Japanese Science

From the Inside

Samuel Coleman

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JAPANESE SCIENCE

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JAPANESE SCIENCE

Japan's performance in the field of scientific research has been less than might be expected. There is a curious dichotomy between what has gone on in the laboratory and the country's outstanding technical sophistication and economic success. However, this may be about to change.

This new ethnograpic study of Japan's scientists looks firsthand at the career structures and organizational issues that have hampered their advancement. It provides an analysis of the problem of career mobility in science, the status quo in university and government laboratories, relations between scientists and lay administrators and the problems encountered by women scientists.

Japanese Science: From the Inside contests the view that Japan's relatively poor scientific record has been the product of unique thought patterns and instead demonstrates the crucial importance of moribund policy decisions in holding back dynamic and ambitious scientists.

Samuel Coleman is an independent researcher who has written extensively on Japanese science and society. In his former position as Associate Director for Research and Program Development at the North Carolina Japan Center, he led the effort to establish the Harry C. Kelly Fund for United States–Japan Scientific Co-operation.

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IN MEMORY OF MY FATHER,
DAVID M. COLEMAN

FOREWORD BY ARTHUR KORNBERG

Progress in science depends on discoveries by trained, able, and motivated scientists; virtually all industrialized societies have or can have an abundance of such scientists. What is lacking in most societies is the cultural environment and the sustained financial support that scientists need to contribute their creative talents. In the coming decades, when science and technology will be increasingly vital for the welfare of a society, an adequate volume of research support and its proper organization are crucial.

In this needed book by Dr. Sam Coleman, the management of bioscience in Japan, the world's second largest economy, is examined critically to provide a case study which is instructive for other societies, as well as an internal audit for Japan itself. Considering the essentiality of bioscience research and the huge investment being made in the enterprise, such an analysis is timely and of the greatest importance.

As a mentor since 1950 for some twenty Japanese bioscientists and a close colleague of as many more, I have been attentive to how their careers were affected by their research support. Also, on frequent visits to Japan, I have observed the organization of funding of academic and governmental science and on occasion have been asked to advise on future planning. For these reasons, I especially welcomed this in-depth analysis of Japanese support of bioscience by someone with the qualifications of the author.

Sam Coleman, trained in anthropology and possessing a professional command of the Japanese language, has conducted extensive studies on Japanese health and science policies and related issues. In this most recent research, he has focussed on how bioscience research is performed and how it is funded by several governmental agencies in a variety of settings. His findings and conclusions are presented clearly in chapters that dwell on government institutes, university groups, and quasi-independent research institutes along with chapters containing reflections on social issues: insularity, hierarchy, mobility, gender, bureaucracy, and status quo.

His data and interviews with a wide spectrum of scientists and administrators presented in this book corroborate and extend the impressions I have gained over the years from Japanese colleagues and former students. In the post-World War II period, governmental spending on basic bioscience training and research, has until very recently, been abysmally poor. Virtually all postdoctoral training was funded and directed by American laboratories: the National Institutes of Health (NIH) in Bethesda and academic groups supported by the NIH at universities and institutes. The young scientist upon returning to Japan, and fortunate enough to obtain an academic appointment, was indentured to a professor who controlled the meager funds and dictated the research program. Those who climbed the slippery pyramid to a professional appointment then reenacted the hierarchical pattern. University appointments virtually excluded graduates from other institutions; mobility between university departments was uncommon. Both the university administrations and the granting agencies have been and still remain under centralized governmental control, enmeshed in layers of bureaucracy, and dominated by an "old-boy" network. Opportunities for women in academic life remain severely limited.

On the positive side, Coleman did encounter some hopeful signs – effective management of the autonomous Osaka Bioscience Institute, voices of concern and dissatisfaction from many young scientists and a few elders, stirrings in the government that indigenous basic science is needed for long-term technological development, and large increases in the bioscience budgets even in the face of the current downturn in the general economy.

With regard to severe criticism of the magnitude and organization of Japanese bioscience support, it needs to be said that similar patterns have, with few exceptions, also prevailed in the European countries and were extensions of the practices in the pre-World War II period. By sharp contrast and a departure from the accustomed patterns was the magnitude and the organization of bioscience funding by the NIH in the post-World War II period. Although this subject is not treated in this book, I believe that such a comparison between the Japanese and American styles needs to be made.

With the conclusion of World War II, the NIH started something in biomedical science research support that was utterly unique. Competitive applicants are judged by committees of peer scientists from outside the government; grants are now given to some 40,000 individual scientists, young and old, for four to ten years. With the award of a grant, the scientist becomes his own boss. Success or failure depends on what the scientist accomplishes. Research is directed from the *bottom up*. By contrast, in Japan and most other countries, much of research direction is vested in a relatively few senior scientists or administrators. Research is directed from the *top down*.

Were the NIH record to be described for publication as an experiment in research administration, an impartial reviewer, even in this social area of science, might well question whether other factors might have been responsible for the good result. Such an experimental control does in fact exist in the support program of agricultural science in the United States during the same postwar period. The considerable, federally supported research activity remained in the tight grip of the Department of Agriculture, which retained all authority within its own bureaucracy. Research programs were limited to the established regional laboratories around the country; there were no grants to universities or private institutes. With this old-fashioned system of management, the knowledge base for agriculture remained stagnant. Little was learned about the basic biochemistry and genetics of plants and farm animals. Only recently, with the introduction of recombinant DNA technology, funded largely by the NIH, has there finally been an awakening of interest and activity in basic agricultural science.

The independence of an American scientist to initiate and pursue his own research program in the biomedical sciences has sometimes been attributed to the policies of American universities and institutes. Not really. This independence has been achieved because the individual scientist is not indebted to a senior professor, to a department head, to a dean or is prey to university politics. The university has no choice but to give scientists their independence in order to compete for their teaching contributions, the prestige of their discoveries, and for the very considerable income from the indirect costs attached to their grants. Yet it should be recognized that the very competition for grantees is an essential ingredient of the success of the NIH granting system because both the private and public universities are free from centralized government controls, something also virtually unique in the United States. With all its success, this system is constantly under strong pressures to centralize and collectivize research support; constant vigilance is needed to restrain these pressures.

Science is a global enterprise; instant communications have made it more so. Curiosity, ability, and pursuit of knowledge have no national boundaries. Japan like other nations can have an unlimited reservoir of scientific talent. Proper nourishment of talent is the crucial element. Coleman's book makes a major contribution in identifying many of the ways in which Japan can nourish this talent for the welfare of Japan and all mankind.

Arthur Kornberg
Stanford, California

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A community of colleagues guided me with their insights, encouragement, and constructive critiques. Eleanor Westney, long-time friend and mentor, gave me professional inspiration via conceptual insights and her wisdom throughout this project. Ellis Krauss encouraged me as only a long-time friend and respected colleague could. Shigeru Nakayama has been a wellspring of knowledge in both historical fact and the intellectual landscape of Japanese science studies. He and Morris Low have helped me often and unstintingly. Justin Bloom also very generously shared his extensive knowledge of Japanese science and technology. My thanks go also to Catherine Lewis, Susan Orpett Long, and an anonymous manuscript reviewer for Routledge who, along with Jack, Eleanor and Justin, made suggestions for portions of early drafts that improved the manuscript greatly. I can only hope that the final product approaches the quality of their input. The faults and mistakes that remain are of course mine alone.

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My introduction to the Science, Technology and Society community came from Ronald Overmann, now retired National Science Foundation program officer. In 1983 the eminent historian of technology Ruth Schwartz Cohen wrote that all historians and philosophers of science owed Ronald Overmann much; twelve years later he was still helping immensely. For decades Marvin Harris' writings have raised for me a guiding beacon of intellectual rigor and insight into the human condition. I thank him for the bright light.

Illustrations convey what words alone cannot. This book is the richer for the kind consent of Ken-ichi Arai, who originally composed the figures in Chapter 2, and Noriko Sasaki for a sketch from her delightful *The Animal's Doctor* that graces Chapter 9. Equally, thanks to Norio Yamanoi and *AERA* for the cartoon appearing in Chapter 6, and to Take-emon Sato, Isao Ando, and their publisher, Takarajimasha, for cartoons appearing in Chapters 5 and 8; they helped me convey the wit and irony of editorial commentary on Japanese science. The radar graph in Chapter 1 appears courtesy of the British Council and Brendan Barker. I also thank the Society for Applied Anthropology and the Association of Japanese Business Studies for their permissions to reproduce portions of my papers on the Protein Engineering Research Institute that originally appeared in *Human Organization* and *Best Papers* of the AJBS, respectively, in 1995.

Sam Coleman
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CONVENTIONS

The yen value for figures given in US dollars is 125/$US. All Japanese names appear in the Western fashion, i.e., personal name first and then surname, as in international scientific journals. Romanization of Japanese language follows the Hepburn system, but where individual Japanese have transliterated their names differently I have followed their preference. English translations of Japanese publication titles and organizational names appear as written by their Japanese authors or organizations.

Abbreviations used in the text

ARS	Agricultural Research Service (United States Department of Agriculture)
BERI	Biomolecular Engineering Research Institute
GRE	Graduate Record Examinations
IMSUT	Institute for Medical Science, University of Tokyo
JBS	Japanese Biochemical Society
JRDC	Japan Research and Development Corporation
JSC	Japan Science Council
MAF	Ministry of Agriculture, Forestry and Fisheries
MHW	Ministry of Health and Welfare
MITI	Ministry of International Trade and Industry
MOE	Ministry of Education, Science, Sports, and Culture
MRC	Medical Research Council (Great Britain)
NIH	National Institutes of Health (United States)
NISTEP	National Institute of Science and Technology Policy
NSF	National Science Foundation (United States)
OBI	Osaka Bioscience Institute
PERI	Protein Engineering Research Institute
RIKEN	(Rikagaku Kenkyūjo) Institute of Physical and Chemical Research
SRF	Science Research Fund
STA	Science & Technology Agency

CONTENTS

1

INTRODUCTION

This is a book about the careers and aspirations of Japan's scientists, with special attention to its bioscientists (the laboratory scientists who study the workings of the cell through biology, chemistry, and physics). At first glance, Japan would not be a particularly interesting country in which to study any of the sciences. As the twentieth century closes, Japan has yet to capture more than 1 per cent of the Nobel Prizes ever awarded in the sciences. And many commentators, Western and Japanese, have stated that good science, after all, requires original and innovative expression, which Japanese society seems to suppress in the name of consensus and group discipline. But what if there were Japanese scientists in an area of research that, despite a lackluster showing in the past, had the potential to attain world leadership, given a different organizational configuration? A closer look at the organization of those scientists' efforts – in particular, the ways in which individual scientific careers are rewarded – would tell us something about the makings of an internationally competitive science community as well as the place of the individual in Japanese society.

The life sciences now account for some of the most profound and far-reaching developments in the sciences today, making them a good candidate for a closer examination of the organizational state of Japanese science as the century ends. Japan's 128,000 bioscientists are part of an exciting and important worldwide quest. Thanks to techniques for replicating and connecting portions of DNA molecules in new combinations, it is now possible to analyze the properties of a wide range of genes and proteins and their relationships with each other, affording detailed insight into such grand processes in the evolution of life as speciation, growth, maturation, and death.

Although most of us will have little contact with these questions, the laboratory tools devised to investigate them are spawning new technologies. Among basic science fields the life sciences have a particularly close connection to applications. Some are still on various drawing boards, others are in widespread use already, and many will exert profound influences on the way we live. Human genes have been inserted into bacteria to generate proteins for medicinal purposes. Many genes controlling susceptibility to major diseases have been identified, aiding prediction and treatment of ailments. The potential applications from bioscience are wide-ranging and surprising, sometimes delightfully so. My own favorite examples involve the genes that generate light in fireflies or luminescent squid; they are now used in biochemical assays, and inserting such genes into the DNA of various shrub species may offer an energy-efficient form of illumination for airport runways and highway shoulders.

The industrial potential of these innovations represents several tens of billions of dollars in markets worldwide, but the new knowledge generated by the life sciences also offers applications in critical fields of public concern as diverse as epidemiology, energy conservation, and ecosystems management. This potential has been recognized among Japan's science policy makers for some time. Official statements citing the importance of research in the life sciences have appeared with increasing frequency since the prestigious Council on Science and Technology (Kagaku Gijutsu Kaigi) submitted its 1971 recommendation (STA 1994: 409–10).

Upward trends and bright spots

Japan is making notable progress in the life sciences. International publications by Japanese authors show a clear increase in frequency that began in the early 1970s (Garfield 1987). Between 1988 and 1994, the absolute number of Japanese articles appearing in international journals covered by the Medline data base increased by over 60 per cent (Yamazaki 1996a: 18). Japan overtook the United Kingdom in the late 1980s as the world's second largest producer of internationally published papers in the fields of biochemistry, genetics, cancer research, and neurology (Yamazaki 1996b: 396). In 1990, the American-based Institute for Scientific Information could report that Japanese biology had displayed "robust growth" in its share of articles in the world's leading scientific journals (*Science Watch* 1990: 7).

The top medical schools in Japan are now producing, per researcher, as many international publications as their prestigious Western counterparts, according to a careful study examining international life science journals in the first half of 1993; indeed, Kyushu University's figure of 0.94 publications per year per researcher, which approached the figure of 1.01 for Oxford, nearly trebled that of the Johns Hopkins University (Yamazaki 1994: 125). As Japanese bioscientists have turned more to the international scientific community, they have also devoted less effort to domestic publication activity. Between 1988 and 1994, the number of life science papers published in Japanese decreased by 23 per cent; in that same period, output of international papers rose from a rough parity with domestic publications to well over twice their number (Yamazaki 1996a: 18).

In this same period, several Japanese biomedical researchers have attained international prominence. The most cited scientific paper of the 1980s (with

3,074 "hits" – i.e. citations by other authors) was a 1984 publication in *Nature* by Kobe University's Yasutomi Nishizuka on protein kinase C (an enzyme that plays a critical role in intracellular processes). Other well-known and well-cited scientists today include Osamu Hayaishi (the oxygenases and prostaglandins), Tasuku Honjo (molecular immunology), the late Shosaku Numa (sodium channels), and Tadatsugu Taniguchi (cellular responses to cytokines).

Individual Japanese biomedical researchers have been recognized internationally for well over a hundred years. Shibasaburo Kitasato produced the world's first pure culture of the tetanus bacterium in 1889, and by the next year had also proved the existence of the bacterium's antitoxin. These advances enabled Japan's pioneer development of serological therapy for cholera and diphtheria as well as tetanus (Iinuma n.d.; Bartholomew 1989: 122). Kitasato's student, Kiyoshi Shiga, had discovered the bacillus that causes dysentery. (Shiga was only 27 years old at the time.) Jokichi Takamine was the first to identify and isolate adrenalin, in 1900. Umetaro Suzuki discovered Vitamin B-1 and reported it in 1911, at the time that chemist Casimir Funk announced similar experimental results. At the time of World War I, Tokyo University pathologist Katsusaburo Yamagiwa devised a technique for inducing tumors in experimental animals that became an important building block for modern oncology (Bartholomew 1989: 55).

Persisting mediocrity

Despite bright spots throughout the sciences such as these, Japan's scientists have yet to claim a prominent international position. One indication of the quality of internationally published research is its "impact," or the extent to which other specialists make use of it and cite it in their own articles. Citations per published scientific paper by Japanese authors between 1981 and 1994 barely exceeded half the American rate (May 1997: 793). Citations for Japanese contributions in the life sciences were noticeably weak in proportion to their share of world papers. Figure 1.1, based on all of the articles published between 1989 and 1993 by Japanese authors, makes the point by comparing the percentage of all international scientific publications by Japanese authors and the extent to which they are cited by all authors in their fields worldwide. In most life science fields, the publications are not generating attention commensurate with their presence. This conclusion agrees with the results of previous investigations covering the late 1980s (reported in Garfield 1987: 344 and Swinbanks 1991). The figure also suggests that the most activity and recognition belongs to applied physics, an area – as its name indicates – that is oriented to industrial applications.

Comparing Japan's performance in the life sciences with the United States' has limited meaning because the United States is an unrivaled powerhouse of scientific activity, in a class by itself in resources and accomplishment. Postwar