

Bhopal: The Tragedy of Collective Amnesia

Methyl isocyanate (MIC) is a relatively simple chemical; its formula, $\text{CH}_3\text{-N=C=O}$, fits conveniently into a line of text. Simplicity can, of course, be deceptive in chemistry with some of the most simple chemicals, hydrogen cyanide and carbon monoxide among them, acquiring great notoriety because of their alarming toxicity. The largest industrial disaster in our history occurred over 25 years ago when MIC leaked from the storage tank in the Union Carbide factory at Bhopal on the night of December 2–3, 1984. The carnage that followed has, over the years, claimed an estimated 20,000 lives and left many many more struggling with the consequences of inhaling MIC and other toxic substances that enveloped the area around the chemical plant. Bhopal's tragedy has slowly faded from public memory; even the observance of the 25th anniversary in December 2009 was muted. The judgement of a local court handing down punishment to those held guilty of negligence, a couple of weeks ago, has sparked waves of indignation at the small quantum of the sentence. A post-mortem has begun on the circumstances which allowed the Union Carbide chairman, Warren Anderson, to leave the country a quarter of a century ago. Discussions now rage on the compensation package that was accepted in an out of court settlement. Sadly, 25 years after the incident we now discuss the costs of clean-up of the site and the contamination of soil and groundwater. The 25th anniversary of the disaster, which passed largely unnoticed last December, was marked by an unusual event; a scientific lecture held in a small lecture room of an institution in Delhi. S. Sriramachari, undoubtedly a legend amongst pathologists and medical scientists in India, gave his last lecture on December 3, 2009, speaking of his long, and sometimes lonely, trail of research to understand the events at Bhopal and the effects of MIC and other toxic substances on the thousands of affected individuals. He died a few days later on December 25, 2009 of chronic pulmonary disease, a condition that he had undoubtedly encountered in the many victims of Bhopal.

Sriramachari (1925–2009) was an unusual man (Indira Nath, *Curr. Sci.*, 2010, **98**, 709; *Indian J. Med. Res.*, 2010, **131**, 463; Ramachandran, R., *Frontline*, Jan 16–29, 2010). In an interview, less than two years before his death, Sriramachari describes the circumstances that took him to Bhopal shortly after the deadly gas leak. The

scene, in his words, 'was so dispiriting and horrible – several thousand people had died and mass cremation was done. There was continuing damage to the eyes and lungs of people, and the bodies were scattered round the Medico-Legal Institute (MLI) – one of the most extraordinarily equipped forensic laboratories in the country, of which my friend Dr Heeresh Chandra was the Director; he was an outstandingly dynamic and committed scientist' (Varadarajan, S., *Resonance*, March 2008, pp. 292–306). Heeresh Chandra, by many accounts was an unsung hero of the days and weeks that followed the leak of MIC from the Union Carbide plant in Bhopal. Together with his colleagues at the MLI, he bore the brunt of the enormously difficult task of performing autopsies on the bodies that began to pour into his institution. In Sriramachari's words: 'By 7:00 AM 70 people were dead, by 9 AM 260 were dead and thereafter the figures continued to rise. Though not all dead bodies were brought to the MLI, 311 bodies were received on 3.12.1984. Thereafter, the rate declined. A total of 731 bodies were received in December 1984 alone, 103 in 1985, 90 in 1986 and 44 and 22, respectively, in 1987 and 1988. These figures from the morgue may not account for all the deaths in the city of Bhopal. The MLI continued to perform autopsies on gas-affected victims in subsequent years.' Heeresh Chandra and Sriramachari presented their forensic and pathology findings at the Third Indo-Pacific Congress on Legal Medicine held at Madras, five years after the Bhopal disaster, in December 1989. Sriramachari quoted years later from a review of the proceedings: 'A silent stunned audience listened with awe the terrible story of 1984, when on one tragic day poisonous fumes killed hundreds of people or maimed thousands of them in coming months'. The reviewer 'likened this tragedy to "Pompeii suddenly engulfed in the dust of Vesuvius or Hiroshima when the atom bomb was dropped"' (Sriramachari, S., *Curr. Sci.*, 2004, **86**, 205). In researching for this column, I searched in vain for an account of Heeresh Chandra's life and work, finding only a 'bio-data' posted some years ago on a website. The 17 scientific papers and one technical report that he published in the years following Bhopal tell us nothing of the man and his undoubted and admirable commitment to forensic science.

I first saw Sriramachari sometime in 1985, when he along with the then Director General of the Indian Council

of Medical Research, V. Ramalingaswami, visited the Indian Institute of Science to speak to biochemists about the events at Bhopal. Sriramachari's purpose then, and he was to pursue the problem for the last two decades of his life, was to determine the biochemical and biological consequences of human exposure to MIC. I cannot recall any significant reaction to the problems that he posed from the small audience that had assembled to hear him. The enormity of the tragedy and the potential for long-term consequences of toxic gas exposure did not seem to be appreciated. In the last ten years or so I met Sriramachari several times and heard him describe his work and ideas on the 'biochemical lesions' induced by MIC. In the terrible hours following leakage of about 40 tonnes of MIC, from the now notorious tank 610, a problem that confronted the clinicians and medical staff of Bhopal's hospitals was whether there was an 'antidote' that could be administered. For many extremely hazardous chemicals, protocols for emergency treatment of exposed individuals are usually known. The horrendous toxicity of the 'Bhopal gas' was hardly anticipated by its manufacturers in India. Sriramachari described the immediate observations by the medical team at MLI, Bhopal: 'The autopsies revealed an intense red discoloration of the viscera, especially the lungs, trachea and upper respiratory tract and my friend [Heeresh Chandra] coined the term "cherry red discoloration". . . . Death was very sudden and was due to lack of oxygen reaching the respiratory centres' (Varadarajan, S., *Resonance*, March 2008, pp. 292–306). I heard the term 'cherry red discoloration' on many occasions as Sriramachari sought to interest listeners on the subject of the biochemical and pathological investigations on Bhopal victims. There was a very special reason for his interest. 'On the basis of autopsy findings, Heeresh Chandra postulated cyanide toxicity as a causative factor.' Immediately after the disaster a German toxicologist, Max Daunderer, who suspected cyanide toxicity, arrived in Bhopal carrying 'diagnostic kits and ample supplies of sodium thio-sulphate (NaTS). These developments spurred vigorous research into the possible causes of the "cherry red discoloration"' (Sriramachari, S., *Curr. Sci.*, 2004, **86**, 905). The 'cyanide theory' was countered by Union Carbide which 'let loose a campaign of misinformation'. The results of NaTS treatment were puzzling; several survivors of the gas leak appeared to respond well, but many instances of relapse and recurrence of symptoms were noted. Did NaTS administration need to be countered so vigorously that government agencies ensured cessation, effectively discounting the 'cyanide hypothesis'? If Sriramachari were with us he may have raised this question in his characteristically gentle and polite manner.

In March 2003, Sriramachari presented a detailed account of 'The Bhopal Gas Tragedy – An Environmental Disaster' at the Fourth Sir Dorabji Tata symposium on 'Trends in Respiratory Diseases'. He was persuaded to permit reprinting of the text of his paper in this journal

(*Curr. Sci.*, 2004, **86**, 905–920). Almost immediately thereafter this journal received a rebuttal entitled 'The Bhopal gas tragedy: Evidence for cyanide poisoning not convincing' (Gassert, T. S. and Ramana Dhara, V., *Curr. Sci.*, 2005, **89**, 923). The correspondents expressed two major concerns: '(a) lack of evidence of cyanide release and (b) reliance in part upon unpublished and incomplete data'. At that time I was struck by the immediacy of the response and the tone of the critics based in US institutions. Sriramachari responded to the criticism beginning with a disclaimer: '. . . the paper based on our scientific studies does not represent any ICMR report'. He argued that his critics 'with pre-conceived notions have tried to weave a criticism based on some unpublished and some irrelevant published reports to ridicule the cyanide hypothesis'. He reiterated the main findings of his studies, pointing to cyanide as one of the many toxic agents in Bhopal, noting that 'elevated blood cyanide and urinary SCN levels and response to NaTS therapy up to 1986, as reported in *Current Science* provide convincing evidence' (Sriramachari, S., *Curr. Sci.*, 2005, **89**, 924).

The ICMR carried out a series of research investigations between 1985 and 1994. Curiously, the 'Report on Health Effects of the Toxic Gas Leak from the Methyl Isocyanate Plant in Bhopal' has a release date of 2004. While 'nearly three-fourths of the deaths occurred within the first 72 hours of the leak . . . a large fraction of the exposed population continues to be chronically ill with diseases of the respiratory, gastro-intestinal, reproductive, musculoskeletal, neurological and other systems' (Mishra, P. K. *et al.*, *Int. J. Occup. Med. Env. Health*, 2009, **22**, 193). Sriramachari completed a report of his work before his death, which should be valuable to future researchers who seek to understand the nature of the substances let loose in Bhopal and the mechanisms by which they might exert both short-term and long-term effects. In his 2004 summary, Sriramachari suggested that 'the moment the Bhopal gas disaster took place the Union Carbide Company adopted a policy of *suppressio vary* and *suggestio falsi*'. In the context of the current debate on compensation for victims and penalties for negligence, the nature of information provided on chemistry, metabolic fate and toxicity may be important. In thinking of Sriramachari, Heeresh Chandra and the many others who committed themselves to help understand the tragedy at Bhopal, I could not help but reflect on the negligence of those communities which should have acted with alacrity and sincerity; politicians, bureaucrats, industry, judiciary and scientists. In the last quarter of a century no Academy of science, no advisory council to governments and Prime Ministers and no agency devoted to science has thought it necessary to push for environmental clean up or speedy publication of scientific studies which may help to understand the cause of death and long-term consequences of exposure. This is the tragedy of collective amnesia.

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