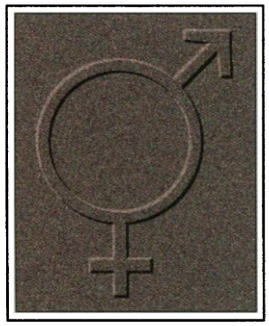
SEXUAL SELECTION—II

Barbary Macaques Challenge Theory of Female Choice



In most mating rituals, it is usually the female that is the choosier sex. A female fruit fly will put a dancing male through his paces before she will mate with him, while a peahen will judge a peacock by the size of his fan, and a female lizard will assess a male by his coloring. It's the same story across the animal kingdom—females usually prefer males of high status, superior physical fitness, or showy physique and will go out of their way to get them to father their offspring.

But now comes a study from the primate world that throws a monkey wrench into this picture of female finickiness. Cornell University anthropologist Meredith Small studied female Barbary macaques living in a forest in the south of France and found that they were remarkably indiscriminate in their choice of mates. When they were in estrus, they mated with many males in the troop, shamelessly swinging their hind ends into the faces of one male after another to elicit their interest. "The day I watched a female copulate with three different males in the span of 6 minutes, I knew it was time to reevaluate the current concept of female choice (in selecting mates)," Small wrote in a review article in the March-April issue of the *American Scientist*.

Now, after reviewing the literature on 25 other species of primates for which there is data on the females' choice of mates, Small concludes that many primate species just don't fit in with the predictions made by evolutionary theories of mate choice. Those theories say that females prefer certain males as mates because they offer some clear-cut benefit to the female—such as producing better quality offspring or helping to care for the young. And by allowing only special males to become fathers, female choice then acts as a powerful evolutionary force, shaping traits in their offspring. But that notion, says Small, may be, well, for the birds—and a few other orders of animals.

Not everyone agrees: Other primatologists say that primate social and mating behavior is so complex that it is hard to really know what they are up to and that it will take genetic paternity tests to determine if female primates are really being indiscriminate or whether they are in fact choosing their offspring's fathers on sound evolutionary grounds. "She may be right, but it's still much too early to say," says Barbara Smuts, a University of Michigan anthropologist who studies baboons.

Either way, the study is getting a lot of attention, partly because it is one of the first tests of female choice theory in primates. Although the idea that female choice might drive the evolution of such exaggerated male traits as the peacock's tail has been around since Darwin (see preceding article on swallows), early evolutionary studies in the male-dominated world of primatology emphasized the importance of the dominant male and his harem of submissive females, not the mate choices made by females themselves. That emphasis did not begin to change until the sociobiological revolution of the 1970s when Robert Trivers of the University of California (UC), Santa Cruz, wrote a landmark paper on parental investment and sexual selection.

Trivers proposed that males and females have different reproductive strategies: Males, who put less energy into producing sperm than females do to make eggs, do best when they mate with many females. But females, who also often invest more energy in begetting and raising their young, do best when they are choosy about their mate and actively solicit those who meet their needs. Since that time, studies on primates have given more weight to female choice—and the "myth of the passive female" has been replaced by an emerging consensus that sexually assertive females often select mates who will further the female's own reproductive success, says UC, Davis, anthropologist Sarah Blaffer Hrdy.

It was in this climate that Small began her studies of female macaques, expecting to confirm that females make choices consistent with evolutionary theory. She already knew from earlier studies by David Taub of Yemasse Primate Center in South Carolina that female macaques solicited many different males. But she expected to find that they had certain preferences when they were in estrus—such as high ranking or familiar males. And that is what she thought she saw in the early stages of her intense, 9-month study of 21 female macaques who were in estrus. But by the end of the breeding season, after she had watched a dizzying 506 copulations in about 300 hours of observation during the breeding season, Small had to admit the facts were different: The females were selecting their mates, but there seemed to be no logic or consistency to their choices. "Sometimes the females choose a high-status male; sometimes they don't," says Small. "Sometimes the females choose a familiar male; sometimes they don't."

Her review of research in other primates did little to clear up the picture. In savanna baboons, females often choose males with whom they have formed a special "friendship," says Michigan's Smuts. But in many species of primates, including rhesus monkeys and vervet monkeys, females sometimes prefer high-ranking males and sometimes prefer low-ranking males. In a few species, females choose familiar males over unknown males—as has been shown in studies by Smuts of olive baboons. But in nine other species, females have been shown to prefer strange males. And female chimpanzees seem to have no clear preference at all, Small says. She concludes: "I think that these females have some preferences, but they are not making the kind of consistent choices that are going to drive a weird characteristic in the male, like a peacock's tail."

MEREDITH SMALL

Not looking for Mr. "Good Genes?" Female macaques in a troop studied by Meredith Small mate apparently indiscriminantly, displaying themselves to one male after another to elicit their interest.

Reactions to her observations have been mixed. Some, such as Oxford University zoologist Paul Harvey, say that female choice may not be so important in primates after all. "If you think of mammals, in general, males don't have bright, conspicuous colors or big tails. This all suggests that female choice is

not important," he says. Competition between males may be more important in evolution, driving the development of larger canines or body sizes in male primates. Or, the competition among males could be at the level of the sperm, says Harvey: "Let all the sperm compete, thereby having male offspring whose sperm will also be good."

Others say that females may be making choices but hiding them: Blaffer Hrdy has proposed that females who mate with many males might be trying to make them all think that the subsequent offspring are theirs: "By drawing several different males into the web of possible paternity, females may increase the likelihood of male protection and even care (of their infants)." And there may be entirely different but equally important factors driving their mating behavior and complicating the picture of female choice in primates. Oxford University zoologist William D. Hamilton speculates that the reason primates spend so much time inspecting rear ends before mating may be that they are checking to see if their prospective mate is carrying a contagious virus.

All that's speculation, however, and other researchers say that the only way to really see if female choice is having an evolutionary impact is through definitive paternity studies. Trivers says such studies are needed to determine whether females are favoring certain males at the peak of their estrus, when they ovulate. Smuts agrees: "We have no direct information on the consequences of female choice until, first of all, we know who actually fathered their offspring. The Barbary macaque may mate with 30 different males, but only one is the actual father."

Those paternity studies have been done in lemurs and in a few other species, but primatologists are just beginning to overcome problems with contamination of DNA samples and are setting up collaborations with molecular biologists so that they can use the method to sort out the complex behavior of primates in the wild. Until those studies are done, however, the evolutionary consequences of female mate choice in primates will remain a puzzle. In the end, it may be that female choice theory doesn't transfer from birds to primates. "What's going on in many birds may be simpler and more straightforward than behavior in primates," says Smuts. But, then, maybe that shouldn't be so surprising if one considers the behavior of that other primate species—humans: "If you took a broad sample of women in our society, looking at who they were dating and mating with, you'd see tremendous variety. If you tried to come up with a single theory, say about women going with men who have money, you wouldn't get very far. I think nonhuman primates are just as complex and subtle on a social level as we are."

–Ann Gibbons

MOLECULAR DESIGN

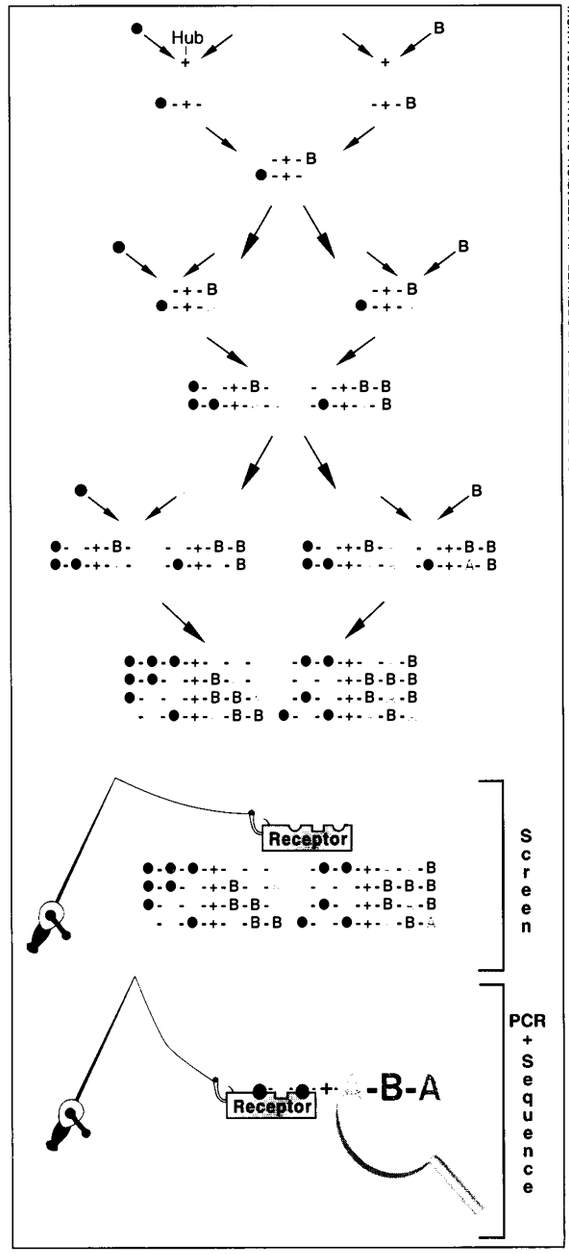
Speeding Up a Chemical Game of Chance

To hang a reality check on the optimistic buzz phrase "rational drug design," molecular biologist Sydney Brenner of Cambridge University titles one of his stock lectures "Irrational Drug Design." Sure, designing a specific molecule for a specific research or medical job is a nice idea whose day probably will come, Brenner says. But making molecules to measure requires knowing the exact shape, size, and chemical characteristics of the environment in which it will function—and such knowledge is usually lacking. In most cases, concludes Brenner, good old trial and error is hard to beat. Too bad: It can cost drug makers more than a decade of research effort and hundreds of millions of dollars before it lands them a product. But Brenner and his chemist colleague Richard Lerner, president of the Scripps Research Institute in La Jolla, California, believe they have a way to cut time and costs: They have set out to make a Ferrari of trial and error methods. Call it rational trial and error.

In the 14 June *Proceedings of the National Academy of Sciences*, Brenner and Lerner unveil what they call encoded combinatorial chemistry. Though the scheme has yet to be tested, chemist Steven Ramcharitar has already worked out its technical basics in Kim Janda's laboratory at Scripps, and the concept itself is dazzling other chemists. Says synthetic chemist Samuel Danishefsky of Yale University, who uses traditional methods to build organic molecules: "It's absolutely ingenious."

Lerner and Brenner have stepped into a fast-growing field. Like other researchers trying to speed up drug design, they hope to turn the laborious process of testing molecules one by one into a more efficient talent search, in which tens of thousands of molecules would be created and screened en masse. That raises a dual challenge: how to mix a limited palette of components such as amino acids efficiently to create a broad array of variants, and how to track down those few variants that show promise, even if they are present in vanishing quantities. By uniting the molecule-making talents of synthetic chemistry with the record-keeping abilities of DNA, Brenner and Lerner's method promises to solve both problems at once.

To spawn a horde of variants, Lerner and Brenner propose a novel way to link a few different building blocks, or monomers—



SOURCE: LERNER AND BRENNER ILLUSTRATION: SUSAN NOWOSLAWSKI

Mix and match. A strategy for linking amino acids *(shapes)* and nucleotides *(letters)* creates a combinatorial explosion of peptides, each with an easy-to-read DNA label.