
The Evolving Female

A Life-History Perspective

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13 Women's Bodies, Women's Lives: An Evolutionary Perspective

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FOR MANY years I have been writing about the role of women in evolution, an interest that grew out of my early research on the origin of human locomotion and functional interpretations of fossil pelvic and limb bones. Hominid (i.e., the human family) locomotion allows individuals to walk long distances and to carry objects. Early in my academic life, I proposed that survival features such as locomotion evolved to promote male activities such as hunting. Women had been largely invisible in reconstructions of early human evolution, and their activities were passively portrayed. However, by the 1970s, I began to rethink women's roles in evolution. As a consequence of this new perspective, Nancy Tanner and I wrote several articles on women and human origins (Tanner and Zihlman 1976a; Zihlman and Tanner 1978). We questioned traditional assumptions such as: hunting is the center piece of human origins; the sexual division of labor is a defining feature of the human way of life; and a pair bond is the primary social and reproductive unit. Our writings, by emphasizing the female contribution to subsistence, focused on putting women into the evolutionary picture as active participants in mate choice and in the wider social world.

Ongoing debates in anthropology focus on sex versus species differences in early hominids. For example, the basis for drawing conclusions about sex differences in behavior has derived from the supposed ability to attribute a male or female sex to fragmentary or isolated fossil bones and teeth. But little thought was given to how physical features affect the behavior of females and males. In this chapter several of my

interests converge: examining the relationship between anatomy and behavior; sorting variation in fossil anatomy (e.g., sex vs. species characters), and portraying women's activities in evolutionary reconstructions. Going beyond the earlier theories on women's activities in prehistory—which have not been based on morphology—I explore how women's bodies and lives reflect continuity with an evolutionary past.

The comparative perspective of evolutionary “layers” illustrates how the physical, behavioral, and social dimensions of women's lives and bodies result in the adaptability that is an important life-history feature of the human species. An evolutionary perspective incorporates two dimensions, process and time. The process of evolutionary change through natural selection operates on individuals during each stage of life from infancy through adulthood. The cumulative effect of change is expressed over generational time in populations. A longer time frame encompasses recent human history, more distant hominid origins, and extends back to nonhuman primate and earlier mammalian ancestors. A life-history perspective brings time and process together, for example, by taking into account growth and development as individuals move through life, as well as long-term adaptations for both survival and reproduction (Morbeck 1991b; chaps. 1, 9; Zihlman et al. 1990).

Life-history theory allows the exploration of females and males in terms of what each sex has to do to survive and reproduce. Although females and males of the same species share species characters, at the same time each sex

diverges to a greater or lesser degree (Zihlman chap. 8).

Many reconstructions of hominid evolution, instead of examining females in their own terms, interpret either women's bodies or lives relative to those of men. In addition, the many facets of women's lives often are ignored in preference to a narrower focus on one aspect, such as child care or labor. I offer alternative ways to view what usually is presented narrowly as the sexual division of labor and a monogamous mating pattern. This chapter discusses how women's bodies and lives are dynamically intertwined throughout life as they have been throughout evolutionary time.

THE ROLE OF LOCOMOTION

One basis for the evolutionary success and behavioral flexibility of women and other female primates is their continued mobility during late pregnancy and lactation. Locomotion is a thread that demonstrates the connections among structure, function, and behavioral capabilities. Movement and weight bearing affect the whole animal and are important aspects of time and energy budgets. As a survival life-history feature, the mode of locomotion affects individual well-being through all stages of life. The structural basis lies within the body, in muscles, bones, and nervous system, and the behavioral expression occurs in the context of the social group and physical environment. Locomotion, then, illustrates the dynamic interaction among evolutionary history, reproduction, and individual experiences within an environmental context (Zihlman 1992). For the human lineage, bipedal locomotion is a distinguishing character. It appears early in hominid evolution and offers a means to connect life-history characters with our evolutionary past.

Exploration of the connection between behavior and morphology sets forth key features that emerged during successive stages in mammalian, primate, and hominid evolution. Primates share with other mammals the basis for social life in mother-infant interaction. By

deepening and lengthening the bond, the primate stage opened up new possibilities for that interaction. Then, by shifting to a new locomotor pattern, hominids further elaborated on the communication system and laid the foundation for the greater behavioral flexibility that is characteristic of the human species. With this sequence in mind, a way to integrate, rather than to separate, women's biological, social, and cultural dimensions is feasible as I demonstrate in the next sections of this paper.

Mammalian Revolution: A New Kind of Social Life

The foundation for a radically new kind of social life emerged during the mammalian revolution some 180 million years ago. In contrast to the ancestral reptiles, mammals are characterized by a complex of structures and interactive behaviors: (1) female mobility while supporting a fetus or newborn, (2) infant-maternal contact through lactation and suckling with maternal care, and (3) audio-vocal communication.

For females, the mammalian locomotor system enables foraging and traveling even during the awkward, later stages of pregnancy and during lactation (Pond 1977). This mobility is possible because of a well-developed muscular system, flexible and mobile joints, as well as the development of motor skills and a high metabolism.

Gestation, lactation, and suckling result in defined stages of growth and maturation. Fetuses and newborns receive from their mothers warmth, nourishment, and protection from environmental perturbations. For infants, the ability to suckle is made possible by the appearance of new neuromuscular structures in the oral-pharynx region not found in reptiles (K. K. Smith 1992). In addition to suckling, this region is associated with all other major functions of mastication, respiration, swallowing, and vocalizations. The appearance of a set of teeth at weaning promotes independence in feeding, allowing the weaned infant to adopt the adult diet (Pond 1977). During juvenes-

cence, body and bone growth continue, and finally sexual maturity and reproductive capacity are reached (Morbeck chap. 1).

The close association of young and adults, however minimal, is unlike the pattern for most reptiles (i.e., probable ancestors of mammals), in which the young must survive without adult assistance or risk being eaten by them. In mammals, contact between a lactating female and her suckling young is facilitated by the infant's keen sense of smell and hearing and the ability to emit vocalizations and to perceive these high-frequency sounds (MacLean 1990). Using smell, females, their young, and litter mates identify each other, and using vocalizations and hearing, communicate their locations, pleasures, and distress. In mammals, the distress call of young may be a universal vocalization (MacLean 1985). Therefore, the survival of young mammals depends on maintaining contact with the mother, promoted by olfactory and audiovocal communication.

Among mammals, the intensity of the bond between female and young varies by species; it may be minimal or extensive. Social interaction and communication begin at birth and are linked to and facilitated by the emotions. Active social interaction is fundamental and pervasive in mammals, initially between mother and offspring and extending to interactions between the young and their litter mates or older siblings. Social play probably originated among litter mates (MacLean 1990), becoming a major activity during juvenescence; it is associated with a period of growth, when learning and practicing of motor and social skills is stressed. The bonds developed during this period become the foundation for social bonds with other individuals later in life.

The social interactions and communications associated with the period of infancy and juvenile development are facilitated by sensory developments as part of major changes in the structure and function of the brain. The limbic system comprises a new part of the forebrain that has no counterpart in birds or reptiles. Damage to the limbic area of the brain also interferes with maternal care (MacLean 1985),

and the limbic system is the seat of the emotions. In other words, it is part of being a mammal (see Smuts [chap. 5] for its importance in primates).

Anatomy and Physiology

The mammalian system of reproduction and infant care imposes greater energetic demands on females than do other vertebrate reproductive systems; it involves physiological responses in bone, fat, and hormones. The system has shaped female anatomy and physiology through the appearance of new structures: mammary glands and fat deposits. Milk production, in conjunction with maternal care, imposes increased energetic demands on females. The mobilization of fat stores and calcium from bones promotes effective lactation and thus ensures both the survival of a female's offspring and the maintenance of her own health (McFarland chap. 12; Galloway chap. 10). In addition, acquisition of sufficient fat reserves promotes a female mammal's own growth and maturation, the conception and development of a fetus, and later the support of a neonate and infant (Pond 1984; Bronson 1989; McFarland 1992).

Fossil Record

There is no direct fossil evidence of mammary glands, fat stores, or brain structures in the earliest mammalian fossils, but all living mammals—including the egg-laying prototheres (platypus and echidna) and marsupials—produce some type of milk to feed the young. The behavioral occurrence of lactation suggests that it is a fundamental mammalian feature that emerged in the earliest stages of mammalian evolution (Pond 1977).

Although fossils do not preserve soft tissue, they do provide evidence for mobility and communication. Complete skeletons in the fossil record indicate a flexible locomotor system for foraging, finding mates, and avoiding predators (Crompton and Jenkins 1973). The masticatory system also ensures the processing of the large quantities of food necessary for maintaining the energetic demands associated

with locomotor independence and reproductive activities. Fossils indicate that the middle ear, emerged from two ear ossicles homologous with bones from reptilian jaw bones, increased acuity for reception of higher sound frequencies (Davis 1961; Crompton and Parker 1978). The implications of the development of the mammalian vocalization capacity is that such features made possible new ways for individuals to communicate with each other.

In sum, young mammals, as contrasted to other young vertebrates, require more time and energy to survive to reproductive maturity; consequently, mammals produce fewer offspring than other vertebrates. The mammalian caretaking system—with a potentially long and intense association between young and mother and among siblings (i.e., as in primates, including humans)—made it possible for social learning to extend over a long period during development. This system laid the foundation for the behavioral adaptability that characterizes a number of mammalian groups. The variety of mammals illustrates the diverse ways that female mammals meet the demands of survival, mating, and caring for offspring. The primate and later human way of life build on the mammalian foundation of mobility, lactation, and communication.

Primate Revolution: Behavioral Flexibility

Primates, one of many orders of mammals, expanded into new realms of behavior. The mammalian features—mobility during lactation and of communication—were enhanced by extending the life stages and increasing the time and energy females invest in each offspring. Longer periods of gestation, infancy dependency, and especially childhood were the result.

Just as lactation and suckling underlie the mammalian way of life, female behavioral flexibility and the ability of infants to cling to their mother's hair underlie the primate way of life. Primate locomotion is based on the ability to climb by grasping. Hands and feet with long, mobile digits are equipped with nails and sen-

sory pads and have an opposable thumb and big toe (Washburn 1951).

An infant primate (except humans) is able to hold on to its mother from birth. The hands and feet, equipped with considerable muscle and joint flexibility, function effectively in grasping. Newborn catarrhine primates' hands and feet, for example, are relatively twice as heavy as those of adults. While suckling and getting a free ride, the infant manipulates and explores the environment and, at the same time, develops motor coordination and social skills for later independent survival. As it grows, its body proportions change in response to the acquisition of childhood locomotion and manipulative skills (Grand 1983; Morbeck chap. 1).

From the female's point of view, her primate locomotor system equips her for carrying young on her body through all reproductive stages. In contrast to the marine mammals that suckle their infants on the beach (Ono chap. 3; Reiter chap. 4), or to those mammals that keep their young in dens or nests, most primate females, regardless of the presence of helpless infants, remain in social groups that travel around the home range all the year around (Hiraiwa-Hasegawa chap. 6; Pavelka chap. 7). This mobility underlies female behavioral flexibility and plays a key role in the ability to adjust her behavior to meet the demands of reproduction.

Such mobility also affects the infant. Because the infant moves with its mother from birth, it acquires an instant social network through its mother. This social group consists of both sexes and all ages categories. From the bonds established initially with its mother and siblings, the infant expands its social repertoire by forming bonds with other group members (Pavelka chap. 7). Thus, the close physical and emotional attachment of primate infants to their mothers provides the experience for establishing position in the social order (Smuts chap. 5).

Primate infants are socially responsive from birth. They are born with large brains and are precocial in their sensory development (Portman 1990). Like other mammals, they perceive the world through olfaction and touch and also

actively grip their mothers. But, unlike other mammals, primates rely on vision, and monkeys, apes, and humans have the ability to perceive color, depth, and details of faces. Continual close physical contact between an infant and its mother facilitates the development of face-to-face communication. From early social experience, primate infants learn the meaning of the nuances of facial expressions, body postures, and gestures that form much of the communication system and promote the development and maintenance of complex social networks.

In many catarrhine species, the infant primate—by learning from its mother's actions and support—acquires a social rank similar to that of its mother (Pavelka chap. 7). Generations of females, or matriline, contribute to the long-term stability of social groups in most species. Social connections during life and across generations require "brain power," and primates have large brains relative to body size. The primate ability to anticipate and manipulate the behavior of other group members promotes the exchange of information within and between groups (Cheney and Seyfarth 1990). This "social intelligence," as Jolly (1966; chap. 19) labels it, promotes linkages within and between generations and is the basis for behavioral adaptability. Consequently, primates have increased potential to respond to environmental perturbations or to adjust during their lifetime to specific social situations. This ability is acquired during the prolonged experience of growing up. It is related to the long period of lactation and maturation of the brain that continues into adolescence and is acquired before sexual maturation (Lancaster 1985).

MEETING THE DEMANDS OF REPRODUCTION

Perhaps the best illustration of primate adaptability and individual behavioral flexibility comes from analysis of adult female lives, the major portion of which are spent in pregnancy or nurturing young. When they are not

pregnant or lactating, females experience sexual cycles of ovulation and menstruation (Richard 1985). Sexual activity persists until conception takes place and may continue in some species into the early stages of pregnancy. At about the weaning stage, adult females become pregnant again within a few months of weaning, beginning a new cycle of reproduction.

Females and their infants adjust in a variety of physiological and behavioral ways in order to meet the combined energetic demands of surviving, caring for offspring, and maintaining social contacts. Responses combine alteration of travel time and mode, foraging time, and dietary composition, social activity, and infant carrying (see table 13.1).

Anatomy and Physiology

The physiological capabilities of female primates are like those of other mammals. They can add body weight consisting of fat deposits before conception and when pregnant. This added weight is then available for later lactation. Females gain weight and are at their heaviest during pregnancy and at their lightest in the later stages of lactation (Bercovitch 1987; McFarland 1992; chap. 12). During lactation, calcium is drawn from a female's long bones and is transferred via the breast milk to the growing infant for bone and tooth formation. After the infant is weaned, the mother's bone calcium is replenished (see Galloway chap. 10).

Individual Activity

Time-allocation studies on focal animals help estimate energy budgets during different reproductive phases (Coehlo 1986). To alter their energy budget during different reproductive phases, females adjust daily or seasonal activities in a variety of ways. For example, they may increase foraging time and food intake, consume higher-quality foods by entering feeding areas first, taking priority in feeding, or having access to particular feeding places (Dunbar 1977; Waser 1977; Gautier-Hion

TABLE 13.1. Female Accommodation to Reproductive Demands

Anatomy/Physiology
Body weight
Body composition and fat stores
Calcium mobility
Individual Activity of Female
Travel
Time spent
Substrate and height in trees
First access to feeding areas
Feeding
Dietary composition
Quantity of food
Time spent
Mother-Infant: Lactation and Weaning
Time and distance infant carried
Variation in lactation
Early weaning of infant
Late weaning of infant
Social Dynamics
Decrease in social interaction during lactation
Preferential access to feeding sites
Sharing of caretaking of infant with others

1980; Cords 1986; Kano 1992). Additionally, during pregnancy and lactation, females may decrease the distance they travel or spend less time traveling (Altmann 1980).

Mother-Infant Interaction

The species pattern of female biology and infant development affects the duration and nature of mother-infant interactions. For example, among baboons, mothers accommodate by altering the time and distance they carry suckling, growing infants (Altmann and Samuels 1992). The youngest infants, which are completely dependent nutritionally, are carried by their mothers during all travel and foraging, for a total of 8 to 10 km per day. By 8 months of age, both carrying time and distance declines to almost zero (Altmann and Samuels 1992). The physiology of lactation

also can vary even within a single species (e.g., Japanese macaques [Tanaka 1992]).

In addition, the relationship between growth and weaning may vary among and within species. Fast-growing infants may wean earlier, as in patas monkeys, whereas slower-growing baboon infants wean later (Altmann 1980; Chism et al. 1984). Even after weaning, most catarrhine females continue to interact with juvenile offspring that remain emotionally dependent, and this social activity contributes to a female's energy output (Morbeck chap. 1; Smuts chap. 5; Pavelka chap. 7).

Social Group

As noted previously, primate reproduction and caretaking take place in the context of social life and affects all group members. Females and their offspring, even if adults, form the core of social groups of many catarrhine species. Consequently, older primate females generally contribute to generational continuity, to passing on traditions, and to the stability of social groups over the long term.

Social living provides many benefits to a mother. For example, it offers protection for the lactating females, their infants, and especially vulnerable juveniles. Because social interaction requires that individuals devote time and energy at all life stages to establishing and maintaining social connections, the time spent in social interactions and relationships varies during females' lives. From an energetic perspective, for instance, the time a mother has available for feeding or resting may be increased by her infant's time spent with a group member "baby sitter." Or, a mother may decrease the time spent grooming, as do savanna and gelada baboons when they are particularly stressed during lactation. When the infant is weaned and is no longer being carried, the mother may again engage in more grooming (Altmann 1980; Dunbar and Dunbar 1988). This very flexible reproductive system thus allows a variety of ways to promote both survival of a mother and investment in the biosocial future of her infant.

Fossil Record

Fossil evidence for grasping hands and feet appear among early primates about 50 million years ago. Catarrhine primates are found in the fossil record some 35 million years ago. Forward-facing bony eye orbits and an expanded occipital (visual) region of the cranium suggest the development of stereoscopic and, probably, color vision and day living. Later, less than 20 million years ago, large incisors and square low-crowned molars suggest fruit eating, and limb bones indicate generalized quadrupedal locomotion. Although there is little direct fossil evidence for interpreting social behavior, it is possible that at least small social groups (10–15) existed.

In sum, the combination of features—locomotion, long gestation and lactation, and complex communication—contribute to a reproductive system with considerable investment by adult females. Moving from reptiles to mammals to primates entails an increasing commitment of female time and energy to producing and rearing offspring. At the same time, the entire group contributes to the welfare of its members and allows the context for young to be protected during their long period of dependency and provides time for learning. A fundamental part of the behavioral flexibility and adaptability of primates is the ability to adjust behavior to meet the competing demands of survival and reproduction.

Hominid Revolution: Bipedal Walking and Communicating

The human family, the Hominidae, builds on the combined mammalian and primate foundations of infant care, female mobility, and social communication. The origin of hominids from ape ancestors came about during the acquisition of a new locomotor pattern based on upright posture, weight bearing, and movement. The new way of life was based on habitual bipedal walking that, in turn, profoundly modified body shape and proportions.

For all hominids, the new locomotor pattern

enabled long-distance travel and carrying. This pattern probably emerged when early humans came to rely heavily on ground resources dispersed seasonally and spatially, as they moved away from the forests into the more mixed vegetation of the savanna mosaics (Laporte and Zihlman 1983). Individuals then could forage over a wide area, collect and carry a variety of foods, and scan the landscape for resources and possible danger. Upright posture makes for more effective displays against predators by permitting vocalizations, jumping, arm waving, or throwing objects. Their hands and upper limbs could be used for manipulation and gesturing rather than for weight bearing during locomotion.

The distinctly human body shape and proportions can be attributed to this locomotor adaptation. In body proportions, humans have massive lower limbs and light upper limbs relative to total body weight (Zihlman 1992). The size and shape of the human pelvis and associated musculature play a major role in locomotor function. The short and broadly curved human pelvis provides a link above with the upper trunk and below to the thigh, leg, and foot. The curves of the pelvis and thigh accommodate the attachment of muscles for hip extension and rotation and reflect the underlying massive musculature and large joint sizes.

There are physiological and mechanical costs of this upright posture. Increased biomechanical stresses on hip, knee, and ankle joints and in the vertebral column, especially in the lower back, result from the vertical body alignment and intense compressive forces generated during bipedal locomotion. The brain now lies above the heart and sufficient blood flow is maintained by overcoming gravity (Falk 1990). This locomotor system, a “makeover” from that of a quadrupedal ape, must have offered advantages that outweighed these difficulties (Zihlman and Bruner 1979).

Bipedal locomotion and consequent body reorganization affected hominid females even more than males. For women, the pelvis serves multiple functions and possible competing selection pressures: the basis for bipedal loco-

motor function; the pathway to conception, exit for birth, and a framework for positioning the genitals; and a means of internally carrying a fetus and externally carrying a nonclinging, suckling infant, and possibly food and implements. For these reasons, looking at the hominid way of life in greater detail from a life-history perspective—from the point of view of females, infants, and juveniles—offers a different perspective on the hominid adaptation in contrast to a traditional, usually male, point of view.

WOMEN'S BODIES: MOBILITY, WORK AND REPRODUCTION

As is becoming clear from studies of women cross-culturally and of women athletes, the physical capabilities of women are indeed amazing. During several million years of human prehistory, until food production some 10,000 years ago, women routinely traveled long distances to collect and carry food, and nursed and transported their infants during their early years. They had to adjust to competing demands of ovulation, gestation, lactation, work, and child care (Shostak 1981; Lee 1979). Women's bodies have evolved in response to the range of activities throughout the life course needed to survive and reproduce. Their anatomy and physiology accommodate an extended period of breast-feeding an infant with a great deal of brain growth after birth, while maintaining their own mobility and survival.

The human species is unusual among mammals and primates in having abundant body fat, and women have significantly more fat than men and children (Pond this volume). Relative to body weight, women, on average, have more than 25% fat, whereas men have only 14% (Forbes 1987). Other primates—female macaques, for instance—have about 13% body fat (9% in males), which is less than half of the percentage for women (McFarland chap. 12). Therefore, this lesser amount of body fat may be more typical of nonhuman primates.

Several issues center on this nature of tissue

composition. First, why do women have so much body fat? Second, how does the amount of fat affect the proportion of other bodily tissues, especially muscle? Third, what can account for the specifically human pattern of fat distribution (Pond chap. 11)? In order to address these issues, we must look at not just fat, but the whole body and its function.

There is not complete agreement about the function of human body fat. Laboratory and field research suggest that, from an evolutionary perspective, women meet the competing demands of lactation and work effort by using fat reserves as a cushion against nutritional variation. In the long evolutionary time frame, such reserves probably contribute to successful reproductive outcome at all levels: in ovulation, conception, successful completion of a pregnancy, lactation, and survival of infants and children.

The distribution of human and primate body fat follows a mammalian pattern: storage in the pectoral region, thigh, and base of tail (or buttocks in the absence of a tail) (Pond and Mattacks 1987b; Pond chap. 11). These locations lie near the center of gravity, a placement that does not interfere with efficient locomotion. Locomotor function is vital to all aspects of survival and reproduction, and the ability to walk long distances, to carry food and infants, and to use the upper limbs and hands cannot be compromised.

The greater percentage of body weight devoted to fat in women, compared to other primates and to men, alters the proportion of other body tissues. For example, in macaques, 40 to 45% of body weight is devoted to muscle, a figure that is typical for many other quadrupeds (Grand 1977a). In women, 36% of body weight is muscle. Men, who have about 43% muscle, have departed less from this primate pattern than have women.

With lesser amounts of muscle tissue, which muscles groups have been modified in women? Muscles of the hip, thigh, and leg provide propulsion, braking, and balance functions during bipedal walking, and these muscle groups seem least affected in women. Women are capable of

endurance in long-distance walking and running, and physiological research indicates thigh muscle strength is similar in women and men (Dyer 1982).

Humans share with other apes (hominoids) a large clavicle, broad and flat chest (Schultz 1969a), and well-developed shoulder and arm musculature (see Zihlman chaps. 8, 13). The upper trunk of women departs more noticeably from this pattern than does that of men. Women are less muscular in their upper trunk and upper limbs. Nonetheless, women are capable of heavy work, and they do such work throughout their lives.

Women's bodies, then, build upon the mammalian and primate features of fat storage and mobile calcium, but during hominid evolution, a greater proportion of body fat was added, reshaping tissue composition. The modified proportions of fat to muscle tissue does not diminish women's locomotor abilities, endurance, and strength. Women's bodies not only perform many tasks but also do so during their reproductive lives. In their postreproductive lives, women continue to participate in economic activities, in caretaking, and in the social activities of the group.

WOMEN'S LIVES: MOBILITY, WORK AND REPRODUCTION

For most of human history, humans had a nomadic way of life. It is under these conditions, rather than those of our more familiar village or urban life, that human lives and bodies evolved.

The interrelationship between locomotion and mobility, work effort, and the several dimensions of reproduction in women's lives have been highlighted by anthropological studies (e.g., Marshall 1976; Shostak 1976; Lee 1979). Studies on the gatherer-hunter !Kung in Botswana provide a perspective on how nomadic life affects women. The findings challenge the traditional and static image of immobile, stay-at-home, and physically weak women (Lee 1968, 1969; Marshall 1976; Shostak

1976). Data on the contributions of women—from before through after the reproductive life phases—to the economic and social life of such societies replace the old stereotypes. The subsistence pattern requires that people traverse a large home range to carry implements, find water, collect, hunt, and transport food and implements. Women travel long distances, carry heavy loads, find and collect food for their families, take care of others, all the while carrying and nursing their infants.

Women accommodate to frequent travel, to the effort of finding, picking, digging, and carrying food and firewood back to camp during pregnancy, infant-carrying, and lactation (Lee 1972, 1979). A !Kung woman nurses and carries each child for more than 3 years; consequently, the birth interval is over 4 years. Early studies recognized that lactation acted as a contraceptive by suppressing ovulation and contributed to wide spacing of births (Konner and Worthman 1980). The birth interval perhaps also is compounded by nutritional stress and disease and by the effort of collecting food while carrying infants; together these factors contribute to amenorrhea (Howell 1979).

Research during the past few years has focused on the variables that influence the outcome of a woman's reproduction during her lifetime (Ellison 1990). Ovarian function, time spent in activities (an indirect measure of energetics, see Panter-Brick chap. 17), and the types of activities women perform have been measured (Ellison et al. 1989; Peacock 1985) under a variety of conditions. Together these studies demonstrate the complex interrelationship between individual physiology—including body weight, nutritional status, ovarian function, and milk production—and external, ecological variables—such as food availability and caloric intake and disease—on reproductive outcome (Prentice and Whitehead 1987). In addition, the behavioral dimension of individuals, such as the distances they travel and the amount of work done each day, clearly intersect with cultural practices relating to subsistence patterns and child care (Panter-Brick chap. 17; Vitzthum chap. 18).

A cross-cultural perspective on child care, according to time-allocation studies, indicates that women add child care to their other tasks (e.g., Efe foragers in Zaire [Peacock 1991]). In other words, women with and without children spend a similar amount of time engaged in multitask work.

In foraging and horticultural societies, women can and do perform the same range of tasks as men. For example, work patterns are influenced by the seasons, and among the Tamang in rural Nepal, increased efforts coincide with rice planting during the monsoon. All agricultural labor is valued equally, and everyone works. Mothers and non-childbearing women engage equally in agricultural tasks (Panter-Brick 1992a; chap. 17). Among the Agta in the Philippines, women with and without children work hard, take risks, travel many miles over rugged forest slopes, and hunt with bow and arrow (Estioko-Griffin and Griffin 1981; Estioko-Griffin 1985). Every able-bodied Agta is capable of accomplishing any task necessary for the group's subsistence. Among the Efe in Zaire, task assignments are not determined by physical strength, but rather by the energetic constraints imposed by pregnancy and lactation in a food-limited environment (Peacock 1991). Women also cooperate in child care. For instance, women may suckle each other's infants so that Efe women who are lactating may continue their work in the fields. In addition, women may travel shorter distances than men, in order to return home by evening to prepare the meal.

Cultural practices affect the relationship between women's work and their reproductive outcome. For example, among the Tamang, children are weaned after the age of 2 years because they become too heavy to carry. These juvenile children are not taken to the distant fields but are left alone or with an older sibling. They are at risk because their health is compromised by inadequate nutrition and sanitation. In fact, there is a high mortality rate for children under 5 years (Panter-Brick 1989). Because their child-care practices and work patterns differ, children of the Hindu and Tibetan

ethnic groups in the same region do not have high mortality rates. Children in these families either travel with their mothers or stay home with senior women, often the grandmother.

In each culture, the particular combinations of work and child-care practices may affect survival of children and therefore also influence women's lifetime reproductive effort. It is evident that when all dimensions of women's lives are looked at in a variety of cultures, women around the world "do it all." Women are physically capable of performing a full range of tasks including hard labor; child care is simply added to the other tasks that women already perform.

The Fossil Record

During the course of human evolution, two anatomical changes that profoundly influenced the hominid way of life are documented in the fossil record: bipedal posture and locomotion and the development of a large brain. The earliest evidence for the adoption of upright posture and two-legged locomotion dates to more than 3.5 million years at Laetoli, Tanzania. There, tracks of hominid footprints, along with teeth and jaws in the same fossil deposits, indicate the appearance of bipedal hominids (Leakey and Hay 1979). At this early stage of evolution between 3.5 and 2 mya, fossil evidence provides a picture of early hominids. They had small brains (450 cc)—little larger than those of modern common chimpanzees—small canine teeth, and large molars and premolars. Body proportions indicate short rather than long lower limbs—proportions similar to those of apes—and somewhat shorter upper limbs, suggesting a lower center of gravity than in living apes (Zihlman 1992). Between 1.5 to 2 million years ago, the genus *Homo* developed a larger brain size (850–1000 cc) and smaller molar teeth. A nearly complete skeleton of *Homo erectus* from Kenya shows body size and proportions that appear to be similar to those of modern humans (Walker 1991; Walker and Leakey 1993).

The fossil record provides little evidence of soft tissue and, therefore, few clues about when

an increase in body fat might have occurred. Except for teeth, jaws, and crania, which are more often preserved as fossils, remains of the rest of the skeleton are rare and incomplete. Sorting females from males always is problematic, even for fossil pelvises. In modern humans, this part of the anatomy distinguishes between women and men, because the female pelvis changes during growth and development to create a birth canal large enough to accommodate the passage of a large-brained neonate. But brain size in early hominids is small, so that the pelvis is probably similar in females and males, much as it is in modern apes (Hager 1991).

The fossil record, however, does provide evidence for rates of development and offers opportunities for reading some of the life-history characters in the bones and teeth of past hominids (Morbeck chap. 9; B. H. Smith 1992). Studies of hominid dentition demonstrate that the rate of development, although distinct in early hominids, is more similar to that of chimpanzees rather than to that of modern humans (Bromage and Dean 1985; B. H. Smith 1986). By the time *Homo* appears, overall brain size is larger and the life stages devoted to growth and development of the brain are presumably longer. Probably, at this time, the length of gestation increased over that of the apes, and infants required greater care and a longer period of lactation. Therefore, the length of the juvenile stage also may have increased, which in turn, required mothers and other caretakers in the social group to adjust to this longer social dependency.

Social Communication and Dependent Infants

Looking at human evolution from the perspective of mothers and infants also permits interpretation of the evolution of the large brain and the origin of human language. The two obvious anatomical changes that occurred during human evolution—bipedal locomotion and enlarged brain size—had profound effects on infants, both in their growth and development

as well as in their relationships, first to their mothers and, later, to other members of the social group. Both changes required that, compared to other primate infants, hominid infants receive longer and more intensive care after birth.

The reorganization of the body that occurred with hominid bipedal locomotion affected infants' ability to cling and their mothers' needs in assisting them. In hominids, the hands are not involved in weight bearing during locomotion and are less massive in humans (1% body weight) than in quadrupedal chimpanzees (2% body weight [Zihlman 1992]). Furthermore, modifications in the feet for greater stability during walking on two limbs suggest the feet are less effective for clinging. Also interfering with a human baby's ability to cling to its mother might have been the reduction of human body hair. This probably occurred early in human evolution in order to reduce excess heat generated from activity in the open savanna (Zihlman and Cohn 1988). For a variety of reasons, therefore, early hominid mothers had to assume a more active role in supporting infants. Infants, in turn, assumed a more active role in maintaining contact with caretakers through enhanced communication channels (Borchert 1985; Borchert and Zihlman 1990).

The hominid communication system builds on the mammalian ability to give and receive vocalizations for mother-infant interaction (MacLean 1985; Zihlman chap. 8). Added to this is the primate emphasis on visual, especially face to-face, communication, which is facilitated by the active holding of infants and the close physical association of infants and mothers during nursing and carrying (Tanner and Zihlman 1976b). During hominid evolution, both infants and mothers actively maintained mutual contact by elaborating both the visual—gestures and facial expressions—and vocal modes. For example, the hands no longer used in clinging to a caretaker, now became available for more effective gesturing. The development of smiling, reaching and pointing, cooing and crying helped to ensure contact

with mothers and other caretakers and thus contributed to the infant's survival.

Language may have emerged from this infant-mother interaction as part of the changes accompanying the adoption of bipedal locomotion. From the point of view of the infant, babies may have first made use of soft vocalizations in order to coordinate activities with their mothers. This need for babies to maintain a more extensive vocal dialogue with their mothers may have produced the initial development and later evolution of sensorimotor intelligence (Borchert 1985; Borchert and Zihlman 1990).

Furthermore, infant and mother hominids, like other primates, functioned in the larger social context and not as an isolated unit. Therefore, vocalizations also could have facilitated interactions between the infant and other group members who also contributed to its survival. Viewing language origins as enhancing the survival of infants and juveniles is consistent with the pattern of evolution of mammalian communication. Vocalizations that are part of infant-mother interactions characteristically show up in adult mammals' greeting displays and sexual behavior (Gould 1983; MacLean 1985).

After weaning during the long juvenile period, young hominids are vulnerable; their body size has not yet reached the adult state; they are practicing their social skills and learning about the environment. A juvenile hominid, like other juvenile primates, is still dependent—especially on its mother and siblings—for food sharing, protection, and for emotional well-being. However, in the context of the social group, young hominids also develop relationships with playmates and other adults. Vocalizations, gestures, and facial communication would have facilitated interaction with others and would have enhanced survival at this life stage also.

The increase in brain size and change in pelvis size during the last 2 million years of hominid evolution indicate that, at some point, infants were born with relatively larger brains compared to other catarrhine primates. Like

other primates, human infants have well-developed special senses at birth (tactile, auditory, taste, olfactory, visual), but are very immature in motor function and are, therefore, quite helpless. The human brain is the anatomical basis of language, memory, and social intelligence. It develops rapidly postnatally, from 25% of adult weight at birth to about 95% by 10 years of age (Tanner 1990), and as it grows, so does the learning rate of children. Aside from learning language, juveniles acquire social roles early in life—by the age of three (Morelli chap. 15; Draper 1975b). If the evolution of large brain size is interpreted from the point of view of infants and children, then it relates to the ability of the young to learn a lot quickly so that they survive to sexual maturity. Once language developed, however, it could be applied in all realms of life.

The origin of language might relate more to this early stage of life, rather than to the traditionally emphasized model of language as a product of hunting and therefore a male activity. Language origins are often held up as marking the transition to modern humans, which implies that language was a survival feature, rather than a more specific way to communicate.

SUMMARY: LESSONS FOR RECONSTRUCTING EARLY HUMAN SOCIAL LIFE

Through the discussion of women's bodies and lives as dynamic, variable, and adaptable, this chapter offers another perspective for looking at women during prehistory in terms of their physical attributes, workload, and reproductive system. When placed in an evolutionary framework, the abundance and distribution of women's body fat is usually interpreted as a sexual attraction for men. Interpretations about body fat should consider the overall function of women's bodies over evolutionary time. With this perspective, major changes in women's bodies—including the abundance of fat—emerged in order to accommodate many

kinds of activities, such as collecting and preparing food, traveling, nursing, and carrying dependent but growing infants, as well as caring for children after weaning.

Reconstructions of early hominid social life, almost without exception, postulate monogamy as a hallmark of humanity, that is, monogamy supposedly originated some 5 million years ago and has remained unchanged until the present time. The basis for this conclusion is the supposed high parental care by males. This supposition ignores three facts. First, in most cultures, men have little direct involvement in child rearing. Second, women add child care to a wide range of other tasks and often cooperate with each other to handle child care. Finally, it also omits the fact that children are not just part of an isolated mother-infant unit, but are part of a social group, all of whom contribute to a greater or lesser degree to the well being of children. Children, in turn, begin contributing to the society, by practicing skills or by actively participating in caretaking of siblings or assisting in herding, food preparation, and other activities (Morelli chap. 15).

The sexual division of economic labor often is viewed as a defining hominid feature. The implication usually is that women do the "easier" tasks and men do the "heavy," risky work, like hunting. This assumption obscures

the fact that cross-culturally women engage in vigorous activities, ones that involve risky behavior, skill, long-distance travel, and the carrying of heavy loads. When the full range of women's activities are acknowledged, it is difficult to view early hominid women's activities as rigidly limited.

In conclusion, women's bodies and lives were shaped over evolutionary time as mammals, primates, and hominids and did not arise merely from conditions evident in the recent historical past. Once that is acknowledged, then it is possible to shift from defining women's bodies and lives only in terms of anatomical and physiological traits or only in the stage of adult life. The cross-cultural variation in women's lives highlights their adaptability and exemplifies the behavioral flexibility established as part of this evolutionary background.

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