

Soviet Science: Practitioners' Reports

Soviet Science on the Edge of Reform. HARLEY D. BALZER. Westview, Boulder, CO, 1989. xxii, 290 pp. Paper, \$32.50. Westview Special Studies on the Soviet Union and Eastern Europe.

Harley Balzer's book provides an informative account of the condition of Soviet science in the 1980s. His study is based in large measure on a survey of 202 emigre scientists conducted in the early 1980s. All of these people had worked recently as scientists or science administrators in the Soviet Union, and the survey asked them about their education, working conditions, and attitudes to science and technology.

This kind of study was particularly important before *glasnost*, when free discussions with Soviet scientists were difficult and the Soviet press was given more to boasting than to reporting. But Gorbachev's policies have not made Balzer's book redundant, for Balzer has integrated his survey results into a broad analysis. He makes excellent use of the secondary literature on Soviet science, of the revelations of the Soviet press in the age of *glasnost*, and of conversations with Soviet scientists. The result is a nuanced picture of Soviet science "on the edge of reform."

Soviet science is a vast enterprise, embracing more than a quarter of the world's researchers. The state has placed a high value on science and technology and has made abundant resources available for research and development. Soviet surveys show that science enjoys high prestige in the society at large. But Soviet science has not done as well as might have been expected, in terms either of scientific discovery or of technical achievement.

Performance has been best in theoretical fields such as mathematics that do not require expensive equipment, as well as in those areas to which the state has given priority. Balzer's respondents evaluated the level of Soviet technology in much the same way as Western studies have done: high ratings in the military sphere, middle ratings in industrial technologies, and low ratings in consumer technologies. Soviet computers and electronics were ranked very low.

In spite of this general picture, however, what emerges from Balzer's study is an impression of great unevenness across the whole R&D system. It is not that some

types of institution—Academy institutes or military establishments, for example—are strong and others weak. Rather, within each type of structure and each field of science Balzer finds evidence of the coexistence of high quality with mediocrity. Balzer is able to assess the similarities and differences between the various institutions in the overall system, and the similarities are greater than one might have expected.

This emerges most strikingly in the chapter on military R&D. Here there are privileged institutions with special conditions, but the very size of the military R&D effort argues against the proposition that it is uniformly better than civilian R&D. "Most of the military's performance," writes Balzer, "derives from its being the first claimant on all research and production no matter where it is carried out." Moreover, the factors that account for the relatively successful performance of military R&D—priority, better quality control, more resources—can be created only in a limited number of cases. Not everything can be given top priority.

By committing massive resources the Soviet Union has achieved major results in high-priority areas of technology. But the R&D system, in its day-to-day operation, poses serious obstacles in the way of science and technology. Secretiveness inhibits the flow of scientific information; rampant departmentalism inhibits innovation and diffusion; the inadequate infrastructure puts a brake on scientific research; weak computing capability also hampers research; political interference has had a dire effect on some disciplines, notably biology.

Much of this has been clear for a long time. What Balzer adds is an impression of how the system looks to those who have worked in it: what hindered their research and helped it; how they used informal ties to overcome bureaucratic rigidities; what they see as the strengths and weaknesses of Soviet science. Our overall picture is not, I think, changed in any fundamental way, but we get a more subtle and differentiated sense of how the broad structures affect those who actually do the research and engineering.

For anyone wanting to understand the state of Soviet science on the eve of Gorbachev's reforms, this is an excellent guide.

Balzer notes that the condition of Soviet science grew worse in the Brezhnev years, in line with the overall demoralization of society. He also makes the point that the old system of R&D has come under increasing criticism, especially now that there is more readiness to count the cost of the resources devoted to science and other government activities. He is not particularly sanguine about the prospect of reform and thinks that some false starts have been made. The most obvious effect of reform has been greater contact between Soviet and foreign scientists. This is very much to the good, but Balzer makes it clear that more needs to be done if Soviet science is to flourish.

DAVID HOLLOWAY

Center for International Security and Arms Control,
Stanford University,
Stanford, CA 94305

Evolution of Life Histories

Alternative Life-History Styles of Animals.

MICHAEL N. BRUTON, Ed. Kluwer, Norwell, MA, 1989. xviii, 617 pp., illus. \$215. Perspectives in Vertebrate Science, vol. 6. From a conference, Grahamstown, South Africa, 1987.

The morphological diversity of animals is exceeded by the diversity of their life histories. Naturalists describing variation in life histories have always followed closely on the heels of taxonomists, who traditionally have used only morphological differences to recognize species and to infer relationships among them. Frogs, for example, are morphologically rather conservative, but they display life histories that range from no parental care of aquatic eggs and larvae to paternal or maternal care with direct development or brooding of eggs in foam nests, on dorsal pits, in the vocal sac, or even in the stomach. Some species are explosive breeders in response to heavy rains; others have prolonged breeding seasons and are highly territorial.

The Darwinian view of natural selection is based on the differential survival and fecundity of genetically different phenotypes. This interplay between the phenotype as the external product of the genotype and fitness as the result of ecological factors acting on the phenotype has made the study of life-history evolution the modern way to do natural history. The recent renaissance of life-history studies has involved two rather separate approaches. One uses the statistical methods of quantitative genetics to uncover the deterministic genetic component to life-history variation. Central to this approach is the notion of phenotypic plasticity, by

which a single genotype can produce one of several alternative phenotypes in response to the environment. This approach is concerned with issues such as the constraints on selection due to genetic correlations between components of fitness in two environments. The emphasis is on variation among individuals within a population.

The second approach does not explicitly include genetics, but rather studies patterns of variation resulting from ontogenetic trajectories and allometric relationships among characters such as egg size and body size. The emphasis is on variation among related but not interbreeding taxa. Central to this approach is the notion of heterochrony, the relative timing of developmental events in related taxa.

In 1987 a conference was held in Grahamstown, South Africa, to discuss "the ways in which epigenesis . . . shapes the life-history styles of plants and animals." The organizing concept of the conference, and the volume that it spawned, was alternative life-history styles—that is, that organisms have bifurcations in their development in which they have genetic instructions to follow more than one pathway, with the environment determining which branch is taken.

The conference logo was a coelacanth fetus with a yin-and-yang yolk sac, and the first chapter, by Balon, entitled "The Tao of life," is a primer on Taoism and its application to evolution and developmental biology. Those of us who spent the '60s talking about life-history evolution will be amused by this chapter's summary table, which has "yin" and "yang" as column headings and such familiar pairs of concepts as *r* and *K* selection and altricial and precocial development as the entries. The epigenetic concepts of Goldschmidt, Waddington, Løvtrup, and Balon join the thoughts of Lao Tzu (the Old One) in other chapters.

One should read beyond this first chapter; the volume contains some very straight and empirical reviews of life-history diversity in fishes (Flegler-Balon), amphibians (Duellman), small mammals (Perrin), and birds (Siegfried and Brooke). These review chapters tend to be extensions of the post-G.C.-Williams era of adaptationist interpretations of life-history diversity. There are also some mixed chapters, such as one by Fabian on sex determination that first presents a concise review of mechanisms and then a brief speculation on "ontogenetic memory," by which organisms alter regulatory genes to recall phenotypes from their evolutionary past. Geist reviews phenotypic dimorphisms in mammals with a fascinating historical account of the experimental study of the effects of nutrition on growth and development of deer. He then presents his dichotomy of dispersal and maintenance phenotypes

and argues that we are all the genetically fixed dispersal form of *Homo erectus*.

There is much to think about when reading this volume, but one must be prepared to cycle from dry factual recitations of the life histories of particular groups to reviews of conventional evolutionary theory to rather flaky excursions out of the mainstream. I found myself in a rather peculiar eddy with a chapter by Løvtrup reviving the Lamarckian dichotomy of divergent and progressive evolution. Divergent evolution is phylogenetic bifurcation (we call it speciation), which Løvtrup says requires isolation and the suspension of natural selection. Progressive evolution is said to occur whenever two taxa attempt to inhabit the same niche, with the competitive exclusion axiom driving the process. Progressive evolution is directed, with the branch resulting in the most secondary branches being on the progressive side of the bifurcation. Løvtrup develops a phylogenetic classification of the vertebrates, producing a progressive lineage leading to mammals. At one point he had to decide whether birds or mammals were the more progressive. He chose mammals by resorting to the ecological criterion "when flightless birds are exposed to competition with mammals they usually lose the battle."

This is a book about bifurcations. I found myself sorting the chapters into good ones and bad ones. The good ones summarize decades of empirical work. The bad ones are half-baked attempts to apply nonscientific approaches to legitimate evolutionary questions.

HENRY M. WILBUR
Department of Zoology,
Duke University,
Durham, NC 27706

Some Other Books of Interest

Biology and Utilization of the Cucurbitaceae.

DAVID M. BATES, RICHARD W. ROBINSON, and CHARLES JEFFREY, Eds. Comstock (Cornell University Press), Ithaca, NY, 1990. xviii, 485 pp., illus. \$69.50. Based on a conference, Ithaca and Geneva, NY, Aug. 1980.

The plant family Cucurbitaceae, best known through such fruits as squash, pumpkin, cucumber, and melon, is also a source of other useful products and has, as the editors note in the preface to this volume, been studied from a wide variety of perspectives. Among features of both biological and agricultural interest the editors note the widespread occurrence of bitter tetracyclic penoids, affecting relations with insects; unisexuality, expressed through both monoecy and dioecy; and "synergistic relationships

with early agriculturalists." All these and other themes are represented in this volume, which has been expanded beyond the 1980 symposium in which it originated. The volume opens with a group of 14 papers on the systematics and evolution of the family, beginning with an overview by Jeffrey (who also provides an outline classification as an appendix to the volume) and including considerations of cytogenetics, isozymes, phyto-geography, coevolution, and domestication of various species. There follow five papers on comparative morphology and four on sex expression. The remainder of the volume is devoted to more immediately practical concerns. A group of six papers under the heading Utilization includes discussions of pharmacological properties of New World tropical species, a program to develop the food potential of the New World buffalo gourd, and the possibility of cultivating the Namib Desert species *Acanthosicyos horridus*, which has been utilized by foragers since antiquity. The final seven papers are devoted to crop improvement and protection. Among the approaches to genetic improvement discussed are cell, tissue, and organ culture techniques, addition of an extra chromosome, and manipulation of genes affecting capacity for chlorophyll synthesis. Other subjects discussed include resistance to viral and other diseases, encouragement of multiple fruiting to increase the efficiency of mechanical harvesting, and advantages of bush over vine cultivars. The book has an international authorship, including scientists from India and Africa as well as Europe and North America. It concludes with a 20-page index.—K.L.

Herbicides and Plant Metabolism. A. D. DODGE, Ed. Cambridge University Press, New York, 1990. x, 277 pp., illus. \$65. Society for Experimental Biology Seminar Series, 38. From a seminar, York, U.K., April 1987.

In his preface Dodge notes that investigators of photosynthesis have long used herbicides as experimental tools and that the shikimic acid pathway and various other processes of biosynthesis in plants have attracted new attention because of the discovery of compounds that inhibit them. The Plant Metabolism Group of the Society for Experimental Biology has thus prepared this collection of 12 review papers by 19 (mostly British) authors in the hope that it will be useful to both students and research workers in the field. In an opening chapter K. B. Parry provides some background information on the use and development of herbicides, including data on the market for agrochemicals and discussing the cost and effectiveness of the four major approaches