



## REVIEWS AND COMMENTARIES

### Mating Games

Review by Peter D. Sozou

**EROS AND EVOLUTION: A NATURAL PHILOSOPHY OF SEX**, by Richard E. Michod. Addison-Wesley Publishing, 1995 (\$25). **HUMAN SPERM COMPETITION: COPULATION, MASTURBATION AND INFIDELITY**, by R. Robin Baker and Mark A. Bellis. Chapman & Hall, 1995 (\$78.95). **WITH PLEASURE: THOUGHTS ON THE NATURE OF HUMAN SEXUALITY**, by Paul R. Abramson and Steven D. Pinkerton. Oxford University Press, 1995 (\$25). **WHAT'S LOVE GOT TO DO WITH IT: THE EVOLUTION OF HUMAN MATING**, by Meredith F. Small. Anchor Books, 1995 (\$24.95).

Sex—the fusion of genetic material from different individuals—is widespread in the living world. It is the mode of reproduction practiced by the vast majority of higher organisms. But scientists have no sure explanation of why living things go to the trouble of having sex, rather than simply reproducing asexually—which appears, on the surface at least, to be much more straightforward. And debates still rage about its role in shaping the way humans think and act. The books reviewed here all testify to the enduring hunger to understand the reproductive process that made us who we are.

Richard E. Michod starts by posing the most basic question—“Why sex?” The origin of sex opened up new evolutionary pathways that led to multicellular organisms and distinct male and female genders. These developments are a consequence of sex, but they have also had a profound bearing on its costs and benefits. Hence, to ask “Why sex?” is really to ask two distinct questions: “Why did sex originate?” and “Why does sexual reproduction exist among modern, complex plants and animals?”

To the first question, Michod gives a simple answer: sex repairs genes. The genome consists of two strands of DNA bound together in a double helix. If a single strand is damaged, the adjoining strand can be used as a template for

repair. But if both strands are damaged at the same site, the required sequence of DNA must be obtained from somewhere else. In primitive single-celled organisms that have just a single genome, such genetic repair necessitates getting DNA from a different individual—sex. This explanation is supported by the observation that simple life-forms such as viruses are more likely to have sex if they are damaged.

The second question poses a greater challenge. Most higher organisms are “diploid,” meaning that they have a double genome made up of a number of pairs of chromosomes. Sexual reproduction involves the production of “gametes,” containing a single set of chromosomes from the parental germ cell. Before separation, the chromosome pairs usually exchange long sequences of DNA, a process known as crossover. Two gametes from different individuals (normally a male and a female) then fuse to produce a new organism.

There is a cost to this sexual process—the cost that the female germ cells pay for accepting half the genes for their progeny from an unrelated male. This genetic sharing is sometimes referred to as the “cost of males,” because in most species males do not contribute resources toward their offspring. A female who reproduced asexually, giving virgin birth to clonal daughters, would enjoy a doubling of the representation of her genes in the next generation. What of species in which the males make a substantial contribution to parental care? Even in this case, a female could still double her genetic output by fooling a male into copulating with her and providing resources, while in reality giving birth to a genetic copy of herself. So why does sex persist in a relentlessly competitive world?

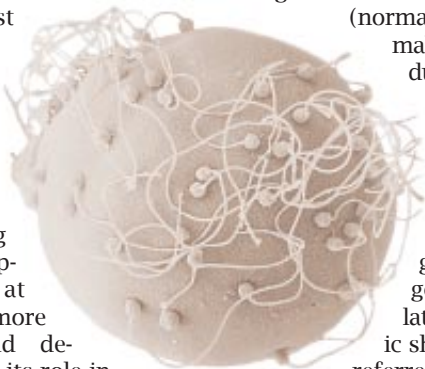
Most current theories regarding the advantage of sex are concerned with the benefits of providing a good complement of genes to offspring. Among the early proposals was the idea that sex

can bring together beneficial mutations from different individuals, or that it can help eliminate bad mutations from a lineage. More recently, some researchers have argued that, in an uncertain environment, there are benefits to producing a diverse crop of offspring, or that sex enables hosts to keep changing defenses in their battle against parasites.

Michod believes these ideas are not adequate to the task of explaining why sex is so widespread. His alternative solution is again based on gene repair. In diploids, genetic information is duplicated in the chromosome pairs. A sister chromosome could therefore provide a template for repairing double-strand damage. Why not avoid the cost of sex by directly producing diploid offspring? The answer, according to Michod, lies with the mechanism for repairing genes. A damaged chromosome will join with the sister chromosome; when the two separate chromosomes are re-formed, there is a roughly 50-50 chance that crossover will occur. An offspring inheriting all its chromosomes from the same parent after such repair would inherit a double dose of some genes, and consequently, recessive harmful mutations would be expressed. Sex keeps them masked.

A distinctive feature of this theory is that crossover is regarded not as a deliberate method of shuffling genes but as an incidental consequence of a mechanism for repairing gene damage. But Michod does not explain why there is normally no crossover during sperm production in the fruit fly *Drosophila melanogaster*. Are males of this species somehow protected from gene damage?

Much of the ecological evidence about sex is open to sharply differing interpretations. A case in point concerns the “haplodiploid” sex-determining system of ants, bees and wasps. In these animals, fertilized eggs develop into diploid females, whereas unfertilized eggs develop into “haploid” males—that is, they have only a single set of chromosomes. Michod argues that this system facilitates the purging of harmful mutations in males, which explains why many of these animals are highly inbred. Other researchers believe instead that the unusual



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genetic relationships between haplodiploid siblings facilitate certain life histories, such as the formation of social colonies, which result in inbreeding. It is worth noting that some social animals that are not haplodiploid—such as termites and naked mole rats—also exhibit inbreeding.

Despite the evident problems with Michod's ideas, much of *Eros and Evolution* is compellingly written. An early chapter gives an excellent introduction to the basic ideas of evolutionary biology. One of the appendices explains with great clarity how changes in the mating system have an effect over several generations: I found this particularly illuminating. It is a pity, however, that Michod has made no space for a discussion of the fascinating evolutionary questions associated with the sex chromosomes and with cytoplasmic DNA. An evolutionary chronology would have been useful, as would a glossary of technical terms. There are also places where Michod muddies the waters, such as a tortuous chapter attempting to clarify "survival of the fittest" and a baffling attempt to make sense of Freud's theory of the "death instinct."

Michod tries to invest his thesis with emotional appeal by casting it as a reincarnation of arguments in Plato's *Symposium*. In this view, sex enables mature adults to produce youthful offspring, because "the losses caused by age are repaired." This is a charming idea, but Michod does not explain how certain asexual creatures, such as whip-tail lizards, cope with gene damage in the germ line. The overall evidence is too inconclusive to accept or reject firmly the gene-repair theory of sex.

The remaining books move on to more familiar turf by considering one of the consequences of the evolution of sex—human sexuality. Not surprisingly, popular culture intertwines with science. Of the three, only *Human Sperm Competition* does not refer to any Woody Allen film. Perhaps R. Robin Baker and Mark A. Bellis were more inspired by the World War II film, *Tora! Tora! Tora!*, for they advance the astonishing idea that the majority of human spermatozoa are designed for warfare.

This conclusion is preceded by a broad discussion of how evolution has molded sex and reproduction. The received wisdom is that natural selection will favor males whose sperm can successfully compete for the prize of fertilization. It will also favor females who can maximize the chances of their eggs being fertilized by sperm from the best males.

Sperm competition occurs when a female mates with more than one male

during a single fertile cycle. Under these circumstances, the male is expected to produce a large number of sperm to try to swamp the opposition. In chimpanzees, which are highly promiscuous, males have large testes for prodigious sperm production and an external scrotum that facilitates sperm storage. Gorillas, in contrast, are not subject to sperm competition and hence have comparatively small, nonscrotal testes.

The genital anatomy of human males—external scrotum and moderately sized testes—suggests that there has been significant sperm competition in our ancestral line. Baker and Bellis suggest that the human penis is shaped to function as a piston, with copulatory thrusting movements flushing out sperm from earlier rivals. The discussion of this and other anatomical points in *Human Sperm Competition* is accompanied by line drawings that leave little to the imagination.

Some researchers have proposed that the female orgasm increases sperm retention, enabling women to influence the chances of a given partner's sperm achieving fertilization. Baker and Bellis describe their tests of this hypothesis, in which volunteers collected "flowbacks" that emerge after intercourse. The authors conclude that an orgasm affects sperm retention not only from the current copulation but also from the following one. This influence on future encounters extends to "noncopulatory" orgasms, hinting at a role for female masturbation in controlling fertilization.

Baker and Bellis's most original idea is that sperm have evolved specific features for combat, which the authors unblushingly call the "Kamikaze Sperm Hypothesis." This notion stems from the researchers' observation that, within a single ejaculate, sperm have

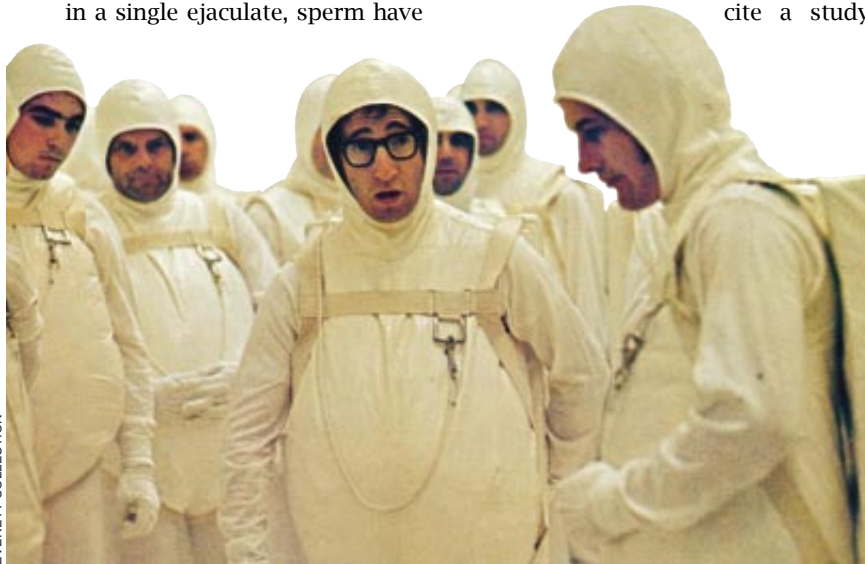
a variety of shapes and sizes, many of which appear patently unsuited to penetrating an egg. The authors believe some of these sperm are "blockers" that obstruct passage of future inseminates through the female tract. Others have a "seek-and-destroy" function, actively attacking sperm from rival males, or a "family-planning" role, taking out both the enemy and the home team. This division of labor leaves only a small number of "egg-getters" for fertilization.

On the basis of this theory, Baker and Bellis suggest that a man may vary the number and composition of sperm ejaculated according to circumstances. If he has been separated from his mate for a long time, he should deposit more sperm—and a higher proportion of seek-and-destroy or family-planning types—to guard against possible recent cuckoldry. In this light, male masturbation may be a means of discarding older sperm, with the composition of the fresh cohort's being customized to suit current requirements.

These ideas are intriguing, but the supporting evidence remains equivocal. The study of flowbacks, for instance, provides only an indirect method of determining sperm retention. Such observations constitute less than compelling proof of the role of the female orgasm on future sperm retention.

Baker and Bellis support their kamikaze hypothesis with studies of numbers of different sperm forms in ejaculates, in flowbacks and in different parts of the female tract. The classification of sperm was performed manually, however, which makes the results difficult to replicate. Demonstrating the existence of specific seek-and-destroy sperm types is particularly problematic.

Baker and Bellis cite a study



WOODY ALLEN portrays a sperm dressed for reproductive battle in the 1972 film *Everything You Always Wanted to Know about Sex (But Were Afraid to Ask)*.

by R. A. Beatty showing that some bulls sire substantially more calves than others when their sperm is mixed with that from other bulls. Beatty found, however, that bulls that perform well in sperm competition also perform well in its absence. To bolster their view that very few sperm are egg-getters, Baker and Bellis refer to a study by Dina Ralt and her colleagues indicating that a small proportion of sperm will swim toward chemical attractants. Recent research by Amnon Makler of the Israel Institute of Technology casts doubt on the reality of this effect, however.

Reproductive biologists will need to see stronger evidence before they embrace the kamikaze hypothesis, but Baker and Bellis are to be commended for raising such provocative ideas in a forthright manner.

Paul R. Abramson and Steven D. Pinkerton offer lighter reading in *With Pleasure*. This book is essentially a celebration of sex—in the colloquial sense, meaning genital activity—from a liberal, hedonistic perspective. The authors' central argument is that sex is for pleasure, not procreation, because it is usually pleasure that provides the motivating force for human sexual activity. This line of reasoning would seem to lead to the tautological conclusion that the purpose of any action is to satisfy the motivation for carrying it out.

Philosophical caveats aside, much of the book is stimulating and informative and written with ample wit. The ethnographic and historical references illustrate the enormous cultural variability of human sexual practices. We learn that in the Innis Beag community of Ireland "intercourse is invariably completed quickly, with the man falling asleep shortly after achieving orgasm," whereas among the Mangaians of Polynesia "a 'good' man is able to bring his partner to climax two or three times for every one of his." The Sambia of Papua New Guinea have practiced ritualized fellatio, believing that "the ingestion of older men's semen is essential to masculine development."

Abramson and Pinkerton offer an impassioned defense of pornography, arguing that it represents a moral counterculture and hence deserves the same protection as the scientific thoughts of Galileo and Darwin. But it is surely simplistic to claim that all opponents of pornography have "a shared opposition to nonprocreative sexuality."

Of greater concern is a misleading treatment of HIV transmission dynamics in an otherwise instructive discussion of AIDS. We are advised that "provided that condoms are used consistently,

engaging in 100 one-night stands is actually safer than having 100 unprotected sexual contacts with a single partner of unknown HIV status." This conclusion is based on the assumption that there is a constant probability of HIV transmission for a given type of sexual act for the whole population. In reality, some HIV carriers are more infectious than others, and there may be couple-dependent factors that affect the probability of transmission. Furthermore, a highly promiscuous partner is likely to have a greater prior probability of carrying the AIDS virus. Allowing for these considerations, promiscuity with protection is not necessarily the safer of the two scenarios.

In *What's Love Got to Do With It?*, anthropologist Meredith F. Small presents a personal, feminist take on the mating game. She adopts an intimate style, peppered with numerous anecdotes. The book succeeds in conveying a flavor of what participating in scientific research is all about.

Small's fascination with primate and human sexuality is clearly evident, and she goes into considerable detail about the physiological stages of sexual arousal. She argues that the traditional Victorian view of women as passive participants in sex is being overturned by recent findings, including those laid out in *Human Sperm Competition*. In fact, the view that women have an active sexual role dates back to the writings of Hippocrates and Galen. An unfortunate consequence of this belief, as Abramson and Pinkerton point out, was that women who conceived after being raped were sometimes branded as harlots.

The main thesis of *What's Love Got to Do With It?* is that women are just as motivated as men to have sex and just as promiscuous by nature. Small rejects evolutionary psychologists' findings to the contrary, arguing that these results are a consequence of cultural conditioning among both subjects and researchers. Her own analysis, however, is hardly objective, nor does she help her cause with a poorly informed discussion of the effects of AIDS on the preponderance of "gay" genes in the population.

By openly revealing her political perspective, Small is perhaps being more transparent and honest than many other researchers. And her book points to one of the central difficulties in studying sex and sexuality: they are so intimate a part of our lives that it is often difficult to separate scientific thesis from subjective belief.

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## Walking in Water

Review by N. Katherine Hayles

**OF TWO MINDS: HYPertext PEDAGOGY AND POETICS**, by Michael Joyce. University of Michigan Press, 1995 (\$29.95).

Walking in water, catching a few sentences from the murmur of many voices, bicycling through a landscape that is also a text—these are some of the images that Michael Joyce, a professor of English at Vassar College, uses to describe the emerging form of electronic writing known as hypertext. Hypertext is the underpinning of CD-ROM multimedia and the World Wide Web; its intricate, nonlinear nature is revising the way everyone from research scientists to preschoolers interact with the written word. Writers since Gutenberg have dreamed of achieving "definitive" texts; editors have sought to determine which one of many versions of a manuscript was the most authentic; generations of students have learned to navigate canonical texts by means of chapter titles, page numbers and indexes. Hypertext challenges these traditional practices. In *Of Two Minds*, Joyce reflects on the new technology—how we will use it, and on what.

Stepping back from metaphor, Joyce quotes Theodor H. Nelson's definition of hypertext as "non-sequential writing with reader controlled links." In an electronic hypertext, a block of text on the computer screen contains embedded interactive elements—an icon, a word or phrase, or a concealed "hot spot" the reader finds, sometimes by trial and error. Clicking the cursor on an interactive element brings up another block of text, which in turn has other links leading from it. The text exists not as pages bound in a linear sequence but as a network of screens that the reader activates as he or she chooses.

A variety of elements can fit within that electronic mesh, customizing it to different applications. Hypertext may be easily combined with digitized images and sounds, as is becoming common practice on the World Wide Web. In literary studies departments, classic works are being encoded into hypertext format and integrated with critical commentary, historical information and graphics. Meanwhile modern writers (including Joyce) concoct interactive fictions, which resemble the "Choose Your Own Adventure" stories many of us read as children.

Hypertext destabilizes such fundamental notions as the text, the author and the reader. In a hypertext fiction, for example, there is not one story but a series of different narratives that



emerge in conjunction with the reader's choices. Because the reader actively collaborates with the author in bringing the narrative into existence, the distinction between the two fades away. For the author, hypertext means ceding control over the text, accepting the reader as partner, finding one's voice blended with a chorus of others.

The unity of the text also disperses. The best way to understand this process is to experience it. For instance, in Jon Lanestedt and George P. Landow's pedagogical hypertext *The 'In Memoriam' Web* (Eastgate Systems, 1992), certain sections from Alfred, Lord Tennyson's poem of that name are linked with other blocks in the poem that resonate with them, as well as with critical commentary—some of it written by students—interpreting the significance of the links. As one clicks from the poem to a student essay to another section of the poem to a bit of biographical information, the "text" ceases to be just the poem by itself and becomes instead the entire interconnected network.

More than one scholar has blanched at the prospect of turning the classic texts of Western culture into hypertexts. Joyce recounts a walk he took with a philosopher, who when he discovered what Joyce was up to asked plaintively, "You can't let the students change Plato, can you? Surely you can't let them do that." Joyce contemplates responding, "Which Plato?"—suggesting that "Plato" is already a hypertextual fiction, a composite that never existed in original purity. I find that answer somewhat disingenuous, for it underplays the transformative force of hypertext that elsewhere Joyce eloquently defends.

Better, to my mind, is when *Of Two Minds* confronts the meaning of hypertext head-on. Joyce's language soars when he writes of hypertext as a metaphor for the interconnectedness of contemporary life: "A constant murmur surrounds us and becomes palpable... as charged as the lives of those unfortunate souls we read about who dwell under high-voltage transmission wires. Surrounded by a surge of information, we spend our days, our hair standing on end, the fillings of our teeth complaining like the red-wing blackbirds perched on the thrumming wires above us; even at the center of our cells the proteins vibrate and mutate into some new and terrible variety of information."

In Joyce's book, phrases, sentences, even entire passages repeat from one chapter to the next, sometimes printed in italics to alert the reader to the repetition, sometimes cycled through without warning. The practice reminds us that this is a text written *on* a comput-



JEFFREY SHAW 'LEGIBLE CITY' (1989), from collection of ZKM Karlsruhe

**VIRTUAL-REALITY INSTALLATION simulates the feel of hypertext.**

er as well as written *about* computers.

When the University of Michigan Press invited me to read the manuscript of Joyce's book, my impression then was that there was too much repetition, and I voiced these reservations to the press. Because I was not in direct communication with the author and had no hand in soliciting the manuscript, I heard only indirectly, after the book was out, how strongly he felt that the repetition is essential to conveying through a printed text the feel of hypertext.

This difference of opinion highlights the fact that hypertext, compared with print, embodies a different rhetoric, a different aesthetic and different kinds of conceptual structures. Because virtually everyone older than 25 years in our culture has been raised on print rather than hypertext, it is inevitable that we come to hypertext with expectations formed from print. *Of Two Minds* attempts to bridge the gap between the print linearity and the electronic networking by using rhetorical looping to simulate, in paper form, the repetitions that can occur in hypertext.

In an actual hypertext, variations in wording and differences of context quickly become significant in establishing fresh patterns and offshoots. If we think of the linear flow of text as its warp, the repeated sections are its woof; the idea is to weave strand into strand until the interconnections grow as dense and supple as silk.

Another way in which hypertext differs from print, Joyce argues, is through its topology, the virtual space created during the reading process. Unlike print, with its flat surfaces and linear sequences, the "two and a half dimensions" of hypertext mapping resonate both with how we know the world and with how

we know our own bodies. Joyce quotes from Hélène Cixous, a French feminist critic: "I don't write," Cixous proclaims. "Life becomes text starting out from my body. I am already text. History, love, violence, time, work, desire inscribe it in my body." Hypertext creates a virtual expanse within the computer that (far more directly than words on paper) parallels the flow of our perceptions of external and internal space.

Anybody who has spent time on-line will instantly recognize the sensation that a world of connections—the fabled "cyberspace"—lies behind the computer screen. Joyce wants to call hypertext a "city of text," as though it were an urban landscape we negotiate through bodily movements. That vision is realized in "Legible City," a virtual-reality simulation created by the German artist Jeffrey Shaw. Shaw started with a model of a city block in Manhattan and replaced the buildings with letters of the same size. The user moves through the simulation by riding a virtual bicycle, reading the text as it goes by and choosing which path of text to follow.

Is "Legible City" a hypertext, a metaphor for a hypertext or simply a metaphor for life? In the same vein, we might wonder whether *Of Two Minds* is about computers, about hypertexts or about the increasingly common experience of writing and reading on computers. Perhaps, as Joyce repeatedly urges us to do, we ought to rephrase the thought as hypertext would have us do: "rejecting the objective paradigm of reality as the great 'either/or' and embracing, instead, the 'and/and/and.'"

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