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The Living Record of Science 《自然》百年科学经典

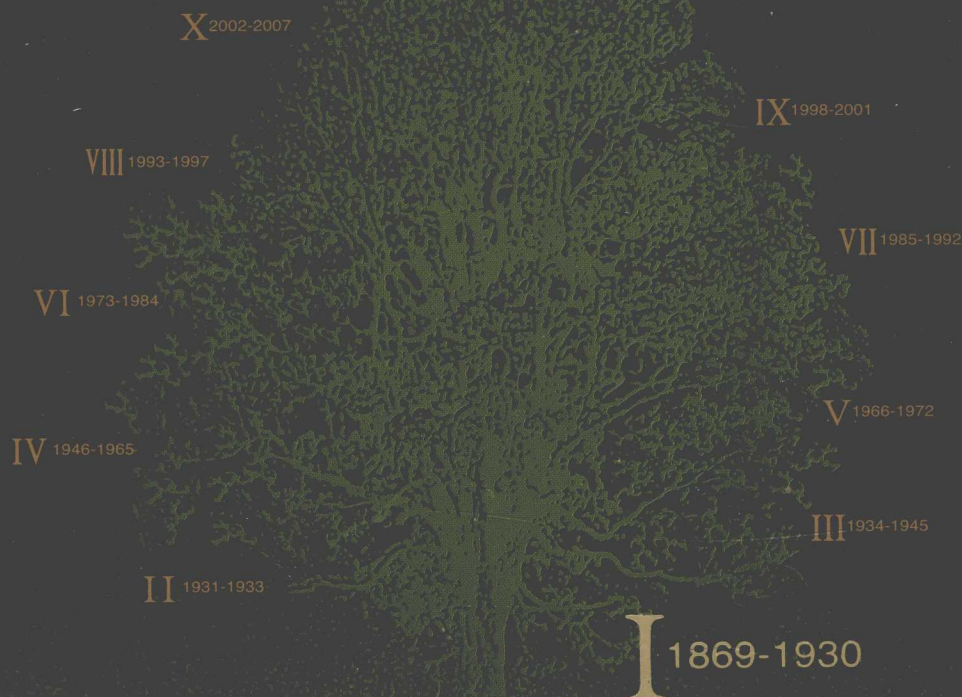
(英汉对照版)

第一卷

总顾问：李政道 (Tsung-Dao Lee)

英方主编：Sir John Maddox
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中方主编：路甬祥



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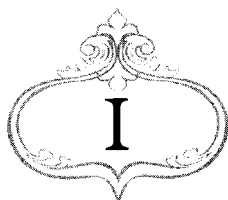
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Foreword by Lu Yongxiang

Since the birth of modern science, and in particular throughout the 20th century, we have continuously deepened our understanding of Nature, and developed more means and methods to make use of natural resources. Technological innovation and industrial progress have become decisive factors in promoting unprecedented development of productive forces and the progress of society, and have greatly improved the mode of production and the way we live.

The 20th century witnessed many revolutions in science. The establishment and development of quantum theory and the theory of relativity have changed our concept of time and space, and have given us a unified understanding of matter and energy. They served as a theoretical foundation upon which a series of major scientific discoveries and technological inventions were made. The discovery of the structure of DNA transformed our understanding of heredity and helped to unify our vision of the biological world. As a corner-stone in biology, DNA research has exerted a far-reaching influence on modern agriculture and medicine. The development of information science has provided a theoretical basis for computer science, communication technology, intelligent manufacturing, understanding of human cognition, and even economic and social studies. The theory of continental drift and plate tectonics has had important implications for seismology, geology of ore deposits, palaeontology, and palaeoclimatology. New understandings about the cosmos have enabled us to know in general terms, and also in many details, how elementary particles and chemical elements were formed, and how this led to the formation of molecules and the appearance of life, and even the origin and evolution of the entire universe.

The 20th century also witnessed revolutions in technology. Breakthroughs in fundamental research, coupled to the stimulus of market forces, have led to unparalleled technological achievements. Energy, materials, information, aviation and aeronautics, and biological medicine have undergone dramatic changes. Specifically, new energy technologies have helped to promote social development; new materials technologies promote the growth of manufacturing and industrial prosperity; information technology has ushered in the Internet and the pervasive role of computing; aviation and aeronautical technology has broadened our vision and mobility, and has ultimately led to the exploration of the universe beyond our planet; and improvements in medical and biological technology have enabled people to live much better, healthier lives.

Outstanding achievements in science and technology made in China during its long history have contributed to the survival, development and continuation of the Chinese nation. The country remained ahead of Europe for several hundred years before the 15th century. As Joseph Needham's studies demonstrated, a great many discoveries and innovations in understanding or practical capability—from the shape of snowflakes to the art of cartography, the circulation of the blood, the invention of paper and sericulture

路甬祥序

自近代科学诞生以来，特别是 20 世纪以来，随着人类对自然的认识不断加深，随着人类利用自然资源的手段与方法不断丰富，技术创新、产业进步已成为推动生产力空前发展和人类社会进步的决定性因素，极大地改变了人类的生产与生活方式，使人类社会发生了显著的变化。

20 世纪是科学革命的世纪。量子理论和相对论的创立与发展，改变了人类的时空观和对物质与能量统一性的认识，成为了 20 世纪一系列重大科学发现和技术发明的理论基石；DNA 双螺旋结构模型的建立，标志着人类在揭示生命遗传奥秘方面迈出了具有里程碑意义的一步，奠定了生物技术的基础，对现代农业和医学的发展产生了深远影响；信息科学的发展为计算机科学、通信技术、智能制造提供了知识源泉，并为人类认知、经济学和社会学研究等提供了理论基础；大陆漂移学说和板块构造理论，对地震学、矿床学、古生物地质学、古气候学具有重要的指导作用；新的宇宙演化观念的建立为人们勾画出了基本粒子和化学元素的产生、分子的形成和生命的出现，乃至整个宇宙的起源和演化的图景。

20 世纪也是技术革命的世纪。基础研究的重大突破和市场的强劲拉动，使人类在技术领域获得了前所未有的成就，能源、材料、信息、航空航天、生物医学等领域发生了全新变化。新能源技术为人类社会的发展提供了多元化的动力；新材料技术为人类生活和科技进步提供了丰富的物质材料基础，推动了制造业的发展和工业的繁荣；信息技术使人类迈入了信息和网络时代；航空航天技术拓展了人类的活动空间和视野；医学与生物技术的进展极大地提高了人类的生活质量和健康水平。

历史上，中国曾经创造出辉煌的科学技术，支撑了中华民族的生存、发展和延续。在 15 世纪之前的数百年里，中国的科技水平曾遥遥领先于欧洲。李约瑟博士曾经指出，从雪花的形状到绘图的艺术、血液循环、造纸、养蚕，包括更有名的指南针和

and, most famously, of compasses and gunpowder—were first made in China. The Four Great Inventions in ancient China have influenced the development process of the world. Ancient Chinese astronomical records are still used today by astronomers seeking to understand astrophysical phenomena. Thus Chinese as well as other long-standing civilizations in the world deserve to be credited as important sources of modern science and technology.

Scientific and technological revolutions in 17th and 18th century Europe, the First and Second Industrial Revolutions in the 18th and 19th centuries, and the spread of modern science education and knowledge sped up the modernization process of the West. During these centuries, China lagged behind.

Defeat in the Opium War (1840-1842) served as strong warning to the ancient Chinese empire. Around and after the time of the launch of *Nature* in 1869, elite intellectuals in China had come to see the importance that science and technology had towards the country's development. Many scholars went to study in Western higher education and research institutions, and some made outstanding contributions to science. Many students who had completed their studies and research in the West returned to China, and their work, together with that of home colleagues, laid the foundation for the development of modern science and technology in the country.

In the six decades since the founding of the People's Republic of China, the country has made a series of achievements in science and technology. Chinese scientists independently developed the atomic bomb, the hydrogen bomb and artificial satellite within a short period of time. The continental oil generation theory led to the discovery of the Daqing oil field in the northeast. Chinese scientists also succeeded in synthesizing bovine insulin, the first protein to be made by synthetic chemical methods. The development and popularization of hybrid rice strains have significantly increased the yields from rice cultivation, benefiting hundreds of millions of people across the world. Breakthroughs in many other fields, such as materials science, aeronautics and life science, all represent China's progress in modern science and technology.

As the Chinese economy continues to enjoy rapid growth, scientific research is also producing increasing results. Many of these important results have been published in first-class international science journals such as *Nature*. This has expanded the influence of Chinese science research, and promoted exchange and cooperation between Chinese scientists with colleagues in other countries. All these indicate that China has become a significant global force in science and technology and that greater progress is expected in the future.

Science journals, which developed alongside modern science, play an essential role in faithfully recording the path of science, as well as spreading and promoting modern science. Such journals report academic development in a timely manner, provide a platform for scientists to exchange ideas and methods, explore the future direction of science, stimulate academic debates, promote academic prosperity, and help the public

火药,都是首先由中国人发现或发明的。中国的“四大发明”影响了世界的发展进程,古代中国的天文记录至今仍为天文学家在研究天体物理现象时所使用。中华文明同其他悠久的人类文明一样,成为了近代科学技术的重要源泉。

但我们也要清醒地看到,发生在 17~18 世纪欧洲的科学革命、18~19 世纪的第一次和第二次工业革命,以及现代科学教育与知识的传播,加快了西方现代化的进程,同时也拉大了中国与西方的差距。

鸦片战争的失败给古老的中华帝国敲响了警钟。就在《自然》创刊前后,中国的一批精英分子看到了科学技术对于国家发展的重要性,一批批中国学子到西方高校及研究机构学习,其中一些人在科学领域作出了杰出的贡献。同时,一大批留学生回国,同国内的知识分子一道,为现代科学技术在中国的发展奠定了基础。

新中国成立 60 年来,中国在科学技术方面取得了一系列成就。在很短的时间里,独立自主地研制出“两弹一星”;在陆相生油理论指导下,发现了大庆油田;成功合成了牛胰岛素,这是世界上第一个通过化学方法人工合成的蛋白质;杂交水稻研发及其品种的普及,显著提高了水稻产量,造福了全世界几亿人。中国人在材料科学、航天、生命科学等许多领域,也取得了一批重要成果。这些都展现了中国在现代科技领域所取得的巨大进步。

当前,中国经济持续快速增长,科研产出日益增加,中国的许多重要成果已经发表在像《自然》这样的世界一流的科技期刊上,扩大了中国科学研究的影响,推动了中国科学家和国外同行的交流与合作。现在,中国已成为世界重要的科技力量。可以预见,在未来,中国将在科学和技术方面取得更大的进步。

伴随着现代科学产生的科技期刊,忠实地记录了科学发展的轨迹,在传播和促进现代科学的发展方面发挥了重要的作用。科技期刊及时地报道学术进展,交流科学思想和方法,探讨未来发展方向,以带动学术争鸣与繁荣,促进公众对科学的理解。中国在推动科技进步的同时,应更加重视科技期刊的发展,学习包括《自然》在内

to better understand science. While promoting science and technology, China should place greater emphasis on the betterment of science journals. We should draw on the philosophies and methods of leading science journals such as *Nature*, improve the standards of digital access, and enable some of our own science journals to extend their impact beyond China in the not too distant future so that they can serve as an advanced platform for the development of science and technology in our country.

In the 20th century, *Nature* published many remarkable discoveries in disciplines such as biology, geoscience, environmental science, materials science, and physics. The selection and publication of the best of the more than 100,000 articles in *Nature* over the past 150 years or so in English-Chinese bilingual format is a highly meaningful joint undertaking by the Foreign Language Teaching and Research Press, Macmillan Publishers Limited and the Nature Publishing Group. I believe that *Nature: the Living Record of Science* will help bridge cultural differences, promote international cooperation in science and technology, prove to be high-standard readings for its intended large audience, and play a positive role in improving scientific and technological research in our country. I fully endorse and support the project.

The volumes offer a picture of the course of science for nearly 150 years, from which we can explore how science develops, draw inspiration for new ideas and wisdom, and learn from the unremitting spirit of scientists in research. Reading these articles is like vicariously experiencing the great discoveries by scientific giants in the past, which will enable us to see wider, think deeper, work better, and aim higher. I believe this collection will also help interested readers from other walks of life to gain a better understanding of and care more about science, thus increasing their respect for and confidence in science.

I should like to take this opportunity to express my appreciation for the vision and joint efforts of Foreign Language Teaching and Research Press, Macmillan Publishers Limited and the Nature Publishing Group in bringing forth this monumental work, and my thanks to all the translators, reviewers and editors for their exertions in maintaining its high quality.



President of Chinese Academy of Sciences

的世界先进科技期刊的办刊理念和方法，提高期刊的数字化水平，使中国的一些科技期刊早日具备世界影响力，为中国科学技术的发展创建高水平的平台。

20 世纪的生物学、地球科学、环境科学、材料科学和物理学等领域的许多重大发现，都被记录在《自然》上。外语教学与研究出版社、麦克米伦出版集团和自然出版集团携手合作，从《自然》创刊近一百五十年来发表过的十万余篇论文中撷取精华，并译成中文，以双语的形式呈现，纂为《〈自然〉百年科学经典》丛书。我认为这是一项很有意义的工作，并相信本套丛书的出版将跨越不同的文化，促进国际间的科技交流，向广大中国读者提供高水平的科学技术知识文献，为提升我国科学技术研发水平发挥积极的作用。我赞成并积极支持此项工作。

丛书将带领我们回顾近一百五十年来科学的发展历程，从中探索科学发展的规律，寻求思想和智慧的启迪，感受科学家们百折不挠的钻研精神。阅读这套丛书，读者可以重温科学史上一些科学巨匠作出重大科学发现的历程，拓宽视野，拓展思路，提升科研能力，提高科学道德。我相信，这套丛书一定能成为社会各界的良师益友，增强他们对科学的了解与热情，加深他们对科学的尊重与信心。

借此机会向外语教学与研究出版社、麦克米伦出版集团、自然出版集团策划出版本丛书的眼光和魄力表示赞赏，对翻译者、审校者和编辑者为保证丛书质量付出的辛勤劳动表示感谢。

是为序。

沈元祚
中国科学院院长

Foreword by Tsung Dao Lee

We can appreciate the significance of natural science to human life in two aspects. Materially, natural science has achieved many breakthroughs, particularly in the past hundred years or so, which have brought about revolutionary changes to human life. At the same time, the spirit of science has taken an ever-deepening root in the hearts of the people. Instead of alleging that science is omnipotent, the spirit of science emphasizes down-to-earth and scrupulous research, and critical and creative courage. More importantly, it stands for the dedication to working for the wellbeing of humankind. This is perhaps more meaningful than scientific and technological achievements themselves, which may be closely related to specific backgrounds of the times. The spirit of science, on the other hand, constitutes a most valuable and constant component of humankind's spiritual civilization.

In this sense, *Nature: the Living Record of Science* presents not only the historical paths of the various fields of natural science for almost a century and a half, but also the unremitting spirit of numerous scientists in their pursuit of truth. One of the most influential science journals in the whole world, *Nature*, reflects a general picture of different branches of science in different stages of development. It has also reported many of the most important discoveries in modern science. The collection of papers in this series includes breakthroughs such as the special theory of relativity, the maturing of quantum mechanics and the mapping of the human genome sequence. In addition, the editors have not shunned papers which were proved to be wrong after publication. Included also are the academic debates over the relevant topics. This speaks volumes of their vision and broadmindedness. Arduous is the road of science; behind any success are countless failures unknown to outsiders. But such failures have laid the foundation for success in later times and thus should not be forgotten. The comprehensive and thoughtful coverage of these volumes will enable readers to gain a better understanding of the achievements that have tremendously promoted the progress of science and technology, the evolution of key and cutting-edge issues of the relevant fields, the inspiration brought about by academic controversies, the efforts and hardships behind these achievements, and the true meaning of the spirit of science.

China now enjoys unprecedented opportunities for the development of science and technology. At the policy level, the state has created a fine environment for scientific research by formulating medium- and long-term development programs. As for science and technology, development in the past decades has built up a solid foundation of research and a rich pool of talent. Some major topics at present include how to introduce the cream of academic research from abroad, to promote Sino-foreign exchange in science and technology, to further promote the spirit of science, and to raise China's development in this respect to the advanced international level. The co-publication of *Nature: the Living Record of Science* by the Foreign Language Teaching and Research

李政道序

如何认识自然科学对人类生活的意义，可以从两个方面来分析：一是物质层面，尤其是近百年来，自然科学取得了许多跨越性的发展，给人类生活带来了许多革命性的变化；二是精神层面，科学精神日益深入人心，这种科学精神并不是认为科学万能、科学可以解决一切问题，它应该是一种老老实实、严谨缜密、又勇于批判和创造的精神，更重要的是，它具有一种坚持为人类福祉而奋斗的信念。这种科学精神可能比物质意义上的科技成就更重要，因为技术进步的影响可能与时代具体的背景有密切关系，但科学精神却永远是人类精神文明中最可宝贵的一部分。

从这个意义上，这套《〈自然〉百年科学经典》丛书的出版，不仅为读者呈现了一个多世纪以来自然科学各个领域发展的历史轨迹，更重要的是，它展现了无数科学家在追求真理的过程中艰难求索、百折不回的精神世界。《自然》作为全世界最有影响力的科学期刊之一，反映了各个学科在不同发展阶段的概貌，报道了现代科学中最重要发现。这套丛书的可贵之处在于，它不仅汇聚了狭义相对论的提出、量子理论的成熟、人类基因组测序完成这些具有开创性和突破性的大事件、大成就，还将一些后来被证明是错误的文章囊括进来，并展现了围绕同一论题进行的学术争鸣，这是一种难得的眼光和胸怀。科学之路是艰辛的，成功背后有更多不为人知的失败，前人的失败是我们今日成功的基石，这些努力不应该被忘记。因此，《〈自然〉百年科学经典》这套丛书不但能让读者了解对人类科技进步有着巨大贡献的科学成果，以及科学中的焦点和前沿问题的演变轨迹，更能使有志于科学研究的人感受到思想激辩带来的火花和收获背后的艰苦努力，帮助他们理解科学精神的真意。

当前，中国科学技术的发展面临着历史上前所未有的机遇，国家已经制定了中长期科学和技术发展纲要，为科学研究创造了良好的制度环境，同时中国的科学技术经过多年的积累也已经具备了很好的理论和人才基础。如何进一步引进国外的学术精华，促进中外科技交流，使科学精神深入人心，使中国的科技水平迅速提升至世界前列就成为这一阶段的重要课题。因此，外语教学与研究出版社和麦克米伦出

Press, Macmillan Publishers Limited and the Nature Publishing Group will prove to be a huge contribution to the country's relevant endeavors. I sincerely wish for its success.

Science is a cause that does not have a finishing line, which is exactly the eternal charm of science and the source of inspiration for scientists to explore new frontiers. It is a cause worthy of our uttermost exertion.

T. D. Lee

版集团合作出版这套《〈自然〉百年科学经典》丛书，对中国的科技发展可谓贡献巨大，我衷心希望这套丛书的出版获得极大成功，促进全民族的科技振兴。

科学的事业永无止境。这是科学的永恒魅力所在，也是我们砥砺自身、不断求索的动力所在。这样的事业，值得我们全力以赴。

李政道

Preface

Nature is the world's most influential science journal. It has published some of the most important discoveries in modern science, and has carried contributions from leading scientists, ranging from Charles Darwin and Albert Einstein to James Watson, Francis Crick and Stephen Hawking. Since its earliest days it has reported on all areas of science, from the study of human origins to the structure of the universe, from genetics to nuclear physics.

So it is surprising that no substantial overview of *Nature's* publication history has been attempted until now. And while *Nature* is known globally, access to its full archive has been rather less easy outside of Western countries (although the full archive is now available online). That is why this collection, titled *Nature: the Living Record of Science*, will provide an indispensable resource. It supplies an unparalleled view of how the preoccupations and priorities of science have changed over the last century and more, often in a way that reflects currents in the broader social and political landscape. The collected papers—more than 840 selected from over 100,000 published in the journal over the past century and a half—offer a vision of what society wants from science, and what science has given society.

The evolution of *Nature*

Nature is almost unique in publishing leading research in every area of science. The journal was begun in 1869 by the enterprising English astronomer J. Norman Lockyer. Its aim, announced (for reasons now forgotten) only in the second issue of 11 November, was:

“First, to place before the general public the grand results of Scientific Work and Scientific Discovery; and to urge the claims of Science to a more general recognition in Education and in Daily Life;

And, secondly, to aid Scientific men themselves, by giving early information of all advances made in any branch of Natural knowledge throughout the world, and by affording them an opportunity of discussing the various Scientific questions which arise from time to time.”

That is a fair statement of *Nature's* goal today. In the first issue, the reader could find Lockyer's description of a recent total solar eclipse in America, Thomas Henry Huxley's analysis of some newly discovered dinosaur fossil bones from the Triassic period, some observations of the absorption and radiation of heat by the German physicist Heinrich Gustav Magnus, and an obituary of the Scottish chemist Thomas Graham, the father of colloid chemistry. Such breadth of subject matter has been characteristic of the journal ever since.

前言

《自然》是全世界最具影响力的科学期刊。它报道过现代科学中一些最重要的发现,并刊登过如查尔斯·达尔文、阿尔伯特·爱因斯坦、詹姆斯·沃森、弗朗西斯·克里克、斯蒂芬·霍金等顶尖级科学家的文章。从创立初期,《自然》就涵盖了所有科学领域,从人类的起源到宇宙的结构、从遗传学到核物理学。

然而,令人颇为诧异的是,此前居然没有任何关于《自然》出版历史的有分量的概述。虽然《自然》是全球发行的,但在西方国家之外查阅其全文并不容易(当然,现在可以通过网络进行全文检索)。因此,《〈自然〉百年科学经典》这套选集可能会成为相关研究的第一手资料。通过这套选集提供的独特视角,读者可以了解过去一个多世纪中科学的前沿和热点经历了怎样的变迁,这通常能够折射出当时更为广阔的社会和政治生活的变化趋势。从《自然》在过去近一个半世纪里发表过的十多万篇论文中精选出来的这八百四十余篇文章,展现了社会对科学的冀求和科学对社会的贡献。

《自然》的变迁

《自然》几乎是独一无二的发表所有科学领域中开创性研究成果的杂志,由非常有魄力的英国天文学家约瑟夫·诺曼·洛克耶于1869年创立。其办刊宗旨发表在当年11月11日的《自然》第2期上(为什么没有发表在第1期上原因不详),内容如下:

首先,将科学研究和科学发现的重大成果呈现给公众,并促使科学理念在教育 and 日常生活中得到更为普遍的认可。

其次,帮助科学家自己,为他们提供自然科学各个分支在世界范围内取得的所有进展的最新信息,为他们探讨不时出现的各种科学问题提供交流平台。

上述内容也是对《自然》现在的办刊宗旨的一个恰当诠释。在《自然》第1期中,读者们可以读到洛克耶对当时的美洲日全食的描述,托马斯·亨利·赫胥黎对最新发现的一些三叠纪恐龙化石的分析,德国物理学家海因里希·古斯塔夫·马格努斯对热辐射和热吸收的一些观察数据,还有胶体化学之父、苏格兰化学家托马斯·格雷姆的讣告。自那时起,如此广泛的学科覆盖就一直是《自然》的特色。

The first issue of *Nature* appeared at a time when periodical publishing was booming and science was increasingly seen as an integral part of daily life. There was a general consensus that scientists deserved greater respect, social distinction and financial support. At the same time, there was a calling for scientific education to be expanded and interest in science to be encouraged. From its inception, *Nature* has been produced by the British publishers Macmillan & Co., although there is now no record of how that arrangement came about.

Lockyer was an astronomer and civil servant who had been elected as a Fellow of the Royal Society six months before *Nature* first appeared in print. He was well connected in the scientific community, counting the biologist Thomas Henry Huxley and the physicist John Tyndall among his circle of associates. He called on the services of both men in the early days of *Nature*, helping to establish its authoritative status. As editor, Lockyer displayed from the outset some of the characteristics that *Nature* went on to display in later times. He was unashamed to parade his own enthusiasms, making the journal particularly welcoming to research on the physics of the sun. He gave it an international flavour, including reports on meetings in such places as St. Petersburg, Vienna and Philadelphia. He was willing, indeed eager, to include news and gossip from within the scientific community, and happy to court controversy and to report it plainly: some of the arguments that rage in the early pages have an acerbic tone that reveals a hands-off editorial touch. And he was ready to offer robust opinions on public affairs and matters of state that might seem only tangentially relevant to science.

Yet despite *Nature*'s mission statement to “place before the general public the grand results of Scientific Work and Scientific Discovery”, the journal made few concessions to the non-scientist. It was not until well into the following century that *Nature* underwent its metamorphosis. John Maddox became editor in 1966 and set about making the journal less scholarly and more engaging to readers, while in no way compromising its academic stature. It was Maddox's hope that everyone would be able to read and understand reports of new discoveries in any area of science.

That was an ambitious goal. Even now, the research papers in *Nature* are not easy reading for the lay person with no scientific education, and with the increasing specialization of science it is often difficult even for scientists to understand papers outside their own field. On the other hand, the expansion of *Nature* into a publishing group with many “sister” journals, such as *Nature Genetics*, *Nature Geoscience* and *Nature Materials*, as well as the advent of new media for communicating and providing content such as news, has given *Nature* further tools and avenues for reaching new, broader audiences. It remains the most highly cited interdisciplinary science journal.

Probably the most famous, and arguably the most influential, paper to appear in *Nature* was that written by Francis Crick and James Watson, published in 1953, describing the