BOOKS: SCIENCE AND SOCIETY

Unreal Science

Kenneth R. Foster

"Pathological science," Nobel laureate Irving Langmuir said in an amusing 1953 lecture (*1*), "is the science of things that aren't so." Robert Park, in these 10 well-written essays for a lay audience, uses pathological science as a starting point for far-reaching discussions of science and society.

Voodoo Science
The Road from Foolishness to Fraud
by Robert Park
Oxford University Press, New York, 2000. 240 pp. $25. ISBN 0-19-513515-6.

Park is an articulate and skeptical voice of reason about science. A former chair of physics at the University of Maryland and head of the Washington office of the American Physical Society, he is also an editorial writer, a sometimes talking head on television, an occasional Congressional witness on science policy, and the author of a weekly Internet newsletter (*2*).

For these essays, he rounds up the usual suspects: cold fusion, homeopathy, perpetual motion machines, and parapsychology. Other less familiar targets include "Vitamin O" (water with dissolved oxygen, whose ads in *USA Today* promised to maximize nutrients and purify the blood). One essay complains about the unwarranted credibility the media give to such claims; the title, "It's Not News, It's Entertainment," tells its story succinctly.

But Park is less interested in debunking weird claims than in commenting, often by narrating stories, on public issues involving questionable science. Not all of the episodes he describes had irrational outcomes. One inventor persuaded the U.S. Congress to hold hearings on whether to force the Patent Office to issue a patent for a machine that supposedly created more energy than it used. Careful questioning by then Senator John Glenn scotched his case. Another chapter describes recent U.S. Supreme Court decisions that exclude egregiously flawed or invalid technical testimony from federal courts.

Other essays deal more broadly with science and technology. Park describes the limitations of manned space flight and the space station (which he views as scientifically sterile) and the strategic defense initiative (which he considers technically unworkable and politically dangerous). The book's penultimate essay describes the wreckage found in 1947 near Roswell, New Mexico, which fueled a UFO frenzy that has continued for many years. The military knew all along, Park reports, that the wreckage was from Project Mogul, a secret high-altitude test to monitor nuclear explosions. But the military kept silent, which produced a case of "voodoo science [being] protected by official secrecy."

Park's accounts lack the anger at science that is evident in some conservative writing about junk science. Park wants to "help [people] judge which claims are science and which are voodoo." People generally read what they find agreeable, and Park may be preaching to the choir. But his essays are delightful to read, and their critical views may be unfamiliar to many nonscientists.

Park's popular approach limits his ability to delve into the details of the issues, which are clearly more complex than he lets on. For example, Park dismisses homeopathy on the sensible grounds that a drug cannot be effective when diluted so highly that not one molecule of it remains. But in the past few years, at least three seemingly well-controlled clinical trials published in peer-reviewed Western journals have reported positive effects of homeopathic treatments in patients. Is this, as one of the articles asked, proof of an effect or proof of the ability of double-blinded clinical trials to yield false positive results? Thus, believers in homeopathy will find in peer-reviewed papers in conventional scientific journals at least a scintilla of scientific evidence in its support. Try explaining that to the folks back home.

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1. A transcript edited by R. N. Hall was published in *Phys. Today* **42** (no. 10), 36 (1989).
2. Newsletter available at www.aps.org/WN/.

BOOKS: PHYSIOLOGY

Approaches to Studying Sex

Montserrat Gomendio

In biology, questions may be addressed from four different perspectives: proximate causes (mechanisms), ultimate causes (function), development, and evolution. Much has been said about the fruitfulness of combining these approaches, particularly proximate and ultimate explanations, but progress has been slow. Scientists interested in proximate explanations, however, wish to understand which underlying mechanisms bring about particular outcomes, and they tend to focus on a few model species, which they study under controlled conditions in the lab. Inter- and intraspecific variation are often dismissed as "noise," and individuals within a species are seen as uniform. Scientists interested in ultimate explanations wish to understand how selective pressures shape whole organisms and why different environments have favored different strategies. In their efforts to infer general principles, they tend to study a variety of organisms in natural environments. Because selection acts on differences in reproductive success between individual organisms, researchers place much emphasis on the strategies of individuals. Poor knowledge of the mechanisms, however, too often prevents generalization of the conclusions and impedes progress beyond the descriptive phase.

Reproduction in Context
Social and Environmental Influences on Reproduction
Kim Wallen and Jill E. Schneider, Eds.
MIT Press, Cambridge, MA, 2000. 534 pp. $60, £37.50. ISBN 0-262-23204-9.

The science of reproduction has traditionally been focused on the study of mechanisms. This focus is mainly due to the development of the science's more applied aspects such as enhancing reproduc-

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tion in domestic animals (from artificial insemination to cloning) and addressing clinical aspects in our own species (sexual dysfunction, sexually transmitted diseases, infertility, and the development of birth control methods). In these approaches, the reproductive system has been studied in isolation from the rest of the organism. *Reproduction in Context* represents a serious and most welcome attempt to consider reproduction as one aspect of whole organisms and thus as interrelated with multiple other facets and influenced by a wide range of environmental and social factors. To provide this perspective, Kim Wallen and Jill Schneider recruited authors from different backgrounds. Some are physiologists or neuroendocrinologists who incorporate evolutionary ideas into their studies; others are behavioral ecologists who integrate the techniques of neuroendocrinology and physiology into their research. The result is rather heterogeneous, but on the whole it is stimulating.

Most chapters elegantly illustrate how the incorporation of an evolutionary framework can shed light on the mechanisms that regulate reproduction. To understand which cues influence reproductive processes it is crucial to consider the types of environments that organisms inhabit. When organisms live in environments in which conditions favorable for raising young are highly predictable, cues that provide long-term predictive information (for example, day length) will usually be used to time breeding. When environmental conditions are less predictable, short-term cues (such as local temperature or food availability) will become more important. When favorable conditions are very unpredictable, gonads may remain continually developed so that no opportunities for breeding will be missed.

The social environment also affects reproductive processes and how the endocrine pathways work. For example, in species in which there is high male-male aggression and low parental care, males have high testosterone levels for long periods of time during the breeding season. And in species with low male-male aggression and high levels of parental care, testosterone levels are lower because high levels of testosterone are incompatible with male parental behavior. The historical perspectives included in some chapters clarify how our understanding has been influenced by the way in which experiments considerably altered, among other things, the social environment of the animals studied.

In his chapter on the relation between puberty and energy reserves, Franklin Bronson shows that life-history traits must also be taken into account if we are to fully understand reproductive processes. The notion that puberty in female mammals depends on the accumulation of a critical level of energy reserves is comfortably accepted by many. Consideration of the life cycles of most mammals, however, reveals what little sense that idea makes; most mammals are short- lived and small. Given the small mammals' short life-spans and their inability to store enough fat to support gestation and lactation, their most efficient strategy is to reproduce opportunistically as soon as conditions improve. Thus, small mammals tend to respond to changes in energy balance, rather than to changes in energy stores. Nor are energy stores critical in the case of large mammals because immediate conditions at the time of mating have little value predicting what conditions will be like months later at the end of pregnancy.

As the contributors to this volume demonstrate, even the most basic predictions derived from examining reproduction as an integrated aspect of the whole organism are proving very exciting. For example, consideration of the energetic trade-off between reproduction and immune function illuminates previously unexplained phenomena, such as the decrease in immune function during reproductive stages.

Another point illustrated in the volume is that the general principles arising from the evolutionary approach help us understand why cases that were formerly considered exceptions are, instead, the result of the same rules being applied to extreme circumstances. In contrast to most mammals, females are the dominant and more aggressive sex among spotted hyenas. As Kay Holekamp and Laura Smale discuss in their chapter, this may reflect the fact that hyenas are the only carnivores in which large numbers of females compete for rich and defensible food patches on a daily basis. Other contributors explain how our views have been constrained by the use of particular models in research and how we can broaden our perspectives by studying a greater range of species. Our understanding of sexuality has been limited, for example, by the focus on species in which sex chromosomes determine the type of gonad; we have much to gain from studies of species with other types of sex determination.

The volume has some minor shortcomings. The lengthy accounts of the results of series of experiments, present in a few chapters, are sometimes difficult to follow. Some fields of research that are currently very productive are only touched upon superficially, as in the discussion of the evolution of monogamous mating systems in primates (and how these relate to true genetic monogamy and, thus, sperm competition). Finally, the book deals almost exclusively with birds and mammals; innovative work done on other taxa is largely overlooked.

Despite these criticisms, I applaud the contributors for their efforts to make sense of a broad field of information. *Reproduction in Context* demonstrates that this tremendously complex and often chaotic topic begins to find a coherent form when organized within an evolutionary framework.

NOTA BENE: MATERIALS SCIENCE

The Nanotechnician's Baedeker

Handbook of Nanostructured Materials and Nanotechnology
Hari Singh Nalwa, Ed.
Academic Press, San Diego, CA, 1999. 5 vols. 3483 pp. $1300. ISBN 0-12-513760-5.

Nanotechnology, with its multidisciplinary nature and numerous potential applications, may be one of the most difficult fields in which to stay informed. Such a new area would typically have to wait several years for a disciplined, well-organized survey to appear, but Hari Singh Nalwa has already compiled a five-volume overview, *Handbook of Nanostructured Materials and Nanotechnology*. The first volume, "Synthesis and Processing," covers numerous methods of inorganic particle formation as well as nanostructured alloys and micromachined materials. "Spectroscopy and Theory" includes not only spectroscopy and scanning probe methods but also discussions of quantum-well lasers, atomic-scale friction, and nanometrology. Two volumes cover electrical and optical properties of minute structures ranging from molecular junctions and single-electron tunneling transistors to photonic band gap materials. The final volume treats organics, polymers, and biological materials as well as supramolecular chemistry and carbon nanotubes. The contributors have exerted considerable effort to include introductory material that will benefit readers who are crossing disciplinary lines. Anyone interested in learning how these materials can be made, how they can be characterized, and what they can and might be able to do will likely be well served by this reference.

—PHILLIP D. SZUROMI