new professions opened up was becoming possible. For the working men Huxley addressed at the School of Mines, who came to (or read afterwards) lectures at BAAAS meetings, at the 1876 sessions, or at Mechanics' Institutes in mid-century, there was no such hope: science for them had to be an interest, an opening of windows. To be encouraged to think empirically, to follow what was described as scientific method, must have been useful educationally; but it was only late in the century that technicians with scientific training were required in any numbers. The word 'technician' unfortunately already carried overtones of narrowness, as specialisation became the order of the day and the gulf between scientific writing for scientists and for outsiders widened.

We shall come to display next. In exhibitions and museums, the hope is that the public with the fruits of the earth and of science before their eyes will come to the right conclusions. But naturally they often do not: here as elsewhere, people are awkward and like to come to their own conclusions rather than someone else's. Curators' attempts to steer those who come to look are interesting but not always effective; people are counter-suggestible. The same happened and happens with reading: we have always read into texts what we would like to see there, and memory is also a creative faculty. This is not something new that came in with post-modernism: Isaiah's 'sign' of a young woman soon to bear a child and call him Immanuel became, for the first Christians, a prophecy of the virgin birth of Jesus, in what we could call a creative misunderstanding (as modern translations make clear). It remains a problem that we know more about writers than readers, except for the small and unrepresentative class of reviewers, though all writers have in mind an ideal reader; and the same is true in the realm of spectacle.

Books, periodicals, museums and lectures have it in common that they are a part of scientific practice as well as attempts to get knowledge across: what scientists did and do was to write, exhibit and speak as well as experiment and theorise. In studying religion we get a very curious picture if we desert practice, what people do, in favour of what they supposedly believe: that way, one cannot get inside those involved. So with science, as we turn to display, we should remember that this was an part of the practice of science, and only partly a way of getting the general public enthused. In museums, botanic gardens and zoos there are and were in the past unavoidable tensions because different people make different demands and have different needs. This is not simply a gulf between the professional and the popular: just as Mary Somerville wrote books that helped specialists understand what others in different branches of science were up to, so in display there is no great gulf fixed between communication to the educated and the lay. For everyone display (like ballyhoo) was and is more fun than learning a syllabus.

7 Display

Robespierre's amazing Festival of the Supreme Being proved with panache that there was a new order of things to go with the new calendar, with its revised months and ten-day weeks. The French revolutionaries after 1789 needed festivals and displays to maintain morale in the face of inflation and military threats, and laid on patriotic alternatives to the great public occasions of the ancien regime. When Napoleon seized power, he also proved a master of ceremony and display, the high point being his coronation, where he took the crown from the captive Pope and put it on his own head. Triumphal arches, buildings adorned with his monogram, splendid uniforms for the Imperial Guard, and ermine for himself brought legitimacy to this upstart from Corsica, who like the hero of a fairy tale had conquered continental Europe, and married a princess. Science was still in 1789 itself an upstart, better-established in France with its paid Academicians than elsewhere, but marginal in the old world ruled by churches and kings, where it was essentially an interest for gentlemen with as yet little practical outcome.

The revolutionary government under Robespierre and the Jacobins during their reign of terror abolished the Academy as an elitist and reactionary body, and executed Lavoisier, effectively its head, in 1794. But the expertise of chemists and engineers, working like Lavoisier on the improvement of gunpowder, on surveys, and also on making guns, proved essential to the state, defending itself from foreign armies, and then exporting revolution, bringing caps and trees of liberty, and guillotines, to those liberated willy-nilly by oppressors. So the Academy had to be in effect re-founded, Napoleon being elected, as the First Class of the Institute. What had not been suppressed was the Jardin des Plantes on the left bank of the Seine, the great botanic garden where taxonomists had improved upon Linnaeus' method, using a natural system based upon many characteristics rather than his artificial sexual system. This entailed a museum collection of dried specimens, for study and comparison. The animals from the King's menagerie at Versailles were brought to Paris, where the zoo, open to the public, still adjoins the botanic garden, and where some buildings go back to the revolutionary epoch.

The revolutionary closing of elitist organisations, and suppression of licensing and professional bodies which had excluded the unqualified, threw open
medical careers for those who before could only have aspired to low-status jobs in the field of health. At the Jardin des Plantes and its associated Museum, professors gave free public lectures aimed, unlike most of those at the Royal Institution, to prepare medical students as well as interest the general public. At the revolutionary (and increasingly militarised) École Polytechnique, the carefully selected students were taught by active researchers in mathematics, chemistry and natural philosophy in a great step towards the modern elite university; but, at the Museum, the lectures by researchers no less distinguished for their research were open. When peace finally came after the Battle of Waterloo in 1815 and the subsequent Congress of Vienna, Britons flocked to Paris in the wake of the Scottish author John Scott, and keen students of science and medicine sought to catch up with what had been going on during the war, and hear the great men who had kept France at the forefront. In zoology, the most eminent were J.B. Lamarck and Georges Cuvier; and Cuvier went on to become the permanent secretary of the First Class of the Institut, flourishing and increasing in power and prestige under the Napoleonic and then the restored Bourbon monarchy.

Scott reported on the important place that the sciences occupied in Parisian culture, on the boost that Napoleon (like later tyrants) had given to scientific and technical training at the expense of education in humanities. His informant noted the chemical laboratories attached to scientific institutions, and the many scientific professorships - though noting ominously (Visit, p. 233) that, while since the Revolution,

They have been undoubtedly improved by new organizations, and by the impulse which has been given to the physical sciences in general. The salaries are all paid by the government, and they are very moderate.

This last point was to lead to the practice of 'cumul', in which leading practitioners held a number of posts, assigning the duties to ill-paid juniors, like eighteenth-century rectors and their curates in English parishes. But in 1814 all seemed well, and the museums of Paris, where knowledge was indeed on display, were particularly noteworthy to tourists. The Louvre still contained all the loot of Italy, Germany and the Netherlands brought home by the French armies, and only after Napoleon's hundred days and Waterloo were the works of art returned to the homelands of the victorious allies, along with some, but not most, scientific collections, in a less-indulgent peace. Scott also included a description of the Jardin des Plantes, with its beautiful botanic garden, its restaurant, its zoo, and its museum, the richest in specimens in the world, though its library was perhaps inferior to Banks'. All was well-lit and well ordered; the zoological treasures were (Visit, p. 297):

Contained in the long gallery on the second [floor]. They are well-lighted by semicircular windows in the roof. The length of this gallery, and the diversified and numerous assemblage of beings which are crowded in it, form a pleasing and animated coup d'oeil, and the interest heightens, when, on public days, we find it nearly impossible to move through the crowd of persons of all ranks which fills it.

Such democratic display of knowledge was not yet a feature of English institutions such as the British Museum, which was essentially for ladies and gentlemen. Scott was also much interested by the Conservatoire des Arts et Metiers, devoted to applied science. There was no such permanent exhibition of the latest techniques in London, because the Royal Institution's original plan had not worked out. It was open to the public on Sundays only, but he was able to frequent it. There were spinning jennies, machines made by the celebrated Aucanston, models of chateaux and manufactories, the basket from a pioneer balloon, fire pumps, agricultural machinery, distillation apparatus, a Chinese pagoda, and a large clock with an organ attached surmounted by a glass celestial sphere and orrery. This was thus one of the first museums of science and technology nowadays so attractive to children of all ages. If it seems surprising that it should have been in France, rather than in rapidly industrialising Britain, we should remember that British manufacturers were (prudently) sensitive about industrial espionage, enjoyed rather weak patent protection, and did not want to broadcast their trade secrets. Display can be looked at askance.

In 1823 Joseph Deleuze (translator of Erasmus Darwin) published, in Paris but in English, an account of the museum and the gardens, including maps and engravings of buildings and animals; now, again, 'Royal' under the restored monarchy, they were becoming a tourist attraction. In describing its history, Deleuze referred to plans that had been made to place the museum and gardens under a single director, rather than a collective leadership of equals: this proposal had been resisted, and finally abandoned. The result was a little Garden of Eden:

How pleasing amid the agitation of a great city to behold an establishment, in which are united fifty families, living in peace, usefully occupied, contented with their lot, attached to the place of their abode and priding themselves in its prosperity, strangers to professional rivalry and political dissensions, and grateful at once to the government which supports and the administration which directs them.

We may smile, as Davy did at young Faraday's notion of the moral superiority of scientists; but cannot doubt that this was both a very high-powered scientific centre, and an accessible public institution. And, in fact, French scientists in the revolutionary and Napoleonic periods, and right through the nineteenth century, were often prominent in political life, and not simply grateful to whatever government was supporting them. Deleuze particularly recommended botany for women:

It presents nothing to offend their delicacy; it furnishes their amusement in retirement, and lends interest to their walks; attaches them to the cultivation
of their gardens; assists them to develop a habit of observation in their children; and affords an opportunity of gratifying their benevolence, by making the poorer inhabitants of the country acquainted with useful plants. The letters of Rousseau first excited a taste for this science in the ladies of France, which has increased with the facility of obtaining instruction. A considerable number repair to the garden at an early hour to attend the lectures, and a separate space has been reserved for them in the amphitheatre.

The total audience at the lectures, delivered three times a week in the summer months, was, we are told, five or six hundred. Ladies were also taught iconography, the art of drawing natural history illustrations, with the professors on hand to indicate what was of scientific importance.

As part of what can be called the second scientific revolution, the science of geology had come into being quite distinct from eighteenth-century Theories of the Earth: the age of "systems" (including evolutionary speculations) was past, and now positive knowledge was required. An important aspect of this was the reconstruction of extinct animals, where Cuvier was the world's leading expert, and the quarries around Paris, especially at Montmartre, were at first the most important site. Napoleon ordered that during his works in Paris, fossils found in the quarries should be brought to Cuvier's attention; and, in the museum, the fossils were under the same roof as the skeletons of animals still around. By comparing specimens, Cuvier had been able to reconstruct extinct creatures, establishing that there had been a series of Parisian fauna; those looking at the displays in the museum, where samples were on show and more in drawers, could do the same.

The system which M. Cuvier has introduced in comparative anatomy has enabled him to determine what genus even an insulated bone belongs, although the animal should have no living analogue. When he established the genus anoplotherium, it was from the scattered bones of different individuals that he determined the general form and distinguishing characters; a short time after, the almost entire skeleton was discovered, which we see above the cases, and it was found perfectly conformable to the description which he had given of it.

Cuvier's principle of correlation required great skill and experience, but was not too recondite for the visitor to be unable to appreciate its results when confronted with the various dry bones that Cuvier had brought back to life.

Among these were ichthyosaurs, some given by Buckland, and pterodactyls; but the name dinosaur was not yet coined, and the great skeletons which were later so prominent in museum displays were not yet excavated. Extinct mammals and fish (which became Cuvier's speciality) were the most obvious features of the fossil collections. Visitors would have got from the display some feeling of the length of the Earth's history, and of the various and perhaps distinct epochs in which different kinds of creatures had flourished. Although models of extinct creatures do not yet seem to have featured, drawings of them were being made and exhibited. Seeing the collection would be very different from reading about fossils; and the work of Cuvier in particular was leading to palaeontology becoming the leading edge of geology, as the strata could now be assigned relative dates from the fossils embedded in them. Similar fossils were laid down at the same epoch; and, from comparisons, a geological column of all the strata (never found together in any one place) was being constructed. Fossils were like coins or medals dug up, both interesting in themselves and keys to the past. What could be learned from Cuvier's great book on the animal kingdom was made visible in the museum's displays.

Davy was one of the few Britons to have visited Paris when it was still the enemy capital; and when he became President of the Royal Society in 1820, he began the process of making it a little more like the Academy. This ambition also involved making London more like scientific Paris. One of his achievements was, in alliance with Sir Stamford Raffles, historian of Java and founder of Singapore, to found the London Zoo. Raffles had, in 1817, "mediated the establishment of a Society on the principle of the Jardin des Plantes at Paris", and while Davy looked more to the usefulness to country gentlemen of naturalising exotic species, Raffles was more concerned with "the scientific department" of zoology. In Java, he had supported the researches of the American doctor, Thomas Horfild, which resulted in a splendidly illustrated book in which, among other things, the Malay tapir was brought to the attention of the world. Raffles died in his mid-forties in 1826, when the Zoological Society had just been founded, on land made available in Regent's Park; shortly afterwards, Davy had a stroke, dying in 1829 at fifty. These early deaths deprived the zoo of its eminent leadership; but it flourished, as both a scientific centre and a spectacle. Raffles' first great collections had been lost in a shipwreck, but he had made more and these went to the zoo.

The prospectus of the Society is a curious document, beginning with the statement that:

Zoology, which exhibits the nature and properties of animated beings, their analogies to each other, the wonderful delicacy of their structure, and the fitness of their organs to the peculiar purposes of their existence, must be regarded not only as an interesting and intellectual study, but also as a most important branch of Natural Theology, teaching by the design and wonderful results of organization, the wisdom and power of the Creator. In its relation to useful and immediate economical purposes it is no less important.

It was a matter of regret and reproach that there was no zoo in London, as there was in most European capitals. Its model was the Horticultural Society (later to have important gardens in South Kensington) so that emphasis was put upon domestication and acclimatisation: "it is impossible not to hope for many new, brilliant and useful results . . . by the application of the wealth, ingenuity, and varied resources of a civilized people." In ancient Rome, wild animals had been
displayed in the Colosseum, brought there to destroy and be destroyed as a spectacle; in Britain, they would be applied to useful purposes or scientific research, not vulgar admiration. The public would however be admitted to the zoo; in the event, their admission-tickets, rather than the subscriptions of the nobility and gentry, and men of science, kept the enterprise in the black.

Just as animals had been brought in to the Paris zoo from the royal menagerie at Versailles, so the denizens of the Tower menagerie (where animals presented to kings and queens had lived or languished over the centuries) were brought to Regent’s Park as a nucleus of the new zoo. Illustrated guides were soon produced. The Victorian zoo became a huge public attraction, with rides on elephants making it a great family day out. Whereas earlier generations had had to be content with prints of Dürer’s rhinoceros, now there was one on public view. Lions, tigers, serpents and hyenas could be observed, and their feeding and other habits noted: the symbolic, fairy-tale aspects of animals (the chivalrous lion, the indomitable rhinoceros at war with elephants, the ape that imitated mankind) gave way to a much more down-to-earth vision. Again, seeing actual animals was a much more powerful experience than seeing even the excellent pictures of them that were a feature of the books of this time. What was clear, and especially so as great apes were added to the collections, was we were not so unlike the animals as some might have liked to think.

When exotic animals died, their corpses were made available for dissection to members of the Zoological Society. Sometimes they were eaten: in the siege of Paris in 1870–71, the animals in the zoo were killed and eaten, but that was in the interests of survival rather than culinary or zoological science. Frank Buckland, son of the eminent geologist and a great populariser of natural history, was, like his father, notorious for the various dishes based upon the flesh of unlikely animals that he was wont to serve his guests. He also kept unlikely pets, and once, when travelling by train, had been told that he must pay for his monkey because it was a dog, but not for his tortoise because it was an insect. But just as equipages drawn by zebras, or herds of buffaloes or llamas, did not in the event feature much in Victorian Britain, so stewed alligator (which is rather rubbery and faintly fishy to my taste), bear or snake did not find their way on to menus; nor did the nourishing insects (not tortoises) which people were also exhorted to consume.

Dissection (which might precede consumption) was a more seriously scientific business. The star performer was Richard Owen, curator of the museum of comparative anatomy at the Royal College of Surgeons, and subsequently Superintendent of the natural history collections at the British Museum, and in effect first Director of the Natural History Museum. His reputation made with the moa, the giant extinct bird from New Zealand, he became the ‘English Cuvier’ and, like the original, he depended upon having at his disposal a vast collection for comparison. Though he read and enjoyed Tennyson and William Morris, his own writings were mostly very dry, though the *Palaeontology* recently reprinted is readable by non-experts, and was sometimes given as a school prize. He annotated his books copiously, and there is a huge archive at the Natural History Museum. But it is in that museum, and the older ones where he had been in charge, that ordinary people would have been able to learn from the exhibits on display what the ‘Dragons of the prime/that dare each other in their slime’ had really been like, and how the families of animals were arranged.

For Owen and most of his contemporaries, as earlier for Cuvier, ‘family’ and ‘related’, when applied to animals and plants, were metaphors: the Darwins, Erasmus and Charles, were people who took it too literally, and followed will-o’-the-wisp evolutionary hypotheses. Owen’s museums therefore demonstrated change over time, because series of extinct creatures found in the different strata were displayed there; but, with Cuvier, he doubted, or perhaps felt it prudent to doubt, whether such change could have been continuous. Different epochs of stability were separated by catastrophes, after which new species immigrated or were created. For the various groups, there were archetypes, ideal forms, for example of a crustacean. Archetypes were realised in nature in the form of barnacles, shrimps, lobsters and crabs – all of which had their various species, at different times and places. None of the actual species corresponded exactly to the archetype, a generalised form, which nevertheless was in a different and perhaps deeper sense, real. This idea led to what became the standard way of teaching zoology, and also of organising museum collections. When at last he got the great Natural History Museum built, a cathedral of science indeed, he was rising eighty. Just before retirement, he could display exhibits as he wanted, though mortified through the machinations of Huxley into having a statue of Charles Darwin displayed on the great staircase. The arrangement of animals might not look very different when done in an evolutionary way, but the archetype being diversely and incompletely realised, contrasts with the more materialistic notion of community of descent, and divergence from less-specialised ancestors.

At the Natural History Museum, where Owen’s statue now occupies pride of place, and which from its full opening in 1881 (though the transfer was not complete until 1883), became one of the great attractions of London, Owen’s successor was William Henry Flower. He was a disciple of Huxley and Darwin, and at once set about using the museum to display evolution. He was President of the BAAS in 1889, and devoted his address to the discussion of museums, later publishing it and other discussions of museums with biographical essays on Owen, Darwin and Huxley, and a brief history of the zoo. Crucial in his conception of the modern museum of about 100 years ago was the separation of instruction and research. The public display must not be too cluttered with examples; there, arrangement is more important than content. He saw both functions of museums as extremely important, writing about museums aimed at boys (fostering and directing propensities to collect) and for schools, as well as emphasising the work of classifying and naming that went on behind the scenes in the great national museums.

Naturalists in the colonies were expected to send their collections ‘home’ to be properly handled in the metropolis, rather as primary products were shipped
to Europe for manufacture into finished goods. Museums were thus a focus of professional training as well as public information, and paid curators were essential, even for regional or school museums. By this time, on the Parisian model of a century before, science museums were expensive centres of expertise, comparable to research universities, but more accessible to the public (free indeed in London) and thus democratic, bringing national prestige and forming important international links as they exchanged specimens and supported expeditions and collectors.

Given the wealth of Victorian Britain, and its far-flung Empire, the collections at the Natural History Museum became particularly full. National museums all over Europe, and in the USA, played a comparable role; this was indeed their heyday, and a wonderful route for the inquisitive to enter science – and under the careful control of men like Owen and Flower, eminent natural historians who had their quirks and preferences, but were overseen by boards of distinguished trustees, were prominent members of their profession, and were clearly in charge of popularising establishment science. These museums were and are, unlike some others run by showmen, unconcerned with freaks, oddities or crankiness; the public got what its betters believed was right for it, and museums provide a good example of the classic vision of popularisation, getting across facts and ideas from up-to-date science in readily-appreciated form. That is no doubt why they can seem (and can be) stuffy and dull to the easily bored and the rebellious.

In Paris, the Jardin des Plantes gave its name to the museum, and is near the Sorbonne; and the zoo adjoined it. In London, the zoo is not very near the British Museum or the Natural History Museum, and the great botanic garden is even further out, at Kew. This was a royal garden. Loved by the parents of King George III, and adorned with a pagoda as part of the eighteenth-century passion for chinoiserie, it was put into the hands of Banks, who began to turn it into a botanic garden under King George’s patronage, and who also supervised there the acclimatisation of the merino sheep, brought over from Spain despite the prohibition on their export, and subsequently sent to Australia to found the botany wool industry. Banks had brought back a great number of specimens from his voyage, and he ensured that seeds and dried plants from later voyages were sent to Kew. He also arranged for collectors to be sent out, commissioned to get plants and seeds that could be cultivated there. His global and imperial vision set Kew on course to become a great centre for botanical science. But as the King slid into senility, he fell out with Banks, and his son, as Prince Regent and then as George IV, did not much care for Kew; nor did the next king, his brother William IV. The garden lost its scientific importance.

Then, in 1841, it was rescued and taken over by Parliament, as a national rather than a royal garden (though retaining the ‘royal’ in its official title); and William Hooker from Glasgow was appointed its director. Like the earlier Jussieu dynasty at the Jardin des Plantes, Hooker’s family ran the garden for three generations, into the twentieth century, realising Banks’ vision, and overseeing the building of enormous greenhouses that provided a model for the Crystal Palace. William Hooker’s son, Joseph, himself went on a voyage to the Antarctic as a ship’s surgeon, making himself the great authority on the plants of far southern latitudes; and then visited India, bringing back to Kew the rhododendrons from the Himalayas which became such a feature of Victorian gardens. He was also a great friend and prolific correspondent of Charles Darwin, whose voyage had seemed a model for his own, and himself one of the great pioneers of evolutionary theory, experimenting at Kew. In Banks’ day, most growing plants brought back on long sea voyages, through a series of climatic zones and exposed to salty spray or worse, had died; the introduction of miniature greenhouses, named Wardian cases after their inventor, changed all that, and made possible some of Kew’s triumphs in acclimatising plants and introducing them into pastures new, often in the colonies.

These successes, most notably with rubber and quinine from South America, but also with garden plants, built up Kew’s reputation; and the steady flow of botanical literature, often beautifully illustrated by resident artists such as Walter Fitch, sustained it as a great centre of botanical research and information. The herbarium grew steadily, and the greenhouses filled up. Magnificent publications such as Curtis’s Botanical Magazine were associated it; and were indeed a kind of display. Pictures were displayed in the garden, notably in the pavilion donated by the great traveller Marianne North to show her work, and thus the splendours of exotic vegetation. But the chief element of display about Kew was the garden itself. It was open to the public, at a cost of one penny. Joseph Hooker, a scientist of huge distinction, President of the Royal Society from 1873–8, was involved, in 1870–2, in a huge row with Acton Ayrton, First Commissioner of Works in Gladstone’s government and thus responsible for parks, including Kew. He was brusque and dictatorial, a devotee of public economy, committed to cut public spending, and Kew (much more expensive than other parks, and with what seemed curious and idiosyncratic practices), with its wayward Director, looked a good target. Ayrton was offensive. A representation from the presidents of the major scientific societies and other distinguished men of science was sent to the Prime Minister, and Darwin’s friend, John Lubbock MP, agreed to raise the matter in parliament. In the event, Hooker won; the populist Ayrton had underestimated what he took to be an effete naturalist with ideas above his station, and found himself reshuffled to another post — and losing his seat in the next election.

In fact, he was onto something: how were the functions of display and recreation common to public parks and gardens to be combined with those of a major scientific centre, and how were the expenses to be charged? The gardens had limited opening hours for the public which, through taxes, paid for their upkeep, and were costly in ways hard to understand for those outside the world of recon- dite science. It was probably inappropriate to include their maintenance in a government department otherwise concerned with land and buildings having no connection with scientific research. Moreover, Owen was busily campaigning for his new Natural History Museum to be built at public expense, and had not signed the memorandum of the great and the good in defence of Hooker’s Kew.
There were herbaria in the British Museum going back to Sir Hans Sloane, its founder, and including much later botanical material: might not the science done at Kew be better transferred to the (still hypothetical) new museum, and the gardens turned into public space with exotic plants, tended by gardeners rather than scientists? In the event, Kew survived, strengthened by the controversy, which came at a moment when, in the wake of Prussian victory over France in 1870–1, scientific education and practice were suddenly becoming matters of importance to government, as connected with national wealth and power. And the wonderful arrays of plants in the flowerbeds, arboretum and greenhouses of Kew were available to give a taste of botany to ordinary people who could enjoy the display.

Like the Natural History Museum’s, the botany at Kew, presented by the Hookers and their team, was establishment science: though visitors, able to wander where they would, could think their own thoughts more easily than inside a museum. But these were not the only museums established in London in this, their heyday. There had been specialised museums, like that at the College of Surgeons and that in Jermy Street that went with the Geological Survey, where Huxley lectured on fossils. Then after 1851, and the success of that magnificent display at the Crystal Palace, land was bought in Kensington with the profits, and a museum of design set up, with Henry Cole as its patron. This was the ancestor of the Victoria and Albert Museum, and in the event, industrial design did not play much part in it. In 1862 a second ‘Great Exhibition’ was held in South Kensington, in what was agreed to be a boring building and in the shadow of the sudden death of Prince Albert: it neither made a profit nor aroused the excitement and imagination of 1851, particularly no doubt because it was the sequel to an act extremely hard to follow. But it did give a boost, and an opportunity for display, for industry and technology.

In 1876, in the wake of that Prussian victory and resultant boost for scientific education and training, an international loan exhibition of scientific apparatus was held in South Kensington. Associated with it (as with the 1851 exhibition) were lectures, and also daytime conferences in what seems a modern vein. The results were duly published. The twenty-five lectures were free, and therefore open to artisans, if not to unskilled workers, and were planned to bring the display as it were to life.33

It became evident to those who were engaged in organising and arranging the loan collection of scientific apparatus, that its usefulness to the general public would be much increased, and the interests of science furthered, if explanations of the construction and uses of the various instruments could be given. Many of the exhibitors provided explanations at stated times of the instruments lent by them; but . . . it was felt that it would be very desirable to have lectures on the classes of instruments and apparatus used for different purposes . . . At this stage several scientific men came forward and generously offered their services in giving free lectures on the evenings when the collection was open to the public.

Some of the objects displayed were of historical importance: the first lecture, by Henry Roscoe, was on Dalton’s apparatus and what he did with it; Playfair spoke on air and airs, with both the Magdeburg hemispheres and Boyle’s air-pump among the exhibits; while both Tyndall and John Hall Gladstone described Davy’s and Faraday’s apparatus. Two of the lecturers were clergymen (both FRS); two lectures were given by Captain Davis of the Royal Navy on polar exploration; Lord Rosse spoke about telescopes; and the series concluded with a talk about weights and measures, timely in that the French metric system, now international, was becoming the standard in Britain for scientific purposes. The lecturer, here a poor prophet, noted that in the USA ‘preparations are being made for adopting the metric system’. The chairman that night, the naval architect J. Scott Russell, referred to the exhibition where

For the first time you see collected a large museum of instruments and apparatus which represent the great triumphs of human intellect and human science made during the last few centuries, and especially characteristic of the marvellous progress of science made during the century in which you and I have the good fortune to live and work.

And he wound up the proceedings with thanks to foreign exhibitors, and to the lecturers:

I think it would be a great pity that such a collection should be dispersed. I think it would be a great pity that this should be the last lecture of this kind at which you and I are to have the pleasure of meeting each other . . . We believe that the wonderful success which has attended these free lectures, and from the wonderful popularity which has been achieved by the lectures of profound and eminent men— as distinguished from mere professional lectures— profound and eminent men of science coming here and endeavouring to make plain to you the profoundest truths of their own special research,— I say it is a new future and a future which deserves great approbation on our part, and let us hope that the nucleus of a new museum to be entrusted I hope to the same able hands which have brought this together.

In this peroration, he addressed the audience as ‘gentlemen’, but elsewhere they were ‘ladies and gentlemen’— we can probably infer that there were not very many women present, in audiences which various chairmen had complimented on their careful attention to what was said, and which were getting something not unlike the Discourses that their social superiors were hearing at the Royal Institution.

The thirteen Conferences ran from 16 May to 2 June 1876, and were modelled upon sectional meetings of the BAAS, but focused upon the loan collection. Some dealt with the historic pieces, but most were concerned with the latest science and technology. In this era, the acme of classical physics, exact quantitative work and standardisation of units (requiring precision and delicacy
in apparatus) was crucial, involving international rivalry especially with Germany. Spectroscopy, naval architecture, clocks, telescopes, submarine telegraphy, measurement in meteorology, terrestrial magnetism and sea-sounding were all discussed by the speakers. ‘Mechanism’ had by then through Babbage, Whewell and others, become a science, taught at Cambridge, where mechanics was applied to machinery. The reports include the comments made by participants and by chairmen as well as the papers presented, and give us a good idea, fuller than in BAAS Reports, of what the sessions were like, and how in the context of a big exhibition, scientific enthusiasm was shared.

Russell had called for a new kind of museum, where apparatus and instruments old and new might be exhibited. Indeed, sandwiched between the Natural History Museum and the Imperial Institute (where colonial products were displayed) the Science Museum was founded, and some unclaimed exhibits from 1876 found their way there. The site bought with the profits from 1851 was indeed being turned into ‘Albertopolis’, a great cultural and educational centre, its museums comparable to those in Berlin or Munich, and to the Smithsonian Institution in Washington, DC. From the very start, this museum, and similar ones elsewhere, faced the problem of how far they were historic collections of things used in important scientific work, and how far they should be providing hands-on experience to dazzle, enthuse and attract visitors into science. At the Natural History Museum, the collections behind the scenes are research material for people working on taxonomy, classifying animals and plants, and comparing the past and present distribution of organisms. In contrast, the Science Museum is not a centre for research in physics or chemistry: that goes on next door, in Imperial College. Similarly, the Victoria and Albert Museum is distinct from the nearby Royal College of Art, and is a centre of connoisseurship. Curators in both museums work on the provenance and authenticity of the exhibits, and on the best way to display them, but are not ‘doing’ art or science.

By the early twentieth century, there were thousands of what might be called science museums in Europe, North America and the colonies. One of the great problems for major metropolitan museums is that they cannot display more than a small fraction of their holdings. This became a more acute problem in the twentieth century, as acquisitions came in, entertaining hands-on exhibits increased in popularity, and it became didactically fashionable to show fewer things and to have more description and guidance. In natural history, where, as Flower recommended, representative (or more spectacular) objects are on view and full collections accessible and necessary only to researchers, this may not matter so much; but when unique and priceless things cannot be shown to the public to whom they belong, being stored in a warehouse somewhere miles away, it is serious - especially when provincial museums would love to display them, often much closer to their original setting, where they could be appreciated properly. For provincial cities also had their museums, sometimes, like those in Exeter and in Oxford founded in connection with a visit from the BAAS. The Oxford one (scene of Huxley’s confrontation with Wilberforce) resulted from the separation of the science from the fine art in the Ashmolean Museum (as subsequently happened with the British Museum in London), but most remained un specialised, often including stuffed animals, minerals and fossils, archaeological finds, local history and model ships or railway engines in a more-or-less organised display. Science was a source of excitement.

Such local museums could be more quirky, devoted as they might be to a local hero whose activities may not have been mainstream, and curated by people whose expertise could not extend across the whole realm of arts and sciences. Theirs was therefore less the established consensus view of things - they begin to take us into realms of doubt and uncertainty, into what might interest people other than science professors. The same may be true of the exhibitions and expositions which had begun before 1851, but which, following the huge success of the Crystal Palace, became a feature of the second half of the nineteenth century. They had to attract the public, display progress, boost the home city and country - being a great day out, worth travelling far to see, broadening visitors’ perspectives, showing the latest inventions and discoveries and thus arousing enthusiasm for science and technology.

Amongst the most celebrated of these were the ‘Century of Progress’ exhibition in Chicago in 1876 (marking confident recovery from the disastrous fire of 1871) and the Paris Exposition in 1900 where electricity was the great theme and the various industrial nations had their own pavilions in which to display their modernity. To accentuate this, a village from French colonial Africa, complete with ‘natives’, was also on display, demonstrating the benevolence of ‘la mission civilisatrice’. As well as electricity, phrenology was also available, and visitors could have their bumps measured, and other anthropometric data such as cephalic index, fingerprints, height, weight, eye colour, reaction time and dynamometer reading recorded, in the turn-of-the-century preoccupation with measurement and classification. The science might thus be rather softer than that in great museums, but the whole effect stunning. The barriers around science had got taller as it became professional between the time of Banks and of Huxley; but the twentieth century opened with a great festival celebrating technology and science, even if ominously tinged with nationalism.

We may think of the twentieth century as the time when science and warfare came together, with deplorable slaughter as the outcome; with the nineteenth century as the time when science never did anyone any harm. This was not so: science had always been involved with the military - the first President of the Royal Society, Lord Brouncker, had been an expert of the recoil of guns, Lavosier worked on gunpowder, and lecturers at the Royal Institution regularly dealt with military explosives and warships. Voyages of discovery, like those of Captain Cook and of HMS Beagle, were the ‘big science’ of their day, getting a team of experts to distant locations: yielding exciting accounts, imperial claims, interesting objects, and trading possibilities. Military force is expensive, and needs constantly to be justified to taxpayers, but it lends itself very readily to displays. The Colt revolver had been one of the stars of the 1851 exhibition, and improvements in armouries meant that rifles soon replaced muskets as weapons for infantry. Shooting matches began, displaying their accuracy. William
Armstrong’s rifled breech-loading big guns transformed the role of artillery, and more importantly for Britain, accompanied the disappearance of the great wooden sailing ships that had won the Battle of Trafalgar with ironclads, which had proved their worth in the American Civil War. Turner’s sunset painting of the fighting Temeraire being towed by a steam tug to the breaker’s yard symbolised the end of an era. The new Royal Navy, expanded in the effort to ensure that it was as powerful as the two next-largest put together, and crucial for the defence of a maritime empire, displayed its potential in great reviews as both necessary and scientific:

The navy was at the forefront of scientific and technological advance, provoking admiration and fascination. In its celebration the enthusiasm for modern technology was indistinguishable from expressions of national identity. Mock fights and spectacular searchlight displays were part of a distinctly modern imagery of power and technology.  

There were occasions on which such reviews were accompanied by displays of high technology, as when Charles Parsons’ little Turbinia showed her pace, nipping hither and thither through the fleet, and convinced onlookers that the future lay with turbines rather than reciprocating engines.  

These could even be contests, as earlier when in a tug of war, a naval screw steamer defeated one with paddles. Both these proved the greater efficiency of the new methods of propulsion, though, naturally, while the navy had to keep up-to-date and expense was no object, civilian paddle steamers, and reciprocating engines, did not disappear very soon, continuing in use well into the twentieth century.  

Such public contests could also be a part of science. Louis Pasteur, whose research career began with careful sorting out of minutely different asymmetrical crystals in a laboratory, seems to have delighted in the public arena. In his public lectures he cultivated a kind of showmanship (as critics also said of Tyndall, who extended and disseminated Pasteur’s work in Britain); he also brought suspense and spectacle to his work on anthrax, the dire disease of sheep, and rabies. This had previously been the sphere of the quack.  

Indeed, without medical training, he forced doctors (a notably closed and powerful profession) to take note of his experimental results by courting publicity, and building up his own myth.  

This had happened earlier in England, with the original vaccination, against smallpox. Vaccination in Britain had become compulsory as a public-health matter, and Wallace showed his alienation from the mainstream of scientists by opposing it along with other populists and libertarians. Pasteur, whose work on germs was extended and popularised by Tyndall,  

showed the possibility of vaccinating against other diseases; but he and his contemporaries also raised public outrage by the vivisection experiments they carried out. Huxley, who duly spoke up against what he saw as simply opponents of progress and enlightenment, had himself hated such research, and did not do it on conscious animals. However, his efforts to bring up-to-date physiology into Britain from France and Germany entailed experiments on animals, sometimes without anaesthetic, and he thus threw his weight behind the campaign to continue vivisection, against the attacks Frances Power Cobbe and her formidable allies. Here science was indeed brought into the limelight, but not in a flattering way: dissection could be portrayed as heartless torturers, boldly noting (if not enjoying) the squirms and squeals of their animal victims. This was not how scientists (especially in Britain) saw themselves, or wished to be seen – but rather as benefactors bringing medical advances. In the event, the scientific establishment (of which the ‘plebian’ Huxley was in later life a prominent member) succeeded in getting a compromise where animal experiments were done only under Home Office licence. It is curious that experiments on human subjects, often medical students and sometimes self-experiment, but also hospital patients, continued with very little in the way of informed consent being required until into the second half of the twentieth century, when Nazi abuses were exposed. Not all publicity for science was good publicity, even in the Victorian age of science; understanding, private or public, had (and has) a moral aspect.  

Balloonings, rail travel and crossing the oceans in great steamships became commonplace: disasters like balloon crashes, the Tay Bridge collapse or the sinking of the Titanic were again poor publicity, but extremely instructive. They brought technical advance, often taken for granted, into the spotlight, reminded everyone of how dependent upon science life had become, and what gaps there were in understanding and mastery of nature. Sometimes also nature laid on a great and unexpected display of power, stimulating for science, like the eruption of Krakatoa, probably the loudest event in history, and one of the most devastating until the earthquake and tsunami of December 2004 in the same region. The sunsets in Europe and North America became redder and more splendid, and meteorology and optics were among the gainers. The excitement generated by the disaster, the first to happen since remote regions had been linked to the rest of the world by electric telegraphs, was a stimulus to public understanding of science. For most people in Europe at least, the explanations had to be scientific rather than theological; but, of course, there was yet no tourism in Indonesia, and few Europeans had to answer questions like ‘Why was I spared?’ and ‘Why was it my daughter who was killed?’ Though few had visited these islands, except colonial officials and traders, there was intense curiosity in the nineteenth century about exotic regions. Wallace was among the travellers who had gone to what he called the Malay Archipelago, and his book about it became a classic: he was just one of the scientific travellers who form the subject of our next chapter.