them, the somewhat suspect universities in the provinces (Utah and Texas A&M). This prejudice may reflect the author's pedigree, which includes Harvard, Stanford, and Columbia. There are also excellent insights into the goings-on at some of the innocent-bystander institutions (the University of Texas, Harwell, and several others). The rush to get details about the cold fusion experiment by phone, fax, and e-mail is captured in prose that definitely gets across the excitement of the times: this frenetic section of the book authentically chronicles the "fog of fusion." The dramatic announcements at Texas A&M, Stanford, and Georgia Tech that confirmed Pons and Fleischmann's results are described in detail.

Following the initial excitement, the somewhat sad part of the story begins to unfold. This includes retractions by many of those who initially reported positive results. New negative reports also cast a pall over cold fusion: we hear about a particularly damning report from a group at MIT, published in *Nature* (the unofficial journal of cold fusion) in May 1993, that definitively proved that the neutron experiments originally reported by Pons and Fleischmann were poorly executed and incorrectly interpreted. When confronted by this result in person at a scientific meeting held in Los Angeles, Fleischmann admitted the results were incorrect. Now, without a single reliable report of fusion products and only excess heat to hold on to, many advocates of cold fusion transmutated from believers into nonbelievers: the death of serious, widespread cold fusion research was at hand. Taubes reliably covers this period during which the scientific community came to its senses: enthusiasm turns to anger, and the charges range from ineptitude to fraud.

The third part of the book covers the extended death, funeral, and mourning of cold fusion. Here both the scientific community and Taubes are a bit guilty of piling on after the play is dead: after being effectively immersed in the cold fusion drama, most readers will find the epilogue a let-down.

To summarize, the first 400 pages of *Bad Science* are good reading. In tone Taubes's effort falls somewhere between those of Richard Rhodes (*The Making of the Atomic Bomb*) and of Hunter S. Thompson (*Fear and Loathing on the Campaign Trail*). This book is, in the jargon of pulp fiction, excellent beach reading, and it indisputably proves the wisdom of Andy Warhol, who said, "In the future everyone will be world famous for fifteen minutes."

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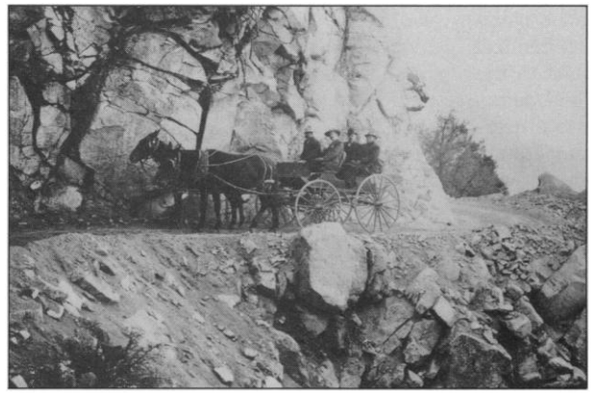
Telescope Builders

Pauper and Prince. Ritchey, Hale, and Big American Telescopes. DONALD E. OSTERBROCK. University of Arizona Press, Tucson, 1993. xviii, 359 pp., illus. $45.

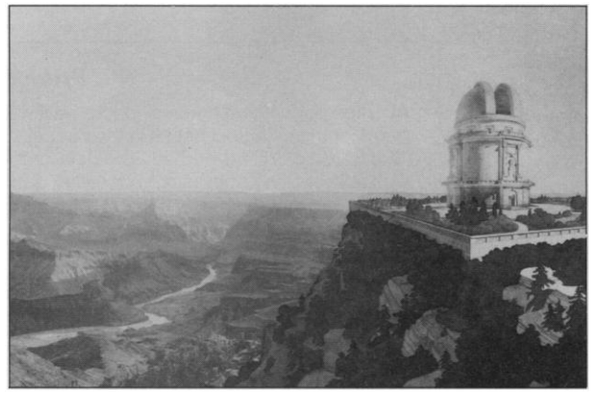
George Willis Ritchey (1864–1945) is the pauper of the title of Donald Osterbrock's book and George Ellery Hale (1868–1938) the prince. Together they did indeed play large roles in both the building of the biggest telescopes and in defining the early research programs these made possible. Hale's story, however, is much better known than Ritchey's. This book is intended to rectify this situation.

Hale was a rich boy, with all the advantages of privilege: private schools and tutors, spectrographs and telescopes. In his teens Hale became enthusiastic about physical astronomy; his father bought him the very best equipment and built him an observatory. He attended MIT and, before graduation, met the most important instrument-makers and astronomers of his day: John A. Brashear, Samuel P. Langley, Henry A. Rowland, and others. Combining his privilege, ability, and perseverance, Hale readily pushed toward his goal of becoming an astrophysicist.

Ritchey had similar doggedness but lacked the rich father. His family immigrated to America from Ireland in the mid-19th century and made its way by means of farming and small industry in the Ohio River Valley. His father owned a successful furniture factory and then went bankrupt. In and out of factory jobs, Willis Ritchey attended the University of Cincinnati, then free to city residents. He never finished university. Instead, he taught woodworking at a Chicago trade school and made his first telescopes in his basement. In 1891, Ritchey met Hale through the Chicago Section of the Astronomical Society of the Pacific. Within a few years he was on Hale's payroll, funded by Hale's father, as a full-time "optician."



"Carriage on Mount Wilson road, 1907." From left to right are the driver, George Ellery Hale, George Willis Ritchey, and John D. Hooker. [From *Pauper and Prince*; courtesy of the Observatories of the Carnegie Institution of Washington]



"Ritchey's composite drawing and photograph of a fixed vertical telescope at the edge of the Grand Canyon." [From *Pauper and Prince*; courtesy of the Carnegie Institution of Washington]

Why write a book about Willis Ritchey? This is more than just another Horatio Alger story. Osterbrock calls Ritchey "the leader of the revolution in concept and scale" that produced the big telescopes. This is a story of a neglected side of science: the instrumentation that fosters and delimits scientific research. Osterbrock provides one of the most extended examinations to date of an instrument-maker's life and work. To understand the success and character of science in America, we must understand the instrumental infrastructure that made it possible. To know the history of theory or of discovery is not enough on its own.

Pauper and Prince has both strengths and weaknesses. Osterbrock has made extensive use of archival materials and of oral-history interviews. Clearly he also based his narrative on a strong knowledge of relevant primary publications and on his own experience as an astronomer. Discussion of relevant secondary literature is, however, thin. The manuscripts provide a fine-grained view of Ritchey's character and of his approach to the design and construction of sophisticated instruments. Much can

also be gleaned in these pages concerning the development of the research institutions that supported science around 1900. Valuable aspects of the book include its discussion of Mt. Wilson Observatory (chapters 4 through 6), insights into behind-the-scenes events at the Carnegie Institution of Washington, and a long bibliography of works by Ritchey. The citations of primary literature would be much more useful, however, if article titles were not omitted.

Another problem is that sometimes the detail takes over, to the detriment of the story. For example, much of the genealogical discussion in chapter 1 seems inadequately connected to our understanding of Willis Ritchey. Likewise, knowing what now stands on the spot where Hale first lived does not contribute to our understanding of historical events. This book is primarily a story about Ritchey, Hale, and the advent of big telescopes. These side stories are simply distracting. I am disappointed with the book on one other point. With all his familiarity with these events, Osterbrock could have drawn more general conclusions. Biographies often display this limitation.

Nevertheless, the reader can draw his or her own conclusions, from an important story. *Pauper and Prince* provides a detailed look at how an accomplished maker of instruments fit into the scientific community in early-20th-century America. More such studies are needed—perhaps studies about makers of less dazzling instruments such as geophysical prospecting equipment—alongside more interpretative works.

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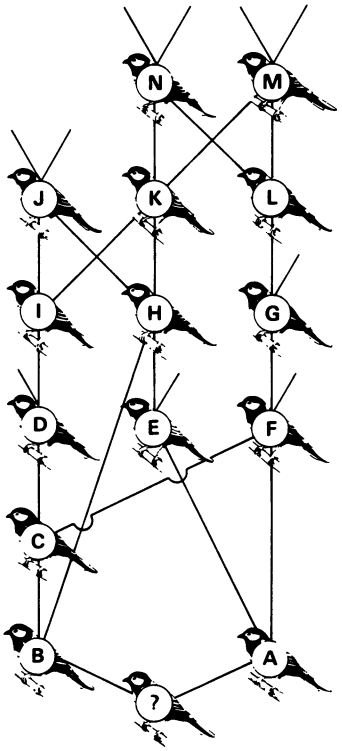
Inbreeding and Evolution

The Natural History of Inbreeding and Outbreeding. Theoretical and Empirical Perspectives. NANCY WILMSEN THORNHILL, Ed. University of Chicago Press, Chicago, 1993. viii, 575 pp., illus. $80 or £63.95; paper, $32.50 or £29.95. Based on a symposium, 1989.

As William Hamilton recalls in the epilogue of this volume, "My mother says that shortly after I was born, ants attacked me in my cradle. The place was Cairo, so I like to guess the ant was 'Pharaoh's,' *Monomorium pharaonis*. . . . I like the idea because, besides being a notorious lover of sweet things, this tiny yellow ant is noted for indiscriminate inbreeding within the nest, including brother with sister." Because of this general fascination that inbreeding, both in our own species and other organisms, holds for humans, the title of this volume will attract attention. However, readers must be forewarned of the need to pick and choose among the contributions, which are highly variable in level of rigor and authors' agendas.

The impact of inbreeding on evolutionary processes, plant and animal breeding, and, recently, conservation biology is a topic of detailed research. To understand its long-term impact in terms of evolutionary genetics, we need to know the level and pattern of inbreeding and the type and extent of its effect on fitness (these issues are the primary focus of this volume). In addition, the magnitude of genetic drift, the importance of mutation in restoring variation or reducing fitness, and the relevance of gene flow in introducing genetic variation may play critical roles. All of these are complex topics by themselves, and their integration into a coherent framework is a truly difficult task.



A pedigree of great tits as compiled by A. J. van Noordwijk and W. Scharloo. There are at least ten relations between A and B, yielding an inbreeding coefficient of 0.145. [Reprinted from *Evolution* **35** (4), 678 (1981)]

Given the obvious difficulty of obtaining information on inbreeding and outbreeding from natural populations, it is surprising that there is little effort in this volume to utilize the information gained from examining cultivated plants and domesticated animals or from forestry genetics, laboratory experiments on *Drosophila*, or studies of human populations, either by anthropologists or by population geneticists. Part of this lack may be deliberate, given Shields's comment that "we must stop interpolating from theory and artificial systems (domestic stock, laboratory populations, or zoos) and gather the critical data in nature. Only then can we be reasonably certain whether inbreeding or outbreeding are good, bad, or indifferent in particular circumstances." Many scientists, including evolutionary biologists, use model organisms and controlled environments to understand complicated phenomena, hoping to establish some general principles. I think that the understanding of inbreeding and outbreeding has greatly benefited from such research in the past and could benefit from additional critical studies of this nature.

This volume is a group of 18 papers stemming from a symposium. Perhaps the best that can be hoped for from such a volume is a summary of the state of a research area or of individual authors' research that provides an entrance into the original literature (there are 105 pages of references in this volume for this purpose). Three of the reviews I found particularly useful as summaries of research areas. Waller provides a reasonable overall examination of the parameters important in mating systems of plants; Waldman and McKinnon give a thorough summary of inbreeding and outbreeding studies in fishes, amphibians, and reptiles; and Lacy examines some of the extensive data accumulated in recent years from mammal populations in zoos. Also quite worthwhile is the original contribution by Werren, which presents new results on the theory of inbreeding depression in haplodiploids, a group of animals that may have high levels of inbreeding.

On the other hand, several papers are devoted to advocating particular viewpoints while ignoring contrary scientific evidence. For example, in his contribution Mitton dismisses the majority viewpoint that recessive detrimental alleles are primarily responsible for inbreeding depression and related phenomena. Instead he takes the position of what may be the last panselectionist and attributes the phenomena to widespread single-locus overdominance. The chapter by Shields seems to have as its main objective to rebut the 1986 review on inbreeding in birds and mammals by Ralls, Harvey, and Lyles, an article that I view as a landmark contribution to the literature. To be more successful, the volume needed critical contributions from such authors as Brown, Deborah and Brian Charlesworth, Lande, Lynch, Ritland, Templeton, or van Noordwijk.

I applaud the attempt to bring together research on inbreeding in plants and animals; often there is a split by kingdom. The extent of inbreeding in general is, of course, very different in the two kingdoms, making its effects on fitness also quite different. A