrees) have arms that are longer than their legs, and some (gorillas, bonobos, and chimpanzees) practice a special form of quadrupedalism called knuckle walking. Because their arms are so long relative to their legs, instead of walking with the palms of their hands flat on the ground like some monkeys do, they support the weight of their upper body on the back surfaces of their bent fingers (Fig. 6-8).

Figure 6-7

Figure 6-8
Chimpanzee knuckle walking. Note how the weight of the upper body is supported on the knuckles and not on the palm of the hand.
Primate Classification

The living primates are commonly categorized into their respective subgroups as shown in Figure 6-9. This taxonomy is based on the system originally established by Linnaeus. (Remember that the primate order, which includes a diverse array of approximately 230 species, belongs to a larger group, the class Mammalia.)

As you learned in Chapter 5, in any taxonomic system, animals are organized into increasingly specific categories. For example, the order Primates includes all primates. But at the next level down, the suborder, primates have conventionally been divided into two large categories, Prosimii (all the prosimians: lemurs, lorises, and, customarily, the tarsi-ers) and Anthropoidea (all the monkeys, apes, and humans). Therefore, as you can see, the suborder distinction is more specific than the order.

At the suborder level, the prosimians are distinct, as a group, from all the other primates. This distinction is important because it makes the biological and evolutionary statement that all the prosimian species are more closely related to each other than they are to any of the anthropoids. Likewise, all anthropoid species are more closely related to one another than they are to the prosimians.

Traditionally, taxonomies were based on physical similarities between species and lineages. However, this approach isn’t foolproof because two species that resemble each other anatomically (for example, some New and Old World monkeys) may not be closely related at all. By looking only at physical characteristics, it’s possible to overlook the unknown effects of separate evolutionary history (see our discussion of homoplasy on p. 000). Fortunately, we’re able to overcome this problem through the use of genetic technologies. For example, since the mid-1990s, genetic research has shown that humans are even more closely related to the great apes (especially the African great apes) than previously thought. Primate classification is currently in a state of transition, mainly because of genetic evidence that has emerged over the past few years. In particular, the DNA-sequencing techniques used in the Human Genome Project have made it possible to make direct between-species comparisons of DNA sequences. This approach is called comparative genomics.

A complete draft sequence of the chimpanzee genome was completed in 2005 (The Chimpanzee Sequencing and Analysis Consortium, 2005), and it represents a major advance in human comparative genomics. But even prior to this, molecular anthropologists had already compared the sequences of a number of chimpanzee and human genes. For example, Wildman et al. (2003) compared nearly 100 human genes with their chimpanzee, gorilla, and orangutan counterparts and determined that humans are most closely related to chimpanzees and that their “functional elements,” or coding DNA sequences, are between 98.4 and 99.4 percent identical. These results are consistent with the findings of several other previous studies that suggested a genetic difference between chimpanzees and ourselves of approximately 1.2 percent (Chen et al., 2001). Other studies have substantiated these figures, but they’ve also revealed more variation in noncoding DNA segments and portions that have been inserted, deleted, or duplicated. So when the entire genome is considered, reported differences between chimpanzees and humans range from 2.7 percent (Cheng et al., 2005) to 6.4 percent (Demuth et al., 2006).

Genetic similarities and fossil evidence together suggest that humans and chimpanzees last shared a common ancestor around 6–8 mya. These facts have caused many primatologists to consider changing how they classify the hominoids (Goodman et al., 1998; Wildman et al., 2003). Most biological anthropologists now support placing all the great apes in the family Hominidae along with humans. Traditionally, the great apes have been placed in a separate family from ourselves. But including the African great apes in the same family as humans reflects the fact that they are even more closely related to us than was previously thought (see Fig. 6-9 and At a Glance, p. 130).

coding DNA sequences DNA sequences that code for the production of a protein.

noncoding DNA sequences Sequences that don’t code for identifiable proteins but in many cases produce molecules that influence the actions of coding sequences. (The terminology is somewhat confusing. Currently, geneticists use the term coding to refer to sequences that code for proteins that are fairly easy to detect. Noncoding currently refers to sequences that seem not to have any function or that code for proteins that regulate the actions of other genes.)
Primate Classification

**ORDER**

**SUBORDER**
- Prosimii (all prosimians: lemurs, lorises, galagos, and tarsiers)
  - Anthropoidea (monkeys, apes, and humans)
    - Cebidae (squirrel monkeys, capuchins, owl monkeys, etc.)
      - Atelidae (howlers, spider monkeys, and muriquis)
        - Callitrichidae* (marmosets and tamarins)
          - Cercopithecidae (baboons, macaques, guenons, etc.)
            - Colobinae (colobus species, langurs)
              - Pongidae (the great apes)
                - Hylobatidae (gibbons and siamangs)
                  - Catarrhini (all Old World monkeys, apes, and humans)
                    - Cercopithecoidea (all Old World monkeys)
                      - Cercopithecidae (all Old World monkeys)

**INFRAORDER**
- Lemuriformes (all lemurs)
- Lorisiformes (all lorises and galagos)
- Tarsiiformes (the tarsiers)
- Platyrrhini (all New World monkeys)

**SUPERFAMILY**
- Platyrrhini
- Ceboidae (all New World monkeys)
- Cebidae (squirrel monkeys, capuchins, owl monkeys, etc.)
- Atelidae (howlers, spider monkeys, and muriquis)

**FAMILY**
- Cebidae (squirrel monkeys, capuchins, owl monkeys, etc.)
- Atelidae (howlers, spider monkeys, and muriquis)
- Platyrrhini (all New World monkeys)
- Ceboidae (all New World monkeys)
- Cercopithecidae (all Old World monkeys)
- Colobinae (colobus species, langurs)

**SUBFAMILY**
- Cercopithecinae (baboons, macaques, guenons, etc.)
- Atelidae (howlers, spider monkeys, and muriquis)
- Platyrrhini (all New World monkeys)
- Ceboidae (all New World monkeys)

**GENUS**
- All primates
- All anthropoids
- All hominoids
- All prosimians

**SPECIES**
- Homo sapiens (humans)
- Pongo pygmaeus (orangutans) (2 subspecies)
- Gorilla gorilla (3 subspecies)
- Pan troglodytes (chimpanzees) (3 subspecies)
- Pan paniscus (bonobos)

*Fleagle (1999) and others have recently eliminated the family Callitrichidae and included marmosets and tamarins in the family Cebidae.

Figure 6-9: Primate taxonomic classification. This abbreviated taxonomy illustrates how primates are grouped into increasingly specific categories. Only the more general categories are shown, except for the great apes and humans.
Another area where changes have been suggested concerns tarsiers (see p. 133). Tarsiers are highly specialized animals that display several unique physical characteristics. Because they possess a number of prosimian traits, tarsiers have traditionally been classified as prosimians (with lemurs and lorises). But they also have certain anthropoid features, and they’re more similar to the anthropoids biochemically (Dene et al., 1976).

Primatologists who maintain that tarsiers are more closely related to anthropoids have supported a reclassification. Instead of simply moving tarsiers into the suborder Anthropoidea, one scheme (Fig. 6-10) places lemurs and lorises in a different suborder, Strepsirhini, instead of Prosimii, while tarsiers are included with monkeys, apes, and humans in another suborder, Haplorhini (Szaley and Delson, 1979). In this classification, the traditionally named suborders Prosimii and Anthropoidea are replaced by Strepsirhini and Haplorhini, respectively. This designation hasn’t been universally accepted. Nevertheless, the terminology is common, especially in technical publications. So if you see the term *strepsirhine*, you know that the author is referring specifically to lemurs and lorises.

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**At a Glance**

### Alternative Classifications of Great Apes and Humans

<table>
<thead>
<tr>
<th>TRADITIONAL CLASSIFICATION</th>
<th>REVISED CLASSIFICATION (evolutionarily more accurate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great apes—separate family (Pongidae)</td>
<td>One family only (Hominidae), including all large-bodied apes and humans; more detailed distinctions made at lower taxonomic categories</td>
</tr>
<tr>
<td>Orangutans</td>
<td>Orangutans</td>
</tr>
<tr>
<td>Gorillas</td>
<td>Gorillas</td>
</tr>
<tr>
<td>Chimpanzees</td>
<td>Chimpanzees/Bonobos</td>
</tr>
<tr>
<td>Bonobos</td>
<td>Humans</td>
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<tr>
<td>Humans—separate family (Hominidae)</td>
<td></td>
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</tbody>
</table>

**Figure 6-10**

Revised partial classification of the primates. In this system, the names Prosimii and Anthropoidea would be replaced by Strepsirhini and Haplorhini, respectively. Tarsiers would be included in the same suborder as monkeys, apes, and humans to reflect a closer relationship with these species than with lemurs and lorises. (Compare with Fig. 6-9.)
A Survey of the Living Primates

In this section, we discuss the major primate subgroups. Since it’s beyond the scope of this book to cover any species in detail, we present a brief description of each major grouping. Then we take a closer look at the apes.

**LEMURS AND LORISES**

The most primitive primates are the lemurs and lorises. Remember that by “primitive” we mean that they’re more similar to their earlier mammalian ancestors than are the other primates (tarsiers, monkeys, apes, and humans). For example, they retain certain more ancestral characteristics, such as a more pronounced reliance on the sense of smell. Their greater olfactory capabilities (compared to other primates) are reflected in the presence of a moist, fleshy pad, or rhinarium, at the end of the nose and in a relatively long snout (Fig. 6-11). Lemurs and lorises also mark their territories with scent in a manner not seen in most other primates.

Many other characteristics distinguish lemurs and lorises from the haplorhines, including eyes placed more to the side of the face, differences in reproductive physiology, and shorter gestation and maturation periods. Lemurs and lorises also have a unique trait called a “dental comb” (Fig. 6-12). The dental comb is formed by forward-projecting lower incisors and canines, and together these modified teeth are used in grooming and feeding. Another characteristic that sets lemurs and lorises apart from anthropoids is the retention of a claw (called a “grooming claw”) on the second toe.

**Lemurs**  Lemurs are found only on the island of Madagascar and nearby islands off the east coast of Africa (Fig. 6-13). As the only nonhuman primates on Madagascar, lemurs diversified into numerous and varied ecological niches without competition from monkeys and apes. Thus, the approximately 60 surviving lemur species represent an evolutionary pattern that has vanished elsewhere.

Lemurs range in size from the small mouse lemur, with a body length (head and trunk) of only 5 inches, to the indri, with a body length of 2 to 3 feet (Nowak, 1999). While the larger lemurs are diurnal and exploit a wide variety of dietary items, such as leaves, fruits, buds, bark, and shoots, the smaller species (mouse and dwarf lemurs) are nocturnal and insectivorous.

Lemurs display considerable variation regarding numerous other aspects of behavior. Some are mostly arboreal, but others, such as the ring-tailed lemur (Fig. 6-14), are more terrestrial. Some arboreal species are quadrupeds, and others (sifakas and indris) are vertical clinging and leapers (Fig. 6-15). Socially, several species, such as ring-tailed lemurs and sifakas, are gregarious and live in groups of 10 to 25 animals composed of males and

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**Figure 6-11**
As you can see, rhinaria come in different shapes and sizes, but they all serve to enhance an animal’s sense of smell.

**Figure 6-12**
Prosimian dental comb, formed by forward-projecting incisors and canines.

**Figure 6-13**
Geographical distribution of modern lemurs.

rhinarium (rin-ee-um) (pl., rhinaria) The moist, hairless pad at the end of the nose seen in most mammals. The rhinarium enhances an animal’s ability to smell.
females of all ages. Others (the indris) live in family units composed of a mated pair and their offspring; and several nocturnal forms are mostly solitary.

**Lorises** Lorises (Fig. 6-16), which resemble lemurs, were able to survive in mainland areas by becoming nocturnal when most other prosimians became extinct. In this way, they were (and are) able to avoid competition with more recently evolved primates, the diurnal monkeys.

There are at least eight loris species, all of which are found in tropical forest and woodland habitats of India, Sri Lanka, Southeast Asia, and Africa. Also included in the same general category are six to nine (Bearder, 1987; Nowak, 1999) galago species (Fig. 6-17), which are widely distributed throughout most of the forested and woodland savanna areas of sub-Saharan Africa.

Locomotion in some, but not all, lorises is a slow climbing form of quadrupedalism. All galagos are highly agile vertical clingers and leapers. Some lorises and galagos are almost entirely insectivorous; others supplement their diet with fruits, leaves, gums, and slugs. Lorises and galagos frequently forage for food alone, and unlike other primates,
females leave infants behind in nests until they are older. Feeding ranges overlap, and two or more females occasionally forage together or share the same sleeping nest.

**TARSIERS**

There are five recognized tarsier species (Nowak, 1999; Fig. 6-18), all of which are restricted to island areas in Southeast Asia (Fig. 6-19), where they inhabit a wide range of habitats, from tropical forest to backyard gardens. Tarsiers are nocturnal insectivores that leap from lower branches and shrubs onto prey (which may include small vertebrates). They appear to form stable pair bonds, and the basic tarsier social unit is a mated pair and their young offspring (MacKinnon and MacKinnon, 1980).

As we have already mentioned, tarsiers present a complex blend of characteristics not seen in other primates. One of the most obvious differences is their enormous eyes, which dominate much of the face and cannot move within their sockets. To compensate for the inability to move their eyes, tarsiers (like owls) are able to rotate their heads 180°.

**ANTHROPOIDS (MONKEYS, APES, AND HUMANS)**

There’s a great deal of variation among anthropoids, but they share certain features that, when taken together, distinguish them as a group from prosimians (and most other placental mammals). Here’s a partial list of these traits:

1. Generally larger body size
2. Larger brain (in absolute terms and relative to body weight)
3. Reduced dependence on the sense of smell, as indicated by absence of a rhinarium
4. Increased reliance on vision, with forward-facing eyes at the front of the face
5. Greater degree of color vision
6. Back of eye socket formed by a bony plate
7. Blood supply to brain different from that of prosimians
8. Fusion of the two sides of the mandible at the midline to form one bone (in prosimians they are two bones joined by fibrous tissue)
9. Less specialized dentition, as seen in the lack of a dental comb and some other features
10. Differences in female internal reproductive anatomy
11. Longer gestation and maturation periods
12. Increased parental care
13. More mutual grooming

Approximately 85 percent of all primates are monkeys (about 195 species). Monkeys are divided into two groups separated by geographical area (New World and Old World), as well as by several million years of separate evolutionary history.

**New World Monkeys** There are approximately 70 New World monkey species and they exhibit considerable variation in size, diet, and ecological adaptation (Fig. 6-20). They are found throughout most forested areas of southern Mexico and Central and South America (Fig. 6-21). In size, they range from the tiny marmosets and tamarins (about 12 ounces) to the 20-pound howler monkeys (Figs. 6-22 and 6-23). New World monkeys are almost
An Overview of the Primates

CHAPTER 6

Callitrichidae (kal-eh-trick´-eh-dee)

Cebidae (see´-bid-ee)

Cercopithecidae (serk-oh-pith´-eh-sid-ee)

cercopithecines (serk-oh-pith´-eh-seens)
The subfamily of Old World monkeys that includes baboons, macaques, and guenons.

colobines (kol´-uh-beans) The subfamily of Old World monkeys that includes the African colobus monkeys and Asian langurs.

Old World Monkeys Except for humans, Old World monkeys are the most widely distributed of all living primates. They are found throughout sub-Saharan Africa and southern Asia, ranging from tropical jungle habitats to semiarid desert and even to seasonally snow-covered areas in northern Japan (Fig. 6-25).

All Old World monkeys are placed in one taxonomic family: Cercopithecidae; in turn, this family is divided into two subfamilies: the cercopithecines and colobines. Most Old World monkeys are quadrupedal and primarily arboreal, but some (baboons, macaques, and langurs) spend much of the day on the ground and return to the trees in the evening to sleep.

The cercopithecines are the more generalized of the two groups: They’re more omnivorous, and they have cheek pouches for storing food (like hamsters). As a group,
A Survey of the Living Primates

Figure 6-23
New World monkeys.

Squirrel monkeys

Prince Bernhard’s titi monkey (discovered in 2002)

Male uakari

Female muriqui with infant

White-faced capuchins
The cercopithecines eat almost anything, including fruits, seeds, leaves, grasses, tubers, roots, nuts, insects, birds’ eggs, amphibians, small reptiles, and small mammals (the last seen in baboons).

The majority of cercopithecine species, such as the mostly arboreal guenons (Fig. 6-26) and the more terrestrial savanna and hamadryas baboons, are found in Africa (Fig. 6-27). However, all but one of the several macaque species, which include the well-known rhesus monkey, are distributed across southern Asia and India.

Colobine species have a narrower range of food preferences and mainly eat mature leaves, which is why they’re also called “leaf-eating monkeys.” The colobines are found
的主要在亚洲，但红叶猴和黑白叶猴都是非洲独有。其他叶猴包括几种亚洲的叶猴物种和婆罗洲的鼻猴。

显着的性别差异，所谓的**性二型**，在一些陆生物种中较为常见，特别是在狒狒中。在这些物种中，雄性体重（在狒狒中可达80磅）可能是雌性体重的两倍。

雌性一些物种，尤其是狒狒和一些猴子，有显著的周期性变化的外部生殖器。这些变化，包括肿胀和红肿，与**发情**（estrus）有关，这是一种通过激素启动的性活动期，与非人灵长类雌性哺乳动物的排卵相关。

旧世界猴生活在几种不同的社会群体中，而且有些种类的种群尚不确定。叶猴倾向于生活在小群体中，只有1到2只成年雄性。草原狒狒和大多数猴子物种生活在由不同性别的成年和所有年龄的小群体组成的大型社会单位中。一夫一妻制在旧世界猴中较为罕见，但在几只叶猴和可能的一个或两个古纳物种中可以看到。

**图6-27** 草原狒狒。 (a) 雄性。（b）雌性。

**图6-28** 黑白叶猴。

**性二型** 指的是不同性别的身体特征。例如，人类是轻微的性别二型，雄性通常比同性的雌性高。

**发情** （estrus）在非人类哺乳动物（除了人类）中，与排卵相关联的性周期。
HOMINOIDS (APES AND HUMANS)

The other large grouping of anthropoids, the hominoids, includes apes and humans, and today, apes are found in Asia and Africa. The small-bodied gibbons and siamangs live in Southeast Asia, and the two orangutan subspecies live on the islands of Borneo and Sumatra (Fig. 6-29). In Africa, until the mid- to late twentieth century, gorillas, chimpanzees and bonobos occupied the forested areas of western, central, and eastern Africa, but their habitat is now extremely fragmented, and all are now threatened or highly endangered (see pp. 144–147). Apes and humans differ from monkeys in numerous ways:

1. Generally larger body size, except for gibbons and siamangs
2. Absence of a tail
3. Shorter and more stable lower back
4. Arms longer than legs (apes only)
5. Differences in position and musculature of the shoulder joint, which is adapted for suspensory behaviors (brachiation and/or feeding)
6. Generally more complex behavior
7. More complex brain and enhanced cognitive abilities
8. Increased period of infant development and dependency

Gibbons and Siamangs The eight gibbon species and the closely related siamangs are the smallest of the apes, weighing around 13 and 25 pounds, respectively. Their most distinctive anatomical features are adaptations to feeding while hanging beneath branches and brachiation, at which gibbons and siamangs excel (Fig. 6-30). In fact, gibbons and siamangs are more dedicated to brachiation than any other primate, and this fact is reflected in their extremely long arms, permanently curved fingers, short thumbs, and powerful shoulder muscles. (Their arms are so long that when they’re on the ground, they can’t walk quadrupedally, so instead, they walk bipedally with their arms raised to the side.) Gibbons and siamangs mostly eat fruits, although both (especially siamangs) consume a variety of leaves, flowers, and insects.

The basic social unit of gibbons and siamangs is an adult male and female with dependent offspring, and like other species that live in male-female pairs, they aren’t sexually dimorphic. Although they’ve been described as monogamous, in reality, members of pairs sometimes do mate with other individuals. Like marmosets and tamarins,
male gibbons and siamangs are very involved in rearing their young. Both males and females are highly territorial and protect their territories with elaborate whoops and siren-like “songs.”

**Orangutans** Orangutans (*Pongo pygmaeus*) (Fig. 6-31) are represented by two subspecies found today only in heavily forested areas on the Indonesian islands of Borneo and Sumatra (see Fig. 6-29). Due to poaching by humans and continuing habitat loss on both islands, orangutans are severely threatened with extinction in the wild.

Orangutans are very large animals with pronounced sexual dimorphism (males may weigh 200 pounds or more and females less than 100 pounds). In the wild, they lead largely solitary lives, although adult females are usually accompanied by one or two dependent offspring. They’re primarily **frugivorous**, but may also eat bark, leaves, insects, and meat (on rare occasions). Orangutans are slow, cautious climbers whose locomotor behavior can best be described as “four-handed,” since they tend to use all four limbs for grasping and support. Although they’re almost completely arboreal, males in particular also travel quadrupedally on the ground.

**Gorillas** The largest of all living primates, gorillas (*Gorilla gorilla*) are today confined to forested areas of western and eastern equatorial Africa (Fig. 6-32). There are four generally recognized subspecies, the most numerous of which are the western lowland gorillas, found in several countries of western central Africa (Fig. 6-33). In 1998, Doran and McNeilage reported an estimated population size of perhaps 110,000. However, a recently published report (Walsh et al., 2003) suggests that numbers are far lower.

The Cross River gorilla, a western lowland gorilla subspecies, was identified in the early 1900s but was subsequently thought to be extinct until the 1980s, when primatologists became aware of a few small populations in Nigeria and Cameroon (Sarmiento and Oates, 2000). Primatologists believe that there are only about 250 to 300 of these animals; thus, Cross River gorillas are among the most endangered of all primates. Currently, the International Union for the Conservation of Nature and Natural Resources (IUCN) is developing plans to protect this vulnerable and little-known subspecies (Oates et al., 2007).

Eastern lowland gorillas, which haven’t really been studied, are found near the eastern border of the Democratic Republic of the Congo (DRC—formerly Zaire), a region that unfortunately is prone to warfare. At present, their numbers are unknown; researchers fear that many have been killed, but it’s impossible to know how many.

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**frugivorous** (fru-gi’-vor-us) Having a diet composed primarily of fruits.
Mountain gorillas, the most extensively studied of the four subspecies, are restricted to the mountainous areas of central Africa in Rwanda, the DRC, and Uganda. Mountain gorillas have probably never been very numerous, and today they’re critically endangered, numbering only about 700. Tragically, in September 2007, rebel forces moved into the gorilla sector of the DRC, which is home to at least 300 gorillas. Since that time (at least as of this writing, July 2008), it’s been impossible to monitor the gorillas’ activities or to protect them.

Gorillas exhibit marked sexual dimorphism, with males weighing up to 400 pounds and females around 150 to 200 pounds. Because of their weight, adult gorillas, especially males, are primarily terrestrial and adopt a quadrupedal knuckle-walking posture on the ground.

Mountain gorillas live in groups consisting of one, or sometimes two, large silverback males, a variable number of adult females, and their subadult offspring. The term
**silverback** refers to the saddle of white hair across the back of full adult (at least 12 or 13 years of age) male gorillas. Silverback males may tolerate the presence of one or more young adult **blackback** males, probably their sons. Typically, but not always, both females and males leave their **natal group** as young adults. Females join other groups, but males, who appear to be less likely to emigrate, may live alone for a while, or they may join up with other males before eventually forming their own group.

Systematic studies of free-ranging western lowland gorillas weren’t begun until the mid-1980s, and not as much is known about them, even though they’re the only gorillas you’ll see in zoos. The social structure of western lowland gorillas is similar to that of mountain gorillas, but groups are smaller and somewhat less cohesive.

All gorillas are almost exclusively vegetarian. Mountain and western lowland gorillas concentrate primarily on leaves, pith, and stalks, but the latter also eat more fruit. Also, western lowland gorillas, unlike mountain gorillas, which avoid water, frequently wade through swamps and forage on aquatic plants (Doran and MacNeilage, 1998).

Because of their large body size and enormous strength, gorillas have long been considered ferocious, but in fact they’re usually shy and gentle. However, this doesn’t mean that gorillas are never aggressive. Among males, competition for females can be extremely violent, and when threatened, males will attack and defend their group from any perceived danger, whether it’s another male gorilla or a human hunter. Still, the reputation of gorillas as murderous beasts is nothing but a myth.

**Chimpanzees.** Although chimpanzees are probably the best known of all nonhuman primates (Fig. 6-35), they’re often misunderstood because of zoo exhibits, advertising, and television. The true nature of chimpanzees didn’t become known until years of fieldwork with wild groups provided a more accurate picture. Today, chimpanzees are found in equatorial Africa, in an area that stretches from the Atlantic Ocean in the west to Lake Tanganyika in the east. But within this large area, their range is very patchy, and it’s becoming even more so with continued forest clearing.

**natal group** The group in which animals are born and raised. (Natal pertains to birth.)

**Figure 6-35**
Chimpanzees. (a) Male. (b) Female.
In many ways, chimpanzees are anatomically similar to gorillas, with corresponding limb proportions and upper-body shape. However, the ecological adaptations of chimpanzees and gorillas differ in many ways, and chimpanzees are more arboreal than gorillas. Moreover, while gorillas are typically placid and quiet, chimpanzees are highly excitable, active, and noisy.

Chimpanzees are smaller than orangutans and gorillas, and although they’re sexually dimorphic, differences between the sexes aren’t as pronounced. While male chimpanzees may weigh over 100 pounds, females can weigh at least 80.

In addition to quadrupedal knuckle walking, chimpanzees (particularly youngsters) may brachiate when they’re in the trees. Chimpanzees also sometimes walk bipedally for short distances when carrying food or other objects.

Chimpanzees eat a huge variety of foods, including fruits, leaves, insects, nuts, birds’ eggs, berries, caterpillars, and small mammals. Moreover, both males and females occasionally take part in group efforts to hunt and kill small mammals such as red colobus monkeys, young baboons, bushpigs, and antelope. When hunts are successful, the group (especially members of the hunting party) share the prey.

Chimpanzees live in large, fluid communities ranging in size from 10 to as many as 100 individuals. A group of closely bonded males forms the core of chimpanzee communities, especially in East Africa (Goodall, 1986; Wrangham and Smuts, 1980; Wrangham et al., 1992). But for some West African groups, females appear to be more central to the community (Boesch, 1996; Boesch and Boesch-Ackerman, 2000; Vigilant et al., 2001). Relationships among closely bonded males aren’t always peaceful or stable; yet these males cooperatively defend their territory and are highly intolerant of unfamiliar chimpanzees, especially males.

Even though chimpanzees are said to live in communities, it’s rare for all members to be together at the same time. Rather, they tend to come and go, so that the individuals they encounter vary from day to day. Adult females usually forage alone or in the company of their offspring, a grouping that might include several individuals, since females with infants sometimes accompany their own mothers and their younger siblings. These associations have been reported at Gombe National Park, Tanzania, where about 40 percent of females remain in the group they were born in (Williams, 1999). But at most other locations, females leave their natal group to join another community. This behavioral pattern may reduce the risk of mating with close relatives, since males apparently never leave the group in which they were born.

Chimpanzee social behavior is complex, and individuals can form lifelong attachments with friends and relatives. Indeed, the bond between mothers and infants can remain strong until one of them dies. This may be a considerable period, because many wild chimpanzees live into their 40s or even longer.

**Bonobos** Bonobos (Pan paniscus) are found only in an area south of the Zaire River in the DRC (Fig. 6-36). Not officially recognized by European scientists until the 1920s, they remain among the least studied of the great apes. Although ongoing field studies have produced much information (Susman, 1984; Kano, 1992), research has been hampered by more or less continuous civil war. There are no accurate counts of bonobos, but their numbers are believed to be between 10,000 and 20,000 (IUCN, 1996), and they’re highly threatened by human hunting, warfare, and habitat loss.

Because bonobos bear a strong resemblance to chimpanzees but are slightly smaller, they’ve been called “pygmy chimpanzees.” However, that term isn’t commonly used by primatologists and size differences aren’t that great. But, there are some anatomical differences between bonobos and chimpanzees; bonobos have a more linear body build, longer legs relative to arms, a relatively smaller head, a dark face from birth, and tufts of hair at the sides of the face.

Bonobos are more arboreal than chimpanzees, and they’re less excitable and aggressive. While aggression isn’t unknown, it appears that physical violence both
within and between groups is uncommon. Like chimpanzees, bonobos live in geographically based, fluid communities, and they eat many of the same foods, including occasional meat derived from small mammals (Badrian and Malinky, 1984). But bonobo communities aren’t centered around a group of closely bonded males. Instead, male-female bonding is more important than in chimpanzees (and most other nonhuman primates), and females aren’t peripheral to the group (Badrian and Badrian, 1984). This may be related to bonobo sexuality, which differs from that of other nonhuman primates in that copulation is very frequent and occurs throughout a female’s estrous cycle, so sex isn’t entirely linked to reproduction. In fact, bonobos are famous for their sexual behavior, engaging in sex frequently and using it to defuse potentially tense situations. Sexual behavior between members of the same sex is also common (Kano, 1992; de Waal and Lanting, 1997).

HUMANS

We humans exhibit our primate heritage in our overall anatomy and genetic makeup and in many aspects of behavior. With the exception of reduced canine size, human teeth are typical primate (especially ape) teeth. The human dependence on vision and decreased reliance on olfaction, as well as flexible limbs and grasping hands, are rooted in our primate, arboreal past. Humans can even brachiate, as many of us demonstrated during childhood.

In general, humans are omnivorous, although all societies observe certain culturally based dietary restrictions. Even so, as a species with a rather generalized digestive system, we are physiologically adapted to digest an extremely wide assortment of foods. Perhaps to our detriment, we also share with our relatives a fondness for sweets that originates from the importance of high-energy fruits in the diets of many nonhuman primates.

But quite obviously, humans are unique among primates and indeed among all animals. For example, no other species has the ability to write or think about issues such as how they differ from other life-forms. This ability is rooted in the fact that human evolution, during the last 800,000 years or so, has been characterized by dramatic increases in brain size and other neurological changes.

Humans are also completely dependent on culture. Without cultural innovation, we would never have been able to leave the tropics. As it is, humans inhabit every corner
of the planet with the exception of Antarctica, and we’ve even established outposts there. And lest we forget, a fortunate few have even walked on the moon. None of the technologies (indeed, none of the other aspects of culture) that humans have developed over the last several thousand years would have been possible without the highly developed cognitive abilities that we alone possess. Nevertheless, the neurological basis for intelligence is rooted in our evolutionary past, and it’s something we share with other primates. Indeed, research has demonstrated that several nonhuman primate species (most notably chimpanzees, bonobos, and gorillas) display a level of problem solving and insight that most people would have considered impossible 25 years ago (see Chapter 7).

Humans are uniquely predisposed to use spoken language, and for the last 5,000 years or so, we’ve also used written language. This ability exists because during the course of human evolution, certain neurological and anatomical structures have been modified in ways not seen in any other species. But while nonhuman primates aren’t anatomically capable of producing speech, research has shown that to varying degrees, the great apes can communicate by using symbols, which is a foundation for language that humans and the great apes (to a more limited degree) have in common.

Aside from cognitive abilities, the one other trait that sets humans apart from other primates is our unique (among mammals) form of habitual bipedal locomotion. This particular trait appeared early in the evolution of our lineage, and over time, we have become more efficient at it because of related changes in the musculoskeletal anatomy of the pelvis, leg, and foot (see Chapter 9). Still, while it’s certainly true that human beings are unique intellectually and in some ways anatomically, we are still primates. In fact, fundamentally, humans are somewhat exaggerated African apes.

**Endangered Primates**

In September 2000, scientists announced that a subspecies of red colobus, named Miss Waldron’s red colobus, had officially been declared extinct. This announcement came after a 6-year search for the 20-pound monkey that hadn’t been seen for 20 years (Oates et al., 2000). Thus, this species, indigenous to the West African countries of Ghana and the Ivory Coast, has the distinction of being the first nonhuman primate to be declared extinct in the twenty-first century. But it won’t be the last. In fact, as of this writing, over half of all nonhuman primate species are now in jeopardy, and some face almost immediate extinction in the wild.

There are three basic reasons for the worldwide depletion of nonhuman primates: habitat destruction, hunting for food, and live capture for export or local trade. Underlying these three causes is one major factor: unprecedented human population growth, particularly in developing countries, which are also home to over 90 percent of all nonhuman primate species. These countries, aided in no small part by the United States, China, and the industrialized countries of Europe, are cutting their forests at a rate of about 30 million acres per year. Unbelievably, in the year 2002, deforestation of the Amazon increased by 40 percent over that of 2001. This increase was largely due to land clearing for the cultivation of soybeans. In Brazil, the Atlantic rain forest originally covered some 385,000 square miles. Today, an estimated 7 percent is all that remains of what was once home to countless New World monkeys and thousands of other species.

The motivation behind rain forest destruction is, of course, economic: the short-term gains from clearing forests to create immediately available (but poor) farmland or ranchland; the use of trees for lumber and paper products; and large-scale mining operations (with their necessary roads, digging, and so forth, all of which cause habitat destruction). Furthermore, the demand for tropical hardwoods (such as mahogany, teak, and rosewood) in the United States, Europe, and Japan continues unabated, creating an enormously profitable market for rain forest products.
THE BUSHMEAT CRISIS

In many areas, habitat loss has been, and continues to be, the single greatest cause of declining numbers of nonhuman primates. But in the past few years, human hunting has posed an even greater threat. During the 1990s, primatologists and conservationists became aware of a rapidly developing trade in bushmeat, meat from wild animals, especially in Africa (Fig. 6-37). The current slaughter, which now accounts for the loss of tens of thousands of nonhuman primates (and other animals) annually, has been compared to the near extinction of the American bison in the nineteenth century.

Wherever primates live, people have always hunted them for food. But in the past, subsistence hunting wasn’t a serious threat to nonhuman primate populations, and certainly not to entire species. But now, hunters armed with automatic rifles can, and do, wipe out an entire group of monkeys or gorillas in minutes. It’s impossible to know how many animals are killed each year, but the estimates are staggering. The Society for Conservation Biology estimates that about 6,000 kg (13,228 pounds) of bushmeat is taken through just seven western cities (New York, London, Toronto, Paris, Montreal, Chicago, and Brussels) every month. No one knows how much of this meat is from primates, but this figure represents only a tiny fraction of all the animals being slaughtered because much smuggled meat isn’t detected at ports of entry. If this weren’t enough, the international trade is thought to account for only about 1 percent of the total (Marris, 2006).

Quite clearly, many primate species, which number only a few hundred or thousand animals, cannot and will not survive this onslaught for more than a few years. In addition, hundreds of infants are orphaned and sold in markets as pets. Although a few of these traumatized orphans make it to sanctuaries, most die within days or weeks of capture (Fig. 6-38).

One major factor in the development of the bushmeat trade has been logging. The construction of logging roads, mainly by French, German, and Belgian lumber companies, has opened up vast tracts of previously inaccessible forest to hunters. What has emerged is a multimillion-dollar trade in bushmeat, a trade in which logging company employees and local government officials participate with hunters, villagers, market vendors, and smugglers who cater to local and overseas markets. In other words, the hunting of wild animals for food, particularly in Africa, has quickly shifted from a subsistence activity to a commercial enterprise of international scope.
Although the slaughter may be best known in Africa, it’s by no means limited to that continent. In South America, for example, hunting nonhuman primates for food is common. One report documents that in less than two years, one family of Brazilian rubber tappers killed almost 500 members of various large-bodied species, including spider monkeys, woolly monkeys, and howler monkeys (Peres, 1990). And live capture and illegal trade in endangered primate species continue unabated in China and Southeast Asia, where nonhuman primates are not only eaten but are also funneled into the exotic pet trade. Moreover, primate body parts are extensively used in traditional medicines, and with increasing human population size, the enormous demand for these products (and for products from nonprimate species, such as tigers) has placed many species in extreme jeopardy.

MOUNTAIN GORILLAS AT GREAT RISK

Mountain gorillas are one of the most endangered of all nonhuman primate species. All of the approximately 700 mountain gorillas alive today are restricted to a heavily forested area in and around the Virunga mountains (the Virunga Volcanoes Conservation Area) shared by three countries: Uganda, Rwanda, and the DRC. This entire area is a UNESCO (United Nations Educational, Scientific, and Cultural Organization) World Heritage Site. In addition, there is a separate, noncontiguous park in Uganda—the Bwindi Impenetrable Forest, that is also home to some of these gorillas. Tourism has been the only real hope of salvation for these magnificent animals, and for this reason, several gorilla groups have been habituated to humans and are heavily protected by park rangers. Nevertheless, poaching, civil war, and land clearing have continued to take a toll on these small populations.

Between January and late July 2007, eleven mountain gorillas were slaughtered in the DRC. In addition, two infants, orphaned in the attacks, were rescued and taken to a veterinary clinic where, as of this writing (July, 2008), they are in good condition (Newport, pers. comm.).

Six of the victims, including the silverback male (Fig. 6-39), were members of one family group of 12. The remnant of this group consists of four immature males and one immature female, and without a silverback, their future is uncertain.
These gorillas weren’t shot for meat or because they were raiding crops. They were killed because their existence in the park is an obstacle to people who would destroy what little remains of the gorillas’ forest home. One of the many reasons for cutting the forests is the manufacture of charcoal, a major source of fuel in rural Rwanda and the DRC.

In 2007, paleoanthropologist Richard Leakey and a colleague, Emanuelle de Merode, established WildlifeDirect.org to help support conservationists and especially the rangers who work to protect the mountain gorillas. You may want to go to their website (www.wildlifedirect.org), where you can read updates and see photographs and videos posted daily by the rangers. These communications offer fascinating insights into their efforts, conditions in the forest, and updates on gorillas and other species.

There are several other conservation groups that work to protect mountain gorillas. And in 2000, the United Nations Environmental Program established the Great Ape Survival Project (GRASP). GRASP is an alliance of many of the world’s major great ape conservation and research organizations. In 2003, GRASP appealed for $25 million to be used in protecting the great apes from extinction. The money (a paltry sum) would be used to enforce laws that regulate hunting and illegal logging. It goes without saying that GRASP and other organizations must succeed if the great apes are to survive in the wild for even 20 more years!

But GRASP and the various conservation organizations face a formidable task just to save mountain gorillas, not to mention the dozens of other primate species at risk. In early September 2007, rebel forces in the gorilla sector of the DRC attacked a ranger station, where they killed one ranger. Consequently, WildlifeDirect evacuated all rangers from the area, leaving the gorillas unprotected. As of this writing (July, 2008), fighting has stopped, but the rangers still can’t return to the area, so the status of the gorillas is uncertain.

As a note of optimism, in November 2007, the DRC government and the Bonobo Conservation Initiative, in Washington, D.C., created a bonobo reserve consisting of 30,500 square kilometers. This amounts to about 10 percent of the land in the DRC, and the government has stated that its goal is to set aside an additional 5 percent for wildlife protection (News in Brief, 2007). This is a huge step forward, but it remains to be seen how protection will be enforced.

Figure 6-39
Congolese villagers carrying the body of the silverback gorilla killed in July, 2007. His body was buried with the other members of his group who were also shot.
If you are in your 20s or 30s, you will certainly live to hear of the extinction of some of our marvelous cousins. Many more will slip away unnoticed. Tragically, this will occur, in most cases, before we’ve even gotten to know them. Each species on earth is the current result of a unique set of evolutionary events that, over millions of years, has produced a finely adapted component of a diverse ecosystem. When it becomes extinct, that adaptation and that part of biodiversity is lost forever. What a tragedy it will be if, through our own mismanagement and greed, we awaken to a world without chimpanzees, mountain gorillas, or the tiny, exquisite lion tamarin. When this day comes, we truly will have lost a part of ourselves, and we will certainly be the poorer for it.

Summary

In this chapter, we introduced you to the primates, the mammalian order that includes prosimians, monkeys, apes, and humans. We discussed how primates, including humans, have retained a number of ancestral characteristics that have permitted them, as a group, to be generalized in terms of diet and locomotor patterns. We also presented a general outline of traits that differentiate primates from other mammals.

You also became acquainted with the major groups of nonhuman primates, especially with regard to their basic social structure, diet, and locomotor patterns. Most primates are diurnal and live in social groups. The only nocturnal primates are lorises, galagos, some lemurs, tarsiers, and owl monkeys. Nocturnal species tend to forage for food alone or with offspring and one or two other animals. Diurnal primates live in a variety of social groupings, including male-female pairs and groups consisting of one male with several females and offspring or those composed of several males and females and offspring.

Finally, we talked about the precarious existence of most nonhuman primates today as they face hunting, capture, and habitat loss. These threats are all imposed by only one primate species, one that arrived fairly late on the evolutionary stage: Homo sapiens.

Critical Thinking Questions

1. How does a classification scheme reflect biological and evolutionary changes in a lineage?
2. How do you think continued advances in genetic research will influence how we look at our species’ relationship with nonhuman primates 10 or 15 years from now?
3. What factors are threatening the existence of nonhuman primates in the wild? What can you do to help in the efforts to save nonhuman primates from extinction?