

## BOOK REVIEWS

**The Private Science of Louis Pasteur.** Gerald L. Geison. Princeton University Press. Prepublication paperback copy (expected publication date – May–June 1995). 366 pp. Price. US \$24.95.

It was a day of one-and-a-half coincidence(s). The morning's newspapers had something about the doings of the members of the British Royal Family. At lunch, the young man in *our* family, who had been boning up for his examination in microbiology, said some admiring things about Pasteur, 'What a great scientist he must have been! Working in pure chemistry, he separated *d*-, *l*- and *meso*-forms from a study of crystals of tartaric acid salts. He did work also in (I really do not know what to call it) microbiology, biomedicine or immunology, and isolated and identified so many microorganisms and prepared vaccines. He must have been very daring to test the vaccines on people the way he did. He did all that just with a pair of tweezers and what must have been an astigmatic microscope. We surely have better equipment supplied to us for our practical classes!'

On the way back after lunch, for the afternoon stint of putting my neck under the yoke, the Editor cornered me and thrust a book under my nose. 'Review it', said he. Fleeting, I caught a glimpse of the title – '*Private Life of Louis Pasteur*', was it? Was '*... of Louis Pasteur*' a coincidence (coincidence number one)? But '*Private Life ...*' Must be coincidence number two. Oh no, I really do not want to know anything about the merry carryings on, if any, of Louis Pasteur *a la* the British Royal Family. But then I read the title properly, '*The Private Science of Louis Pasteur*'. So it was only one-and-a-half coincidence.

Why 'Private'? What did Pasteur do? Did he assume a Mr. Hyde personality and go about exposing people to the risk of infections by inoculating them with microbes, attenuated or not? He nearly did, you would come to agree if you look at the evidence presented in this well-researched book, even while remaining the good Dr. Jekyll, if only because he took pains to isolate the most active preparations and tried to attenuate them in ways he thought would lead to the most effective vaccines.

I read sequences of pages and began to wonder: Is this an attempt at icono-

clasm of a French (Latin) idol of science by an Anglo-American, English-speaking conspiracy. Is it a manifestation of a Protestant-type ethos vs Roman Catholic culture, a kind of Falkland (Malvinas) war? A reaction that prompts such questions would be patently unfair. After all, was it not Pasteur's own nephew and research assistant, Adrien Loir, who disclosed events in the life and work of that man of legendary achievement in an order and perspective that could only have detracted from the picture presented in hagiographic biographies such as that by Pasteur's son-in-law René Vallery-Radot, intending or not to restore a balance to the world's view of the man?

The task of restoration of balance involves an analysis of what could have gone on 'behind the scenes', analysis referred to, nowadays, as 'deconstruction'. For the purpose of this review we shall agree that deconstruction could be the same as what Hercule Poirot does in trying to see the workings of the mind of the butler-whodunit before he (the butler, that is) did it? The book is written in perfect tune with postmodernist (the hyphen-omitted form is now in vogue) deconstructionism (sorry, if it is deconstructionism, it cannot be post-modern but merely modern – post-modernism can come in only after thorough deconstruction, I should presume), perfectly in tune with the phase of spelunking in the labyrinths of the minds of the protagonists that tabloids (and American scholarship) seem to have entered. American scholarship, with its immense resources, can do a thorough job of deconstruction and no heed can be paid to the number of 'reputations' soiled, reputations often built up in dramatic presentations of the achievements of science and scientists (books such as de Kruif's '*Microbe Hunters*' (1959) come to mind as most relevant).

Looked at from a properly distant historical perspective, the workings of the trained minds of scientists may seem to have some sort of temporal and logical sequence – they may include what really went on before the planning of an experiment, the acquirement of the skill (and the means) to carry out the experiment and the gathering up of a motivation to be bold enough to announce something that may upset current thinking. A dressing up in the description of events leading to a discovery

may be inevitable, perhaps. There is no 'honest' intention to cheat but differences among what was planned, how planned, how done and how announced can crop up and these could harbour ethical questions.

Geison, a Professor of History at Princeton University, goes about his task of deconstruction in painstaking and scholarly fashion, having had full access to all the Pasteur papers, the 'Papier Pasteur' in the Bibliothèque Nationale in Paris, that included some 10,000 (unnumbered!) pages of Pasteur's laboratory notebooks. Having Appendices A–K, 32 pages of Notes numbered chapterwise, Acknowledgements and a Bibliography (two entries under 'Z' but none under 'Q'; I have not counted the entries under the other letters!), the book more than makes up for the deficiency the author complains of in other books on Pasteur and similar men of achievement in science – 'the lack of footnotes or other scholarly apparatus'.

Before we come to the meat of Geison's thesis, we amuse ourselves by pausing to ask, 'Have there been other icons of science who have "survived" being deconstructed?', with or without the aid of their lab notebooks. Going by Geison's own list, Antoine Lavoisier, the 'oxygen man', Claude Bernard, the early 19th century biologist, Michael Faraday ('Mr. Minister, you can tax the product of this machine which I call a dynamo'), Robert Millikan of the charged oil drops (incidentally, Millikan's cosmic ray balloons were launched right here, from Bangalore, which was near the then magnetic equator) and Hans Krebs of the 'Krebs cycle' fame can be said to have done so, not becoming open to any charges of unethical/unscientific practice/conduct. It may not be nitpicking to ask, however, if Lavoisier named oxygen as 'oxygen' only because he had a *preconceived notion* that the element that he so named is present in all acids. Should not we now be seriously considering interchanging the names of oxygen and hydrogen because it is the mobility of the hydrogen ion that causes acidity and it is oxygen that forms water?

What is the tone of Geison's 'deconstruction'? And why did Princeton University think fit to publish the book? Let us agree that any discrepancy between what is available in the public domain and a private record (written one, if available, spoken to intimates, if

that be the case) 'must be factored into any assessment of the process of scientific advancement' (to quote the publisher's blurb on the back cover).

Early on, in trying to justify his choice of the title ('*Private Science ...*' in the context of the meticulousness with which Pasteur had kept his laboratory notebooks), Geison quotes Mikhail Bakhtin, the Russian cultural critic, who says, 'Thought itself is nothing but "inner speech" – social conversations we have learned to perform in our heads. When we think, we organize possible "dialogues" with other people whose voices and implicit social values live within us.' (A far cry indeed, isn't this, from *yogascittavrttinurodhaha*, as Patanjali defines yoga, or what don Juan, the Yaqui Indian mentor of the Sonora Desert in Mexico, instructs Castaneda to try and 'Stop the world'?) Who is the interlocutor or recipient that Pasteur imagines would read his 'private' laboratory notebooks? 'Posterity'?

We ask, however, who is the imagined reader of Geison's own book? Could it be a 'mere' lay person? The tone of presentation is one of anticipating objections that may be raised, as if by someone with legal training, and, at places, the text feels overwritten, with repetitive phrases resembling those in a legal document, and you may have to wade through much text, mostly backwards, to find out what it is that is being described or argued about. The most smoothly readable parts are those that have to do with Pasteur's life, his virtual neglect of the intimacies that are possible in family life, the political climate of his times, the prevailing politico-socioreligious attitudes, etc. His articulateness during polemical debates and capacity for dramatic presentations, his overriding concern with having to get financial support for his research, and the tragedy of ill-health as age got the better of him by the time the well-appointed laboratories of l'Institut Pasteur became a reality are well brought out.

These matters appear not very important in the light of Geison's main concern: were ethical dictates knowingly violated when (i) Pasteur, in order to meet a challenge, used, at a public demonstration of the efficacy of his 'vaccine' (at a place called Pouilly-le-Fort), a preparation made by attenuating the active principle by bichromate – a method developed by a contemporary

scientist and not acknowledged to be so by Pasteur – even before he had obtained consistent results from his own attenuating experiments employing oxygen (the method he had employed earlier for achieving an effective chicken cholera vaccine) and (ii) he injected increasingly virulent extracts from desiccated to partially desiccated spinal cords of rabbits, dead of rabies, into humans when he was still without a high statistical surety either of the safety or of the efficacy of the 'treatment'?

In a way this reviewer can pretend not to be overly concerned with the ethical aspects of 'doing' science, even while recognizing that there are such aspects, under the comfortable belief that the nature of science is such that there exists, eternally (or until the nuclear holocaust), a possibility of self-correction. The one who deviates from the ethical path, even in 'fun', is always in 'danger' of being exposed (remember the apocryphal, 'Made in the USA' story of the students who glued together parts of different insects (with the antennae and legs properly paired, I hope) and sent the 'specimen' to Darwin for identification? Pat came Darwin's reply – 'It is a "humbug", not very rare') but it may take time before the damage done by a premeditated act gets undone (remember 'Piltdown man' or the 'discovery' of marine fossils on the slopes of the Himalayas?). While 'hand waving' (an American expression that appears to range in meaning between drawing apparently crucial conclusions from rather bare data and pure speculation) may be a good exercise for the wrists, it can hardly count as being unethical. The unethical act may be mere plagiarism or writing 'virus' programmes for PCs ('fun thing' again?). More seriously, it could be 'copping the credit' by a 'pushy' boss from a creative but timid colleague or assistant (does the discovery of pulsars qualify?) Or, it could take the form of providing slanted interpretations using the cloak of scientific documentation with a view to 'grinding one's own axe' (a recent example is *The Bell Curve*, a book that tries to foster the idea that levels of 'intelligence', purportedly measurable by IQ tests, are related to inheritance and, therefore, to 'race') It could also be either fudging data (apparently favoured by 'psychologists', 'social sci-

entists' and pollsters) or not reporting in what has been *chosen* to be made public what did happen the way it happened. Geison's point is that Pasteur could be held guilty on two counts – the use, in the public demonstration, of bichromate-attenuated anthrax vaccine prepared according to the process of another scientist (Chamberland) when actually leading people to believe that it was, in fact, oxygen-attenuated. And, was not his manner of treating humans bitten by rabid animals with increasingly virulent preparations (the 'Meister method', Joseph Meister being the name of the rabid-animal-bitten boy whom Pasteur treated successfully) outright dangerous and, insofar as it risked infection and near-certain death, completely unethical? No comment from Geison on 'that which is unethical is also unscientific', if the intention is, really, not to cause death (Should we think of multinational pharmaceutical manufacturers in this context?)

Can we ask if there are any extenuating circumstances in Pasteur's case? While misleading the public regarding the actual method of preparation of the anthrax vaccine will remain inexcusable, he did have the knowledge that nonvirulent ('safe'; recall the antipolio vaccine controversies of more recent times) forms of pathogenic agents can raise immunity against virulent forms, and had the intuition, perhaps, that consistent attenuation could be attained by the oxygen method and was eager to ensure success irrespective of the means adopted because only the 'good' will come out if further research receives support by public funding. And, as regards Pasteur's death-risking antirabies 'treatment' of human subjects, could it be the workings of a detached, 'purely scientific' mentality/curiosity, the type that induces a regard for humans only as mere subjects of experiments, like in the 'mad scientists' of sci-fi?

Not considered explicitly by Geison (but clearly apparent to me, an Indian) is the egotism of one who has already achieved something and has become famous for that reason ('one cannot afford failure in the next thing one does, can one?'). In the case of Pasteur the initial projection into fame was due to his work on the 'relationship that must exist between crystalline and molecular asymmetry', he having had the luck to



cer cells find good niches, always?), 'tapes' that may be re-edited constantly (as under continuous evolution) or from time to time (as under 'punctuated evolution') We have acquired considerable insights into the material bases of the preservation and/or modification of genetic information and transmission thereof, how it is transcribed and made manifest, via cell differentiation, as 'organisms' with the 'transparent lenses of the eye and hard enamel of the teeth', (Sherrington in 'Man on his Nature' (1951)). We also seem to be well on our way to the unravelling of the exquisite molecular mechanisms of the immune reaction, an aspect of biological individuality, and have come to believe that we can imitate brain function by means of 'neural networks'. We can speculate on the possibility of 'recreating' extinct organisms in a 'Jurassic Park' which tourists can visit. We can look for 'enantiomeric or diastereoisomeric excess' in the chemical synthesis of asymmetric molecules, after receiving the necessary induction of asymmetry from something that is already asymmetric, following, almost, the original suggestions of Pasteur (an interesting question - Did 'life' intervene when Pasteur, with magnifying glass and a pair of tweezers in hand and equipped with the 'knowledge' necessary to recognize asymmetry, picked out the hemihedral crystals?). But we are nowhere near answering the question 'Is there spontaneous generation?'. We have only managed to reformulate the question in the past tense ('Was there...?'), pushing it back in space and time to the pre-Cambrian age and near the shores of the shallow lakes of primordial soup in Pangaea (if not in Rodinia). This reviewer is reminded here of a conversation he recently had the privilege to have with Abdus Salam in Trieste, Italy - a difficult conversation, indeed, because Salam was barely audible - revolving around, 'Where is the mirror of symmetry in the asymmetry of life - are life-forms based on both R and S amino acids present in the matter world, or are the two divided between matter and antimatter worlds? Did it so happen that life was lit (albeit in a wet place!) by an asymmetric 'spark' in a region where asymmetric molecules happened to congregate (in the endentropic fashion resembling those under which Pasteur managed to separate his 'privileged material' (the tartaric salts) into asymmetric forms? Did that asymmetry (and

life) originate just when the Earth was passing through a magnetically 'screwed up' region of space during its wanderings, carried about in and by the Milky Way?

We still have to go through the contortions necessary to define what is 'knowledge' (the sense of satisfaction that comes when we 'absorb' the 'truth' of a statement like two plus two is equal to four), something that must be intimately connected with sentience and, therefore, with the origin of life. While we are doing that we may as well read this book and make sure that our heads are screwed on in the right manner - between our shoulders - and supplied with well-oxygenated blood and nutrient.

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**New Aspects in Interpolation and Completion Problems. Volume 64.** Ed. I. Gohberg, **Operator Theory: Advances and Applications.** Birkhäuser, Basel. Price not stated. 1993.

A *partial matrix* is a matrix some of whose entries have not been specified. A *completion* of this matrix is a matrix obtained by filling in the previously unspecified entries. A *completion problem* demands a completion under some constraints, such as the completion be positive, have minimal norm or minimal rank.

The solution to completion problems can be hard or trivial. Often, the problem can become considerably more difficult by just a little change of expectations. For example, the minimal-norm completion problem is of this type.

Regard a matrix as an operator on the Euclidean  $n$ -space  $\mathbb{C}^n$ . The operator norm of  $A$  is the number

$$\|A\| = \sup \{\|Ax\| : \|x\| = 1\}$$

The Hilbert-Schmidt norm of  $A$  is the number

$$\|A\|_2 = (\text{Tr } A^*A)^{1/2} = \left( \sum_{i,j} |a_{ij}|^2 \right)^{1/2}.$$

Consider the partial  $2 \times 2$  matrix

$$\begin{bmatrix} 1 & 1 \\ ? & 1 \end{bmatrix},$$

in which the southwest entry is unspecified. What is a 'minimal-norm completion' of this? If the norm in question is the Hilbert-Schmidt norm, the answer is obvious. The free entry can only be zero. If the norm is the operator norm, the answer is not so obvious. The matrix

$$\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

has norm  $(\frac{3+\sqrt{5}}{2})^{1/2}$ , while the matrix

$$\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$$

has norm  $\sqrt{2}$ , which is smaller. Thus, the answer to the problem changes with the norm, and the complexity of the problem also changes.

The minimal (operator) norm completion problem for the partial block matrix

$$\begin{bmatrix} A & B \\ ? & C \end{bmatrix}$$

was solved by S. Parrott and by C. Davis, W. Kahan and H. Weinberger around 1980. This is of interest not only in operator theory but also in numerical analysis, control theory and other areas. The solutions for other interesting norms (like Schatten  $p$ -norms) have not been found.

These papers led to a flurry of activity. Specially noteworthy is the work of I. Gohberg, M. A. Kaashoek and H. J. Woerdman, who introduced a maximum-entropy principle, which has been found to be very useful.

Interpolation means different things to different people. The meaning in the context of the papers in this book is the following.

Let  $c = \{c_n\}$  be a doubly infinite complex sequence with  $c_{-k} = \bar{c}_k$ . Such a sequence is called a *moment sequence*. The classical *trigonometric moment problem* asks for a positive measure  $d\mu$  on  $[-\pi, \pi]$  such that

$$c_k = \frac{1}{2\pi} \int_{-\pi}^{\pi} e^{-ik\theta} d\mu(\theta), \quad k \in \mathbb{Z}.$$

This is an example of an interpolation problem. Closely related to this is the *Carathéodory problem*. A *Carathéodory function* is a complex analytic function