

Conceiving the New World Order

The Global Politics of Reproduction

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Misreading Darwin on Reproduction: Reductionism in Evolutionary Theory

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In formulating the concept of natural selection, Darwin introduced the idea of “reproductive success”—the survival and reproductive outcome of whole organisms. Over the last hundred years evolutionary mechanisms have narrowed dramatically from this focus on whole organisms to a focus on the survival and replication of genes from one generation to the next. In addition, the traditional emphasis on male reproductive success, which also began with Darwin, has profoundly affected theoretical formulations of primate reproduction and reconstructions of human evolution. Most recently an emerging critical consciousness about cultural influences on scientific theory has illuminated the genesis as well as the limitations of these theories. Following a discussion of Darwin, I review here how reproduction was represented in evolutionary theory in the 1940s, in sociobiology in the 1970s, and in reconstructions of human evolution.

Because sexual reproduction is the linchpin of vertebrate evolution, it has necessarily been a consistent theme in discussions of primate, including human, evolution. Yet the theoretical framework remains focused as much on males today as it did more than a hundred years ago, when Darwin proposed the evolutionary mechanism of sexual selection, even though females and males contribute equally to fertilization; female mammals gestate and nurture the fetus and feed the newborn animal; and female primates, like all mammals, lactate and, in addition, carry the infant after birth and continue to promote its survival even after weaning.

This chapter continues the discussion of biological reproduction through case studies in primatology and human evolution. I speculate about the persistent focus on biological paternity in evolutionary theory by examining dual cultural trends: (1) the historical exclusion of women

as participants in science and the historical characterization of women in science (for example, Schiebinger 1989, 1993; Noble 1992); and (2) tenets of monotheism that define women's reproduction and the social relationship between women and men (for example, Delaney 1991).

Finally, this chapter should be understood as part of a larger argument that characterizes science as a masculine activity, challenges its objectivity, emphasizes the contributions of women, and documents how cultural ideologies and historical practices can influence interpretation of research findings (for example, Birke 1986; Bleier 1984, 1986; Borchert 1985; Delaney 1986; Fausto-Sterling 1985; Fedigan 1986; Flax 1990; Haraway 1989; Harding 1986; Keller 1985; Schiebinger 1989, 1993; Landau 1991; Noble 1992). More specifically, I extend the multilayered perspective on reproduction put forth by Ginsburg and Rapp (1991) by exploring the intersection of evolutionary theory and empirical research with cultural practices in scientific and religious discourse.

DARWIN AND REPRODUCTION

When Darwin put forth his ideas on natural selection in *On the Origin of Species* (1859), he viewed reproduction as the means for transmitting hereditary material from one generation to the next. Natural selection—a concept of differential survival and reproduction—is the mechanism for evolutionary change that he proposed. Darwin observed that some individuals and not others survive to maturity; of those that survive, some leave more offspring that survive to maturity than do others in the same population. Sexual reproduction, then, by transmitting new combinations of hereditary material from female and male parents to offspring provides the “raw material” for the longer-term process of natural selection.

In *The Descent of Man, and Selection in Relation to Sex* (1871), Darwin proposed his theory of sexual selection and directed attention specifically to mating behavior as a mechanism that shapes female and male differences within species. Not all individuals who survive to maturity have equal chances to mate or to produce the same number of offspring; the next generation of the population will reflect the outcome of these differential opportunities. This idea of “reproductive success” is at the center of Darwin's concept, and the term is used widely, though not always with the same meaning.

Darwin's theory was strengthened by his experience with many species of animals and his concern with whole organisms. Individual organisms that are members of both populations and species undergo physical and behavioral changes as they grow up and mature under a particular set of external, environmental circumstances. Darwin acknowledged all levels

of biological variability, from the unique traits of individuals to those shared by populations and species. He properly emphasized that natural selection operated on individuals during all stages of life and that the environment created more or less favorable conditions for survival.

Perhaps Darwin's comprehensive approach was made possible by the fact that genes were missing from his formulation. Darwin did have a concept of heritable variation—natural selection relied on it—but he had no mechanism of heredity to account for it. The idea of particulate inheritance and the existence of “genes” were unknown to Darwin. His reliance on the blending of hereditary material was attacked when research in genetics became prominent early in the twentieth century and revealed information about the hereditary transmission of genes through sexual reproduction. An emphasis on genes and traits resulted in a somewhat reductionist view of organisms. Consequently, Darwin's concept of whole organisms who survive and reproduce in an environmental context was lost in some research areas.

In 1859 Darwin only hinted at the implications for human origins—“Light shall be shed on man and his origins”—and in later editions of *Origin* this statement was modified to “much light shall be shed.” Only toward the end of his life, in *Descent*, did Darwin approach the issue of human origins and evolution head on. Whereas species and the variation among them were the earlier objects of study, he shifted his attention to variation among males and females within a species and to formulating the concept of sexual selection.

Darwin highlighted the morphological and behavioral adaptations in males that enable them to find females and to mate with them successfully. Drawing on examples ranging from invertebrates to birds and mammals, Darwin came to the conclusion, still widely accepted, that males compete in order to gain access to females; in order to attract females, males possess secondary sexual characteristics such as a larger body, odors, vocalizations, displays, and fighting ability. According to Darwin, sexual selection is a two-part process—males compete and females choose. Sexual selection is distinct from natural selection, which selects for traits that influence the survival of individuals at all life stages. (For more detailed treatment of sexual selection, see, for example, Campbell 1972; Cronin 1991; Ghiselin 1969, 1974; and see Small (1993) for detailed discussion of female choice.)

Perhaps it is not surprising that Darwin, a nineteenth-century English gentleman, highlighted primarily males—their morphology and behavior—and treated females according to that male standard. For example, he portrayed males as active individuals who establish and maintain territories, seek females, and lure and display to them. He portrayed females as somewhat passive, though he thought they exercised some choice

among the limited range of "fit" males. Regarding women, Darwin suggested that they were even more passive and exerted less "choice" than females of other species (Zihlman 1974). In this view of the perpetuation of the species, male activities relate directly to the acquisition of mates and the sex act itself, and, by comparison, the female's role in reproduction is minimized.

Darwin also confounded morphological and behavioral attributes as part of sexual selection. For example, in reference to humans, Darwin describes men as taller, heavier, and stronger—anatomical and physiological attributes—but he also viewed men as more courageous, pugnacious, and energetic—qualities that involved subjective assessment. This equating of physical features with behavioral qualities persists as a source of confusion in distinguishing female and male characteristics among primates because it conflates the biological with a social-developmental or culturally valued base.

Darwin maintained that because many anatomical and behavioral differences between females and males were directly involved in mating, they necessarily arose through sexual selection. His examples were drawn from many species including spiders and bees as well as birds and mammals. From these examples he attempted to generalize the process of sexual selection, implying that morphological and behavioral traits were homologous among all species. In particular, Darwin illustrated many of his points with birds: the bright plumage of the males and drab coloration of females, the visual and vocal displays of males, their fighting for territories to attract females. In contrast to Alfred Russel Wallace, who was writing at the same time, Darwin did not acknowledge that the drab coloration of female birds might be adaptive for camouflage while incubating the eggs (Cronin 1991). In mammals he singled out the physical attributes of body size and weight and in primates canine size, and he credited the largeness of these features in males to their fighting ability. He implied that sexual selection operated similarly in both birds and mammals, even though the modes of reproduction of each (egg laying versus gestation and parental feeding versus female lactation) have different anatomical and physiological bases.

In sum, he clearly emphasized the role of males in reproduction—in acquiring mates and in copulating successfully—and minimized the extent of female involvement in reproduction. This treatment might in part be attributed to Darwin's lumping together of mammals and non-mammals, which illustrates a more general point that interpretations and hypotheses are influenced by the species chosen for study and by methods of comparison. The narrow focus on males is particularly troublesome for understanding primates because females play a significant role in conceiving and caring for offspring through conception, gestation, and

lactation and in providing a stable social environment through the generations.

THE MODERN SYNTHESIS OF EVOLUTION

What came to be known as "neo-Darwinism" or the "modern synthesis of evolution" (for example, Huxley 1942, Mayr and Provine 1980, Grene 1983, Bowler 1989) consolidated diverse elements from genetics (gene function, mutation, transmission) and population genetics (the role of genetic drift) with the Darwinian concept of natural selection. Some of the tenets underlying this synthesis were that the mutation and recombination of genes during sexual reproduction provide new sources of genetic variation, that individual or group migrations (gene flow) mix up and alter a population's genetic material (gene pool), and that natural selection sorts and shapes the variation so that species survive and perpetuate themselves while adapting to the existing environmental conditions. This new synthesis was becoming established by the 1940s (for example, Dobzhansky 1937, Simpson 1944, Jepsen, Mayr, and Simpson 1945), and during the 1950s it became incorporated into physical anthropology and the study of human evolution (for example, Washburn 1951, Bowler 1986).

Classical genetics remained central to the modern synthesis of evolution. In seeking to relate a gene to its phenotypic expression, researchers must necessarily rely on relatively simple organisms such as *Drosophila* (fruit flies) and even on microscopic organisms like *Neurospora* (bread mold) and *E. coli* (bacteria). In these species it is possible to establish the presence of genes and then to connect a gene directly to its expressed trait. Studies of these species thereby shaped the development of the discipline, and although informative, they are limited in what they can contribute to understanding the developmental program of more complex species. Their lives and their reproduction are simple compared with the lives and reproduction of large-brained, large-bodied, long-lived mammals, including primates, living in social groups of several generations. Except in exhibiting the results of deleterious genes, mammals and primates do not lend themselves to simple demonstrations of gene expression in structure or behavior.

Under the influence of population genetics, evolutionary theory preserved and expanded some of Darwin's ideas, whereas other aspects declined. As it became known that genes are linked to the expression of specific traits, Darwin's approach to organisms as integrated individuals shrank. At one theoretical extreme in the modern synthesis, the concrete living organism is viewed as a "temporary gene carrier" (for example, Dawkins 1975). This approach to the whole animal is reflected in terminology—"gene flow" (the migration or movements of individuals), "gene

pool" (the collection of genes carried by the individuals in a breeding population). As a result evolution comes to be defined as changes in the frequency of genes in populations through time.

Viewing organisms as a collection of inherited adaptive traits diminishes or eliminates the role of growth and development, learning and individual experience, and their contribution to the process of reproduction and, therefore, to the process of natural selection and adaptation. This narrow view of organisms extended into the field of animal social behavior, as sociobiology emerged during the 1970s as a specific theoretical and research area. The situation was not helped by the molecular-biology revolution, which began in the 1950s. The whole-animal concept tended to be further removed from the process of natural selection as a result of discoveries that revealed the structure of the gene, how it replicates itself, and how the genetic code translates a gene into a protein (the "trait" or unit character) and only indirectly into structure (for example, Russert-Kraemer and Bock 1989). Reproductive success, then, at its most reductionist, is success in passing one's genes on to the next generation.

SOCIOBIOLOGY AND REPRODUCTIVE SUCCESS

The early study of animal behavior paralleled but did not intersect with the evolutionary framework of the modern synthesis in biology. The Nobel Prize-winning ethologists Konrad Lorenz, Karl von Frisch, and Nikolaas Tinbergen and comparative psychologists such as T. C. Schneirla and his students emphasized systematic observation and description of animal behavior in selected species of insects (von Frisch on bee language), birds, and fish, starting in the 1930s, but seemed uncertain how to incorporate their data into an evolutionary approach. Field-biology studies on small mammals dealt with population demography, the numbers of individuals moving through the life stages, and rates of population increase or decrease, and not with the reproductive outcomes of individuals, who were abstract parts of changing population profiles.

With the publication of *Sociobiology* in 1975, E. O. Wilson formally placed the study of social behavior and social systems within the realm of evolution. This theoretical framework relied upon the mechanism of sexual selection put forth by Darwin and also integrated the findings of population genetics in the modern synthesis. Wilson focused on kin selection (Hamilton 1964) and sexual selection, mechanisms that many believe address the central theoretical problems of altruism and mate selection (Cronin 1991). His encyclopedic volume, as if following Darwin's approach, combined case studies of animals ranging from jellyfish (coelenterates) and social insects (Hymenoptera) to mammals, including non-human primates and "man." Drawing on Trivers's (1972) ideas about

sexual selection and parental investment, Wilson incorporated the idea that the sex that invests the most in the offspring has the choice among mates who compete among themselves. The central theme is reframed as "reproductive strategies" and "reproductive success," although the focus on male behavior, genetic relatedness ("kin"), and biological paternity continues.

Reductionism

As a field of study, sociobiology perpetuates and expands the focus on the male role in reproduction, especially male-male competition, and includes the idea of a male's "investment" in the survival of "his" offspring. Unlike Darwin's work, however, it loses sight of the whole organism and gives little attention to natural selection acting during all phases of life. This loss of the whole organism compounds the shortcomings of the modern synthesis of evolution, which views organisms as collections of genes and traits, taking adaptation to an extreme (Gould 1983)—for example: "natural selection is the process whereby certain genes gain representation in the following generations superior to that of other genes" (Wilson 1979: 3). The sociobiological theorists (Wilson, Hamilton, Trivers)—like the population geneticists—draw theoretical conclusions from their research on invertebrates, such as the social insects. It may be the case that the gene-to-trait formulation is sufficient to explain invertebrate behavior, but it is inadequate as an explanation for the behavior of many mammals and primates with extended lifetimes and broadly based social behavior.

As early as 1955 Beach criticized the emphasis on instinctive behavior by the early ethologists. Beach, who studied mammals and researched the relationship between hormones and reproduction (he concluded there is no simple relationship), noted that the complex behavior patterns of adults emerge gradually during development and do not appear suddenly or completely, as do behaviors in insects and in some birds. Beach's warning should have been heeded by later students of animal behavior as well, but it was not. The important role that maturation and experience play in the development of adult behaviors, as Beach pointed out, has not been incorporated into theories of animal behavior in sociobiology.

In the search for a universal theory of social behavior and social systems, sociobiology glosses over the fact that mammals, including non-primates and humans, differ fundamentally in their biological organization, physiology and anatomy, and developmental program from invertebrates like the social insects and from other vertebrates like fish and birds. The mammalian (especially primate) reproductive system is

distinguished by marked female investment of time and energy in gestating, lactating, and caring for offspring. Therefore the theoretical framework for nonmammals may not apply to mammals. Because of the reductionist approach to reproduction from the individual to the gene in sociobiological theory, there is no social behavior beyond that directed toward reproduction. Furthermore, "social behavior" becomes an abstract category that is assumed to be homologous across classes of animals from insects to primates.

The concepts of *reproductive success* and *social systems* take on narrow and incommensurable definitions: reproductive success most often means mating success, and social systems are equated with mating systems (for example, Rowell 1991b). For insects, reproduction may be all there is. Primate lives, however, entail a long period of growth and development prior to sexual maturity, when experience varies among individuals, and learning complex social and communicative skills is central (for example, Goodall 1986, Cheney and Seyfarth 1990, Borchert 1985, Sperling 1991).

Language

One of the most revealing aspects of Wilson's new synthesis in sociobiology is the anthropomorphic language, which places females in a passive or inferior position. In describing sexual behavior Wilson and many others use *promiscuity* to indicate multiple matings for females but not for males—for example, "female chimpanzees are essentially promiscuous" (Wilson 1979: 270). Males with multiple matings are polygynous, a word that implies order, whereas promiscuity evokes images of immoral chaos. Descriptions of animal mating systems—monogamous, polygamous, polygynous—are borrowed from cultural anthropology; they are imbued with symbols and meanings and have only the vaguest behavioral referent.

Along these same lines, *harem* is commonly used to describe a mating system where one male controls the fertility of several females. Although the use of the term is said to be a convenient shorthand, it is doubtful that "biologists are so sophisticated that they can use the word without carrying with it the whole portmanteau of *Arabian Nights* associations" (Rowell 1991a: 59).

Cuckoldry, the term Wilson uses to describe "marital conflict and deceit," is applied to reptiles, birds, and mammals as well as to people—for example, "a male cannot always be completely sure that his mate's eggs have been fertilized by him" (Wilson 1979: 164). Trivers (1985: 267) illustrates "cuckoldry in the giant water bug." Some insects seemingly have

been influenced by Latin culture: "Rampant machismo has evolved in some insects" (159).

These and other phrases describing "rape" in mallard ducks, "prostitution" in hummingbirds (Barash 1977, 1979), or "infidelity and adultery" in the pied flycatcher (Birkhead and Moller 1992) form no basis for analysis or experimentation. These terms are problematical because they imply a defined methodology among researchers and assume homologous behaviors across species separated widely by evolutionary history, developmental program, morphology, and adaptation.

The language of sociobiology has been discussed extensively and critically, but since language both reflects and shapes social reality, the problem is not just semantic. Dagg (1983) argues that the created reality is one of female inferiority. This inferiority is established by employing words and concepts to describe animals and their relationships that are biased and stereotype women; downplaying aggression in female animals in accordance with the presumed nonaggression of women; and largely denying females an active role in sex and infant survival. Dagg maintains that researchers transfer their assumptions (unconscious as they may be) about the inferiority of women to their observations and characterizations of the social behavior of animals.

"Infanticide"

The phenomenon of "infanticide" illustrates one sociobiological approach to animal, particularly primate, reproduction. The relationship between infant death by aggression and reproductive success of males, although hotly debated among primatologists, has turned into a showpiece for sociobiology and appears in animal behavior textbooks (for example, Hrdy 1977b, Hausfater and Hrdy 1984, Curtin and Dohlinow 1978, Trivers 1985). I use their controversy as an example of a popular view of primate reproduction and leave aside empirical aspects of the controversy, such as sample size of observations and the conditions under which "infanticide" occurs—for example, population size, density, and ecological setting.

Originally a legal term for a specific kind of human homicide, "infanticide" is most often discussed as a reproductive strategy of male langur monkeys (*Presbytis entellus*). Initially using as a basis a study of langur monkeys in India, Hrdy (1977a) proposed a new variation on the theory of sexual selection deriving from observations that infants occasionally die as a result of aggression. Male monkeys who live together outside a heterosexual group have been observed to aggressively "take over" a group of females and chase out the resident male. At least on some occasions a

new male attacks and kills the young infants of the resident females. According to this theory, after the infants are killed, their mothers will no longer lactate and will come into estrus sooner than if the infants had lived, shortening the birth interval between successive offspring. They will now mate with the new male and presumably produce infants that he has sired. In this framework, the behavior of the "infanticidal" males is interpreted as adaptive, as a reproductive strategy that ensures that the new male passes his genes into the next generation. In other words, killing infants is interpreted as a means for males to compete with each other for biological paternity. (But see Boggess 1984 and Bartlett, Sussman, and Cheverud 1993 for discussion of these issues, and see Haraway 1983 for another slant on the infanticide debate.)

The infant-killing theory illustrates the widespread assumption that certain male behaviors (as defined by researchers)—in this instance, male behavior that involves killing—correspond directly with reproductive outcome (insemination and fertilization). At the most general level, this interpretation demonstrates how researchers using sociobiological theory privilege paternity (versus maternal behavior and investment) and view male behavior as concerned primarily with "outcompeting" other males for access to and fertilization of females. Females are portrayed as reactive "victims" of male aggression. Males are imbued with "strategies," whereas females develop "counterstrategies" in response to male behavior. As Mary Pavelka pointed out to me, a female is then disadvantaged in two ways. She loses her investment in the minimal six months of gestation and some postnatal caregiving. And she may lose because the reduced birth interval may decrease the chances of the next infant's survival.

Challenges to Sociobiological Theories

A number of long-term primate studies challenge this simplistic interpretation of primate reproduction on major grounds. First, reproductive outcome can be meaningful from an evolutionary perspective only if an individual's total offspring are tallied at the end of life. Therefore, the entire life course of males and females (for example, Fedigan et al. 1986) must be taken into account in assessing reproductive success. Because so many males do not survive to adulthood, the first important determinant for reproductive outcome is a male's physical and social ability to survive to sexual maturity; during this period of growth, development, maturation, and learning, natural selection is operating (Rowell 1988, 1989). Second, males often alter their tactics for survival and mating during the course of their lives, and no single behavior can account for "success" (Harding and Olson 1986). Finally, contrary to the emphasis on male

aggression, long-term studies illustrate that a male's access to females often entails social negotiation and friendly behavior toward them rather than overt aggression (Smuts 1985, Strum 1987).

In addition, for females, long-term research illustrates a high investment of time and energy in being pregnant, lactating, and maintaining bonds with weaned and adult offspring. Indeed females alter their behavior (traveling, feeding, socializing) in a variety of ways in order to maintain the energy balance critical during lactation (Altmann 1980). Contrary to sociobiological tenets, field studies show that female primates exert considerable choice in their mates, which no doubt affects males' reproductive outcomes (Small 1993, Huffman 1992). Also, one study on female Japanese macaques correlated lifetime reproductive outcome with several variables, including life span—that is, living and reproducing for a long time. Although Fedigan et al. (1986) found that a short interbirth interval decreases an infant's chance of survival, the interval must not be so long that the female gives birth to fewer offspring during her life.

Perhaps the most fundamental concern in research on reproductive outcomes, though it has rarely been discussed until recently, is that there is no accurate way of determining a male's offspring from behavioral observations in the field or even in the laboratory. Yet theories about mating systems and reproductive outcome necessarily depend upon being able to determine and count a male's offspring. Instead, researchers have almost arbitrarily assigned importance to some (usually aggressive) behaviors as opposed to others (friendly ones) and assumed a correspondence between mating behavior and paternity.

Applications of DNA fingerprinting now make it possible to test newborn infants to determine their genetic connection to specific males. By using these new techniques researchers can begin to address questions about the relationship between specific behaviors of males and their reproductive outcome. Preliminary results from some macaque groups indicate, perhaps surprisingly, that the number and duration of copulations do not correlate with or even correspond to the number of infants a male sires (Bêard, Schmidtke, and McGeehan 1990, Inoue et al. 1991). Group membership, individual rank, and body size also do not seem to correlate in any consistent way with male reproductive outcome.

But limitations in determining biological paternity and male lifetime reproduction have not impeded sociobiological theorists, who have elevated the behavior of infant killing to a reproductive strategy. They may do so because they take the role of females and their investment in reproduction so much for granted that they ignore them in formulating theory and because they do not question the traditional assumption of male privilege. We need to turn now to other dimensions of the reproductive de-

bate and to consider explanations that are different in kind and not so obvious.

HUMAN EVOLUTION: THE PAIR BOND

The contemporary controversy about reproduction in human evolution parallels the sociobiological debate. The evolutionary anchor in almost all reconstructions of early human society is monogamy. Indeed, monogamy is put forward as the defining social feature of humanity and thus joins with other themes that continue to appear in models of human evolution: loss of estrus, male investment in reproduction, sexual division of labor. These traditional hallmarks of humanity seem to me significantly connected because they all imply male control of female sexuality for the purpose of ensuring biological paternity.

A female-centered hypothesis of evolution emerged as women anthropologists began analyzing the high investment of females in several aspects of reproduction, including gestation and lactation; association with and involvement with juvenile, weaned offspring; and the perpetuation of tradition through generational continuity (Slocum 1975; Tanner and Zihlman 1976; Tanner 1981; Zihlman 1978, 1981; Fedigan 1982). For example, Slocum (1975) consciously intended her theory of woman the gatherer as a direct counter to man the hunter. From the beginning, the resulting dichotomy called out for a synthesis, but unfortunately the debate was enjoined mainly on economic grounds and centered on the relative importance of gathering, hunting, collecting, and scavenging.

Therefore, the early debate did not even touch the far more critical issue of sexual arrangements. In a formulation that was more important than we realized at the time, Tanner and I (Tanner and Zihlman 1976, Zihlman and Tanner 1978) directly challenged the notion that the pair bond was a hallmark of humanity. We rejected female dependence and male control of female sexuality and reproduction and emphasized instead female choice. We maintained that the loss of estrus and the concealment of ovulation gave early hominid women even more opportunity to choose their mates since communication shifted from visual external clues to more subtle interactive signals. We also suggested that females would be more likely to choose males who were friendly and sociable rather than dominance-seeking and aggressive.

For some, however, the parameters have never widened. Darwin's formulation of the importance of the male role not only remains but has been strengthened further. In his "new" formulation of economic arrangements, Lovejoy (1981, 1993) continues to argue forcefully for the traditional pair bond by insisting on male provisioning of his mate and their biological offspring, even though the food may be vegetables rather

than meat, and seems to arrive at a recombinant image of man the gatherer. Lancaster's view of sexual arrangements in human evolution also accepts the pair bond but turns it into a woman's reproductive strategy, a "bargain often struck with males for assistance in rearing young in exchange for confidence in paternity" (1991: 1).

By grounding their arguments in the pair bond, Lovejoy and Lancaster grant my point that in the last analysis their real issue is male demand for certainty of offspring. According to them, paternity must be guaranteed so that males will not waste time and energy provisioning offspring not their biological kin! There is a distinctly American entrepreneurial cast to these reconstructions in their assumption that a male will not care for or invest in any young except those that share his genes.

Fedigan (1986) also questions why woman the gatherer is not discussed in all its complexity, why it was truncated into a hunting-versus-gathering dichotomy. Largely ignored in the contemporary gathering-hunting controversy is what is really at stake: female choice and female investment in reproduction, which subverts the ideal of the nuclear family and male control.

A WIDER FRAME: THE HISTORICAL AND CULTURAL CONTEXT

In an attempt to account for the persistent emphasis on males and paternity and the fact that theoretical frameworks do not give equal weight to female contributions, I want to discuss the broader context in which scientific hypotheses are formulated. For example, although everyone reading this chapter takes for granted the biological model of reproduction—an egg from the female and a sperm from the male—the process of fertilization and the role of the egg and sperm became clear only in the late nineteenth century (Moore 1993). But because cultural beliefs and social systems developed without this level of information on sexual reproduction, human social relationships are defined and figured on other than biological links between and among individuals. It is also necessary to consider two cultural dimensions: the historical roots of scientific practice as it relates to women, and monotheistic religions and the way they define the roles of women and men in reproduction.

As science developed into an academic discipline in the eighteenth century, European men came to dominate the field and eventually to formally exclude women (Schiebinger 1989, 1993). Without women's voices, as Schiebinger (1993) writes, "men . . . increasingly tightened the reins on what was recognized as legitimate knowledge and who could produce that knowledge" (142). In primatology and human evolution, women practitioners have increasingly entered the field in recent times and have altered the debates by reporting observations, raising different

questions, and contributing other perspectives (for example, Altmann 1980, Haraway 1989, Fedigan and Fedigan 1989, Hrdy 1981, Small 1984, Lancaster 1985). Nonetheless, these research areas remain part of a scientific tradition that has restricted the participation of women and given them little authority.

Another dimension that may affect contemporary scientific debates is the power of religious tradition not only in shaping women's and men's lives and relationships but also in informing beliefs and practices about reproduction. Delaney's work (1986, 1991) offers a useful perspective in this regard. She points out that the concept of paternity is the foundation for and a central concern of the monotheistic religions—Judaism, Christianity, and Islam. Paternity is “the primary, essential and creative role”: it is “begetting” whereas maternity is “bearing.” The male “seed” is planted and nurtured in the “field” of the female, the vessel. With the metaphor of the seed and the soil Delaney emphasizes the power of verbal imagery “not to gloss reality, but to shape it” (1991: 8). “With seed, men appear to provide the creative spark of life, the essential identity of a child; while women, like soil, contribute the nurturing material that sustains it” (8). In these religious discourses, “paternity has meant begetting; paternity has meant the primary, creative, engendering role, that means the same thing whether the male is human or God the Father” (11). By extension then it becomes clear that in order to ensure their paternity males need to control females.

Wider cultural perspectives allow us to see that the woman-the-gatherer controversy is not simply about social or economic roles—the sexual division of labor—or who brought home the bacon (or salad) nor is it about dominance or sexual activity. One way to interpret the absence of a serious response to the theory of woman the gatherer is to recognize that the formulation threatened the idea of male control of female fertility and therefore undermined the assumption of primacy of paternity put forth in the idea of man the hunter. Children give meaning to finite human lives in many ways, not the least of which is that they fulfill a desire for immortality. Biological mothers know their children; biological fathers do not. It then becomes understandable why the quest for assured paternity, for a certain link between succeeding generations (anatomically obvious for women), has preoccupied men for millenia.

Ongoing and often acrimonious struggles over the reproductive terrain in primatology and human evolution mirror the struggles in Western postindustrial societies between the ideas about male dominance and privilege and experiential knowledge about the vital role of females in reproduction. Theoretical approaches to “reproductive success” and the acceptance of some theories rather than others not only reflect cultural values, religious beliefs, and scientific practice but also illuminate how

they color, shape, and direct methodological investigations and interpretations of empirical findings. For all the reasons given in this chapter, then, human reproduction cannot be reduced to any single dimension—historical, cultural, or biological. For all the same reasons evolutionary theory, primate behavior, and human evolution will remain contentious scientific issues since they are at the discursive center of an ongoing political struggle.

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REFERENCES

- Altmann, J. 1980. *Baboon Mothers and Infants*. Cambridge: Harvard University Press.
- Barash, D. P. 1977. Sociobiology of Rape in Mallards (*Anas platyrhynchos*): Responses of the Mated Male. *Science* 197: 788–89.
- . 1979. *The Whispers Within: Evolution and Origin of Human Nature*. New York: Penguin.
- Bartlett, T. Q., R. W. Sussman, and J. M. Cheverud. 1993. Infant-Killing in Primates: A Review of Observed Cases with Specific Reference to the Sexual Selection Hypothesis. *American Anthropologist* 95(4): 958–90.
- Beach, Frank. 1955. The Descent of Instinct. *Psychological Review* 62: 401–10.
- Berard, J., G. Schmidtke, and J. McGeehan. 1990. Male Reproductive Success in a Free-Ranging Colony of Rhesus Monkeys. *American Journal of Primatology* 20 (3): 173. Abstract.
- Birke, L. 1986. *Women, Feminism and Biology*. New York: Methuen.
- Birkhead, T. R., and A. Moller. 1992. Faithless Female Seeks Better Genes. *New Scientist* 135: 34–38.
- Bleier, R. 1984. *Science and Gender: A Critique of Biology and Its Theories on Women*. New York: Pergamon Press.
- . 1986. *Feminist Approaches to Science*. New York: Pergamon Press.
- Bogges, J. 1984. Infant Killing and Male Reproductive Strategies in Langurs. In *Infanticide: Comparative and Evolutionary Perspectives*, edited by G. Hausfater and S. B. Hrdy. New York: Aldine.
- Borchert, C. M. 1985. A Critique of Neo-Darwinism and Its Implications for the Evolution of Human Language. Ph.D. diss., University of California, Santa Cruz.

- Bowler, P. J. 1986. *Theories of Human Evolution 1844-1944*. Oxford: Blackwell.
- . 1989. *Evolution: The History of an Idea*, rev. ed. Berkeley: University of California Press.
- Campbell, B., ed. 1972. *Sexual Selection and the Descent of Man, 1871-1971*. Chicago: Aldine.
- Cheney, D. L., and R. M. Seyfarth. 1990. *How Monkeys See the World*. Chicago: University of Chicago Press.
- Cronin, H. 1991. *The Ant and the Peacock*. Cambridge: Cambridge University Press.
- Curtin, R., and P. Dohlinow. 1978. Primate Social Behavior in a Changing World. *American Scientist* 66: 468-75.
- Dagg, A. Innis. 1983. *Harems and Other Horrors in Behavioral Biology*. Waterloo, Ontario: Otter Press.
- Darwin, Charles. 1859. *On the Origin of Species by Means of Natural Selection*. London: John Murray.
- . 1871. *The Descent of Man, and Selection in Relation to Sex*. London: John Murray.
- Dawkins, R. 1975. *The Selfish Gene*. New York: Oxford University Press.
- Delaney, Carol. 1986. The Meaning of Paternity and the Virgin Birth Debate. *Man* (n.s.) 21: 494-513.
- . 1991. *The Seed and the Soil: Gender and Cosmology in Turkish Village Society*. Berkeley: University of California Press.
- Dobzhansky, T. 1937. *Genetics and the Origin of Species*. New York: Columbia University Press.
- Fausto-Sterling, A. 1985. *Myths of Gender: Biological Theories about Women and Men*. New York: Basic Books.
- Fedigan, L. M. 1982. *Primate Paradigms*. Montreal: Eden Press. Reprint, Chicago: University of Chicago Press, 1992.
- . 1986. The Changing Role of Women in Models of Human Evolution. *Annual Review of Anthropology* 15: 25-66.
- Fedigan, L. M., and L. Fedigan. 1989. Gender and the Study of Primates. In *Gender and Anthropology: Critical Reviews for Research and Teaching*, edited by S. Morgan. Washington, D.C.: American Anthropological Association.
- Fedigan, L. M., L. Fedigan, S. Gouzoules, H. Gouzoules, and N. Koyama. 1986. Lifetime Reproductive Success in Japanese Macaques. *Folia Primatologica* 47: 143-57.
- Flax, J. 1990. *Thinking Fragments: Psychoanalysis, Feminism and Postmodernism in the Contemporary West*. Berkeley: University of California Press.
- Ghiselin, M. T. 1969. *The Triumph of the Darwinian Method*. Berkeley: University of California Press.
- . 1974. *The Economy of Nature and the Evolution of Sex*. Berkeley: University of California Press.
- Ginsburg, Faye D., and Rayna Rapp. 1991. The Politics of Reproduction. *Annual Review of Anthropology* 20: 311-43.
- Goodall, Jane. 1986. *The Chimpanzees of Gombe*. Cambridge: Harvard University Press.
- Gould, S. J. 1983. The Hardening of the Modern Synthesis. In *Dimensions of Darwinism: Themes and Counterthemes in Twentieth-Century Evolutionary Theory*, edited by M. Grene. Cambridge: Cambridge University Press.
- Grene, M. 1983. *Dimensions of Darwinism: Themes and Counterthemes in Twentieth-Century Evolutionary Theory*. Cambridge: Cambridge University Press.
- Hamilton, W. D. 1964. The Genetical Theory of Social Behavior, I, II. *Journal of Theoretical Biology* 7: 1-52.
- Haraway, Donna J. 1983. The Contest for Primate Nature. Daughters of Man-the-Hunter in the Field: 1960-1980. In *The Future of American Democracy*, edited by Mark Kann. Philadelphia: Temple University Press. Reprinted in *Simians, Cyborgs, and Women: The Reinvention of Nature*. New York: Routledge and London: Free Association Books, 1991.
- . 1989. *Primate Visions: Gender, Race and Nature in the World of Modern Science*. New York: Routledge.
- Harding, R. S. O., and D. K. Olson. 1986. Patterns of Mating among Male Patas Monkeys (*Erythrocebus patas*) in Kenya. *American Journal of Primatology* 11: 343-58.
- Harding, Sandra. 1986. *The Science Question in Feminism*. Ithaca, N.Y.: Cornell University Press.
- Hausfater, G., and S. B. Hrdy, eds. 1984. *Infanticide: Comparative and Evolutionary Perspectives*. New York: Aldine.
- Hrdy, S. B. 1977a. Infanticide as a Primate Reproductive Strategy. *American Scientist* 65: 40-49.
- . 1977b. *The Langurs of Abu: Female and Male Strategies of Reproduction*. Cambridge: Harvard University Press.
- . 1981. *The Woman That Never Evolved*. Cambridge: Harvard University Press.
- Huffman, M. 1992. Influences of Female Partner Preference on Potential Reproductive Outcome in Japanese Macaques. *Folia Primatologica* 59(2): 77-88.
- Huxley, Julian. 1942. *Evolution, the Modern Synthesis*. New York: Harper.
- Inoue, M., F. Mitsunaga, H. Ohsawa, A. Takenaka, Y. Sugiyama, S. A. Gaspard, and O. Takenaka. 1991. Male Mating Behavior and Paternity Discrimination by DNA Fingerprinting in a Japanese Macaque Group. *Folia Primatologica* 56: 202-10.
- Jepsen, G. L., E. Mayr, and G. G. Simpson. 1945. *Genetics, Paleontology and Evolution*. Princeton, N.J.: Princeton University Press.
- Keller, E. F. 1985. *Reflections on Gender and Science*. New Haven, Conn.: Yale University Press.
- Lancaster, Jane B. 1985. Evolutionary Perspectives on Sex Differences in the Higher Primates. In *Gender and the Life Course*, edited by A. S. Rossi. New York: Aldine.
- . 1991. A Feminist and Evolutionary Biologist Looks at Women. *Yearbook of Physical Anthropology* 34: 1-11.
- Landau, M. 1991. *Narratives of Human Evolution*. New Haven, Conn.: Yale University Press.
- Lovejoy, C. O. 1981. The Origin of Man. *Science* 211: 341-50.
- . 1993. Modeling Human Origins: Are We Sexy Because We're Smart, or

- Smart Because We're Sexy? In *The Origin and Evolution of Humans and Humanness*, edited by D. T. Rasmussen. Boston: Jones & Bartlett.
- Mayr, E., and W. B. Provine. 1980. *The Evolutionary Synthesis: Perspectives on the Unification of Biology*. Cambridge: Harvard University Press.
- Moore, J. 1993. *Science as a Way of Knowing*. Cambridge: Harvard University Press.
- Noble, D. F. 1992. *A World without Women: The Christian Clerical Culture of Western Science*. New York: Knopf.
- Rowell, T. E. 1988. Beyond the One-Male Group. *Behaviour* 104: 189-201.
- . 1989. What Do Male Monkeys Do Besides Competing? In *Evolution of Social Behavior and Integrative Levels*, edited by G. Greenberg and E. Tobach. Hillsdale, N.J.: Erlbaum.
- . 1991a. On the Significance of the Concept of the Harem When Applied to Animals. In *Primate Politics*, edited by G. Schubert and R. D. Masters. Carbondale: Southern Illinois University Press.
- . 1991b. What Can We Say about Social Structure? In *The Development and Integration of Behavior*, edited by P. Bateson. Cambridge: Cambridge University Press.
- Russert-Kraemer, L., and W. J. Bock. 1989. Prologue: The Necessity of the Organism. *American Zoologist* 29: 1057-60.
- Schiebinger, L. 1989. *The Mind Has No Sex? Women in the Origins of Modern Science*. Cambridge: Harvard University Press.
- . 1993. *Nature's Body: Gender in the Making of Modern Science*. Boston: Beacon Press.
- Simpson, G. G. 1944. *Tempo and Mode in Evolution*. New York: Columbia University Press.
- Slocum, Sally. 1975. Woman the Gatherer: Male Bias in Anthropology. In *Toward an Anthropology of Women*, edited by Rayna Rapp. Reiter. New York: Monthly Review Press.
- Small, M. 1984. *Female Primates: Studies by Women Primatologists*. New York: Liss.
- . 1993. *Female Choices: Sexual Behavior of Female Primates*. Ithaca, N.Y.: Cornell University Press.
- Smuts, B. 1985. *Sex and Friendship in Baboons*. New York: Aldine.
- Sperling, S. 1991. Baboons with Briefcases vs. Langurs in Lipstick: Feminism and Functionalism in Primate Studies. In *Gender at the Crossroads of Knowledge*, edited by M. di Leonardo. Berkeley: University of California Press.
- Strum, S. 1987. *Almost Human: A Journey into the World of Baboons*. New York: Random House.
- Tanner, N. M. 1981. *On Becoming Human*. Cambridge: Cambridge University Press.
- Tanner, N. M., and Adrienne L. Zihlman. 1976. Women in Evolution. 1: Innovation and Selection in Human Origins. *Signs* 1: 585-608.
- Trivers, R. L. 1972. Parental Investment and Sexual Selection. In *Sexual Selection and the Descent of Man, 1871-1971*, edited by B. Campbell. Chicago: Aldine.
- . 1985. *Social Evolution*. Menlo Park, Calif.: Benjamin-Cummings.
- Washburn, S. L. 1951. The Analysis of Primate Evolution with Particular Reference to the Origin of Man. *Cold Spring Harbor Symposia on Quantitative Biology* 15: 67-77.
- Wilson, E. O. 1979. *Sociobiology: The New Synthesis*. Cambridge: Harvard University Press. Abridged version of 1975 edition.
- Zihlman, Adrienne L. 1974. Review of *Sexual Selection and the Descent of Man 1871-1971*, edited by B. Campbell. *American Anthropologist* 76(2): 475-78.
- . 1978. Women in Evolution. Part II: Subsistence and Social Organization among Early Hominids. *Signs* 4: 4-20.
- . 1981. Women as Shapers of the Human Adaptation. In *Woman the Gatherer*, edited by F. Dahlberg. New Haven, Conn.: Yale University Press.
- Zihlman, Adrienne L., and N. Tanner. 1978. Gathering and the Hominid Adaptation. In *Female Hierarchies*, edited by L. Tiger and H. Fowler. Chicago: Beresford.