AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
150 YEARS • 1848-1998

SCIENCE AND SCIENTISTS IN CHINA

ILLUSTRATION: ALLAN M. BURCH

CHEN-LU TSOU *was director of the National Laboratory for Biomacromolecules in Beijing from 1988 to 1993. He is president of the Chinese Biochemical Society and director of the Department of Life Sciences, Chinese Academy of Sciences, and has twice been awarded the China National Natural Science Prize (first class).*

Confucius, the great Chinese philosopher, had so deep and penetrating a knowledge of human nature that his influence over Chinese history has been immense, and his teachings are of great value even today, and not just in China. During his lifetime (about 500 B.C.), Confucianism was just one of several schools of thought, but it came to dominate Chinese culture from the early Han Dynasty (100 A.D.) onward. Since then, all other kinds of learning have been considered more or less trivial, and scholars of Confucius' philosophy have ruled over the common people, including scholars of other disciplines. One of the great tenets of Confucianism the need for each individual to know his or her place in the social hierarchy, contributed much to the continuation of Chinese civilization through the dynasties. But knowing one's place also militates against curiosity and creativity, and I believe that the influence of Confucius explains why China has never been strong in science, especially abstract science.

In this essay I shall briefly trace the historical development of science in China before examining its current status and what I see as the future of science in China.

Scientific development. The four brilliant inventions of ancient China, namely the compass, gunpowder, paper, and printing, were all technological innovations. They are undoubtedly of tremendous practical value but are not of great importance to our cognition of the world surrounding us. The Western concept of science began to be introduced into China in the middle of 19th century, largely because the leaders of the Qing Dynasty realized that it was not possible to fend off foreign invaders with Confucianism alone. Importing ideas from the West allowed them to consolidate their rule and to enjoy a more pleasant lifestyle, and again it was technological innovations, such as electricity, railways, and automobiles, that were of most interest. To accelerate learning from the West, modern universities were established by the beginning of this century, and the Academia Sinica [now generally known as the Chinese Academy of Sciences (CAS)], with its affiliated research institutes, was founded in the thirties.

CAS expanded greatly during the early years of the People's Republic and was charged with developing basic research. This it did, but for several decades Chinese scientists were isolated from their Western colleagues—interaction and exchange was extremely limited and, while Western journals were available, no one published abroad. Then, in the 1970s, the late Deng Xiao-Ping introduced the celebrated "Open Door" policy, which had dramatic consequences for China in general and for Chinese science in particular. Foreign scientists began to travel more freely in China, and Chinese scientists could publish in foreign journals as well as travel and study abroad. Indeed, the latter freedom has developed to such an extent that a "brain drain" is now a real problem. Throughout the century, CAS continued to grow and develop, and today it comprises over 100 research institutes and a total staff of about 60,000. It remains the bulwark of basic research, although today the task is shared with the universities.

Government support. Old lessons die hard, and even to this day science is virtually always linked to technology. We have the State Commission (now the Ministry) of Science and Technology, the State Prize for Progress in Science and Technology, the China Association of Science and Technology, and the *Science and Technology Daily*. Indeed, the link between science and technology is so intimate that they have merged into one term in the Chinese language, "keji," which means scitech. Unfortunately, scitech refers mainly, sometimes exclusively, to technology and rarely to science. The relationship is exemplified within CAS. Established as the Chinese Academy of Sciences—not the Chinese Academy of Scitech—CAS is supposed to be concerned mainly with basic sciences. However, among its five departments, the Department of Technical Sciences has the largest membership (173 of a total of 604), and its influence continues to grow as it elects more new members every other year than the departments for basic sciences. In addition, the newly formed Engineering Academy has 439 members, making 612 members in technical sciences in the two academies as against 431 members in basic sciences.

It is understandable that China, a developing country, wants to invest in projects that promise a quick return and consequently emphasizes technology over pure science. However, many of my colleagues and I would argue that basic research is of paramount importance to sustained economic growth, and we are disturbed by the negligence shown toward the basic sciences. On the few occasions that government leaders refer to scitech, they invariably have the second half of the word in mind. And even on those rare occasions when basic studies have been mentioned, it has been in the context of basic aspects of technological sciences. Let me provide two examples: (i) The National Science Foundation of China (NSFC) was founded to support basic research, but almost all grant proposals are required to emphasize applied aspects to be successful. (ii) The recently announced National

The author is at the National Laboratory of Biomacromolecules, 15 Fatun Road, Chaoyang District, Beijing 100101, China.

Scientific Prizes included 478 awards for technological progress and 100 for inventions, but just 51 for basic sciences. These examples are underscored by the total amount of money spent on basic science, about 7% of the scitech budget, which was itself only 0.48% of the gross domestic product (GDP) in 1995. It is primarily due to this inadequacy in financial support that Chinese science has slipped to 14th place in the international league tables of papers published in the major journals worldwide, and still lower in terms of total citations (data from the Institute for Scientific Information).

On the positive side, the share of scitech as a percentage of GDP is scheduled to increase to 1.5% by the year 2000, and of this amount 15% has been allocated to pure science. And to be fair to NSFC, since it was founded in 1985 it has done a good job in distributing the limited amount of money that it controls. The NSFC grants, however, are meager, ranging from RMB120,000 to RMB600,000 for a 3-year project (1 US$ = 8.3 RMB). Much fatter grants are available elsewhere, but to get one of these it seems less important to do good work than to gain good publicity. In other words, to publish in, say, *Science* or *Nature* is of less importance than to be covered by the *People's Daily*. Grantees of the NSFC have to justify requests for support by publishing in scientific journals, as would be the normal procedure for scientists in most countries, while it is not generally known how and to whom recipients of these more generous allowances must justify themselves. But clearly, the best work is not always attracting the most support.

"THE LINK BETWEEN SCIENCE AND TECHNOLOGY IS SO INTIMATE THAT THEY HAVE MERGED INTO ONE TERM IN THE CHINESE LANGUAGE, 'KEJI,' WHICH MEANS SCITECH.

The public and the media. Given the relative lack of support at government level, and bearing in mind the low salary levels for scientists, a recent questionnaire sent to members of the general public in some of the major cities produced a very surprising finding: Scientists, along with university professors, are the most respected professionals.

This esteem must be jealously guarded, but it is currently under threat from the inexorable rise of psuedoscience. At present the number of high-profile attempts to pass off superstition and money-making scams under the respectable cloak of science is one of the most disturbing features of Chinese science and society. Let me provide a couple of illustrations of this extraordinary phenomenon. It is claimed that some people are endowed with supranatural powers, sometimes called Qi, in that they can see through solid objects or can move things from one place to another without the owner knowing about it. Those endowed with such powers can read letters enclosed in sealed envelopes or take money out of a safe in another room. In extreme cases it has been claimed that these magicians can not only see people thousands of miles away but can even send their Qi from, say, San Francisco to Shanghai to cure them of certain ailments. It is perhaps not surprising that a public well versed in Confucianism but that knows little about modern science is convinced. But this nonsense also has the support of some well-established, Western-trained scientists. These include a past president of the China Association of Science and Technology and a former professor of the California Institute of Technology, and with their support a research institute has been established to study the "wonders of the human body."

The second example was the recent claim that a certain powder, when mixed with water, turns the water into gasoline. The nature of this powder was, of course, a trade secret, with a patent said to be pending. The process was claimed to have been demonstrated before a panel of 10 professors of chemistry at a well-known university and to have their signed support. Tens of millions of renminbi had been committed for further research and to set up a pilot production plant. Fortunately, in this case the fraud was exposed, but it seems that, at least in the short term, the cause of rational science faces an uphill struggle. It is to be hoped that the high public standing of scientists will emerge unscathed, but at present this seems unlikely.

We do have a fair share of the press for scitech. Apart from the daily published by the China Commission of Science and Technology, CAS publishes *Science News* three times a week; both are concerned mainly, if not exclusively, with scitech. The other national newspapers, as well as a range of magazines, regularly cover scitech. In fact, there is both a Chinese *Science* and a *Nature*, but these are general review, rather than research, journals. Naturally, the media are anxious to publish stories that are sure to attract the public attention; unfortunately, these are not always scientifically sound and tend to play into the hands of pseudoscience and those scientists who consider popularity more important than publishing in established international journals.

The future. The isolation of nearly 30 years has left some legacies for the generation of Chinese scientists that graduated from the universities before the Open Door policy and have been used to publishing in "home" journals. The difficulties lie not so much in following progress in their own fields of interest, but rather in understanding the "rules of the game" of international science. While I am convinced that the editors of most international journals are reasonably free of prejudice, this is not always true of reviewers. However, perhaps the biggest obstacle for Chinese scientists is their poor English, which can often obscure otherwise good work.

With the younger generation, there is another problem—the flow of talented young people abroad. For some of the major universities, it is not unusual for half of the students to arrange postgraduate studies abroad even before their graduation. Since China opened its doors to the outside world, I have supervised about 50 postgraduate students. Without exception, all of them have gone abroad after receiving their postgraduate degree, and until now only four have come back to a job in China. This is to be expected, not only because the research facilities in China are not on a level comparable with those overseas, but also because the pay here is only about 2% of that earned in the West.

In spite of these hardships, there is some cause for optimism. There is a hard core of devoted Chinese scientists working on basic aspects of science, trying to develop good reputations internationally and at the same time trying to improve the infrastructure at home. Will they succeed? I believe that the future of Chinese science hangs in the balance. It depends on two factors: on the higher input of funds from the government (private enterprise is still of minor importance in China), and on the optimal use of those funds to encourage serious research by the most talented scientists.

ILLUSTRATION: TERESE WINSLOW