and the implications of certain toy models for basic properties of our observed world. These subjects did not blaze up so much as baby universes did, but neither have they dwindled so much. Like baby universes, quantum cosmology rests on highly uncertain foundations, but it is somewhat simpler to apply to our world and get quasi-explanations for certain observed features that otherwise seem quite mysterious.

For a good introduction to some of these topics, as well as a glimpse of how the subject appeared just past the peak of interest in baby universes, this conference proceedings is to be recommended.

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Biological Restoration

A History of Regeneration Research. Milestones in the Evolution of a Science. CHARLES E. DINSMORE, Ed. Cambridge University Press, New York, 1992. x, 228 pp., illus. $54.95. Based on a symposium, San Francisco, Dec. 1988.

With the recent specialization and reduction of much biological science to the cellular and molecular level, it becomes important that the studies and insights of the past that have inspired the foundation of this research be recorded and reviewed. This collection of essays dedicated to embryologist Oscar Emile Schotté presents a selected tour through the origins and milestones of regeneration research. Although the editor acknowledges that his own interests have "influenced" the contents of this collection of essays and that it does not attempt to be conclusive, it does present a rich blending of both the history and the science of this old and new field.

Regeneration research led the way for the field of experimental biology, and this book attempts to provide a perspective from which to appreciate that pioneering work. It is a humbling work to read, in that it appears that remarkably little has been accomplished toward our understanding of what T. H. Morgan called "vital factors" of regeneration since the experiments and insights of Réaumur, Trembley, Bonnet, and Spallanzani in the 18th century. For example, Dorothy Skinner and John S. Cook illustrate that the principles underlying our current understanding of crustacean limb regeneration were well reflected in the careful observations of René-Antoine Réaumur, in whose words "Nature gives back to the animal precisely and only that which it has lost, and she gives back to it all it has lost." Similarly, Abraham Trembley's precise and systematic experiments on Hydra regeneration, as reviewed by Howard and Sylvia Lenhoff, still serve not only as our basis for understanding this phenomenon but as a standard "to all researchers in the natural sciences as the best paradigm of method, out of which they must learn the still too little known art of how to investigate the truths of nature." The essay on Trembley as well as others in this collection is enriched by material from the notes and correspondence of the scientists themselves. Trembley's serendipitous discovery that Hydra regenerate is brought to life through his words, "It is to such a happy chance that I owe this discovery which I made, not only without forethought, but without my ever having in my entire life any idea slightly related to it."

Two other themes recurring in these chapters are the role of regeneration research in the establishment of experimental biology and in the debate surrounding preformation and epigenesis. This controversy comes to life through Dinsmore's presentation of correspondence between Spallanzani, Bonnet, and others, which reflects ideas of that period concerning preformationism, emboîtement, and the "infinity of germs" that were presumed by many to exist within regenerative tissues. This background provides an antidote to what Frederick Churchill refers to as "Gipfelsammler's myopia," a syndrome that "afflicts historians of science, philosophy and art and other areas of high culture," resulting in "a single-minded attention to dramatic mountain peaks accompanied by total neglect of the surrounding hills and valleys."

There are several chapters that do indeed reflect the interests of the editor in amphibian limb regeneration. The history of studies of the role of innervation, bioelectricity, and the origin of the blastemal cells in regenerating amphibian limbs in particular is well reviewed by Marcus Singer and Jacqueline Géraudie, by Joseph Vanable, and by Richard Liversage, respectively.

Oscar Schotté was known to say (jokingly) that he would give his right arm to discover the "secret" of mammalian limb regeneration. With the advent of molecular biology and its new arsenal of probes to "key" proteins associated with pattern, differentiation, and cell-cell interactions it should now be possible to discover the secrets governing regeneration. Trembley commented, "It is even good to repeat successful experiments a number of times. All that it is possible to see is not discovered, and often cannot be discovered, the first time." It is safe to say that we are still repeating these "successful experiments." It seems fitting that the regenerating systems that first inspired experimentation in biology may, coming full circle, be those through which the molecular cues and cellular interactions now being characterized may be understood.

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