Shoemaker by Levy – The Man who Made an Impact. David H. Levy. Princeton University Press, 41 William Street, Princeton, NJ 08540, USA. 2000. 303 pp. Price: $27.95.

Seven years ago, some very unusual news hit the headlines – that a comet was broken into 21 pieces. That's not all! It was destined for a suicidal crash onto Jupiter. It sounded like science fiction! The instant of the crash of the first piece was watched with great anxiety all over the globe. The earth was on the 'wrong side' to view the event; however, the 'scar' on Jupiter due to the crash was seen a couple of hours later when the planet turned around.

That was the victory of an idea – the idea that 'impact' played a special role in building the components of the solar system. This idea was the brainwave of Eugene Shoemaker – whose name the book under review bears. That also justifies the extension to the title 'The Man who Made an Impact'!

The comet had three names attached to it – the three are celebrities and have etched their names in the pages of the history of astronomy. Two of them were Shoemakers (Eugene and Carolyn) and the third was David Levy – the author of the book under review. One may recall the scene of the impact of the comet Shoemaker–Levy on Jupiter as watched by the scientists; it was beamed by all TV news channels. The trio was shown jumping with joy as the first piece of the comet crashed on Jupiter.

David Levy was fortunate to be associated with the Shoemakers; he shares the credit of discovery of several comets with them. He sketches the column 'star trails' (in the monthly *Sky and Telescope*, dedicated to astronomy), which is a fine blend of description of personalities and science. In this book, he opens the chapter with, 'The earth is a book, its story carved for all times in pages of rock . . . can be read and understood by any person who is trained like Gene Shoemaker . . .' – an example of his powerful pen.

Eugene Shoemaker, better known as Gene, started his career as a geologist; that gave him an opportunity to recognize some special rocks. Through his systematic study of the craters, he began to believe that their origin lay in impact, quite contradictory to the prevalent belief of volcanic origin. Forty years ago, this thinking was not well received. His suspicions of the impact origin were not unfounded. Edward Chao of the Smithsonian Institution studied the rocks and minerals from the crater site using the X-ray diffractometer. The detection of coesite, whose formation requires not only high pressure, but high temperature also, favoured the impact origin of the crater. Gene immediately recognized the merit of this discovery and pushed the research in that direction.

Gene aspired to land on the moon. He was the Principal Investigator in the Apollo missions. His health, unfortunately, did not permit him to go to the moon. He was involved in the Ranger operations, which served as precursors to the Apollo missions, and watched the progress of the missions with great enthusiasm. He eagerly waited for sample rocks to be brought from the moon. Levy as a close associate of Gene, narrates this part quite extensively.

Gene's early work on mapping the moon proceeded much in the same way as he had put out in Colorado. However, he could not lay his hands on the soil, nor could he use his hammer or the compass! He prepared the geological maps of the moon with the help of excellent photographs taken forty years earlier from Mt. Wilson. He studied the region around the feature designated 'Copernicus' to establish that it was formed when something crashed onto the moon. His studies paved the way for a new avenue recognized as 'astrogeology' today. Stephen Dwornik refers to him as 'the father of lunar geology and stepfather of planetary geology'.

Gene aspired to look for the signatures elsewhere outside the earth. Naturally, the first step was the moon. In one of the colloquia (on this subject) he delivered, aspiring for a faculty position, his ideas (of lunar geology) made a big impact. The colloquium was a success; but he was denied the faculty position. Levy quotes, 'The letter opined that his enthusiasm to go to the moon was contagious and feared that he might persuade . . . the young students towards it!'

His leadership of the Apollo projects are remembered by many astronauts with great reverence. Harrison Schmitt of Apollo 17 is cited as saying, 'Had Gene not been there, the Apollo crews would have . . . collected random samples. It would not have been the program we ended with'. The growth of space activities, ups and downs of the projects, (the-not-so-publicized feat of) Rangers missing their target (the moon), competition with USSR – all these render this chapter as the history of NASA itself.

Neil Armstrong brought cheers with the lunar rocks. Gene longed to see the rocks on the moon – he perhaps would not have needed a lab facility to establish his impact theory. Subsequently, he opted out of the Apollo mission. He openly expressed his unhappiness that NASA concentrated on technological feats, rather than science. The geologists would love to watch a totally different terrain. The evidence of impact on the rocks could have been recognized by them without any instrument, right there, at the first glimpse!

After Gene decided to deviate from the Apollo missions, he concentrated on what is known as paleomagnetics, which has grown into a vast subject today. Levy explains these developments in great detail, rendering them palatable to a commoner. This is the study of the magnetization of rocks. They give a clue to the orientation of the earth's magnetic field at the time of formation (of the rocks). This was indeed a new idea and turned out to be a novel technique for determination of the age of rocks.

The transition of Gene's interests towards the near earth asteroids (NEAs) was gradual. As he puts it himself, 'I spent the first half of my life wanting to go away to the moon, and the second half of my life wanting the moon to go away'. The struggle he and Carolyn had to undergo to create a long list of NEAs and comets makes interesting reading. Here, Levy's first-hand experience with the couple adds to the beauty of narration.

Carolyn deserves a special mention and therefore Levy has devoted an entire chapter on her. Actively participating in the geological field trips in the beginning, she continued to encourage him at every venture. The later field trips into the unexplored terrain in Australia; the hardships encountered therein have all been narrated here, with amusing anecdotes. With no experience of handling telescopes, discovering 17 comets in a short span of a couple of years (at the age

of 40 +) is an amazing achievement. She learnt the trick of searching the worm-like trails of asteroids in a photograph filled with starry dots, from a student of Gene. She surpassed the record of the senior Caroline (Herschel). She goes on to say, 'Passing Herschel's record was a special goal for me . . . not because there was anything personal . . . it was a landmark and special in a way to find more than any other woman had found so far'.

Gene was a wonderful instructor and teacher – his students remember him with great reverence. Levy has compiled a good number of anecdotes and quotations from the students and astronauts as well.

The book makes very interesting reading with lot of tips on comet discoveries, the description of development of the new science of astrogeology and paleomagnetics. It is rich with emotional narration, like the comet crash episode and the 'fulfiling' of his dream to reach the moon (after his fatal accident), running to full-length chapters. Gene's identity as a scientist, as a man with vision – ever toying with new ideas and as a good friend – have been rendered gracefully. While it leaves newcomers with a sad feeling that they could not meet Gene in person, the future generations would definitely get inspired to venture into unexplored avenues.

That was Gene – who etched his name on 32 comets, 24 craters (on earth) and lead five Surveyor missions and six manned landings on the moon. If one ever wondered on the rechristening of the NEAR (Near Earth Asteroid Rendezevous) spacecraft, which landed on the asteroid Eros last February, as NEAR – Shoemaker, the book provides a justification.

Notes, selected bibliography and references for every chapter are apt and useful. The book is recommended for students of science, astronomy, space sciences and geology as well.

B. S. SHYLAJA

Bangalore Association for Science Education
Jawaharlal Nehru Planetarium
Bangalore 560 001, India
e-mail: taralaya@vsnl.com

Renewable Energy and Environment – A Policy Analysis for India. N. H. Ravindranath *et al.* Tata McGraw Hill, New Delhi. 2000. 1st edn. 251 pp. Price not mentioned.

This monograph, one of a series on Environment and Development, has been published for Centre for Environment Education, Ahmedabad. It is very welcome as this is a timely and first full length overview of India's Renewable Energy Technology Programme (RETP). It is undertaken by authors, who are not too much away from RETP, but are not too integral a part of it either. As such it gives the review authenticity and independence at the same time. Readers might like to know that India has one of the largest renewable energy programmes in the world, underpinned by a full department/ministry since 1982. This review is divided into 7 chapters. The first two chapters give a fairly succinct account of the interface between RETP and environment and the consumption patterns and their socio-economic context such as sustainability implications in terms of dispersed and low-intensity use in rural areas, consideration of rising energy demand and energy security for urban areas and the impact on climate change factors of burgeoning demand of industry and transportation sectors. Chapters 3 and 4 outline the historical evolution of strategies, their progress and performance. Need for a RET Policy as part of the National Energy Policy is emphasized. The high upfront costs of RET, which can find a niche only via life-cycle economic analysis, including rebates for avoided climatic change and pollution and not just in terms of traditional economic analysis of installed costs per Mw and tariffs for units costs of delivered energy are emphasized. Chapters 5 and 6 on integration of environmental consequences of RETP and the actual impact of RETP in India are central to the concerns of the monograph. They are treated exhaustively and systematically. However, in the reviewer's opinion, the authors fail to highlight unique achievements and glaring defects of RETP in an emphatic manner. For example, outstanding success of solar PV home-lighting systems in Ladakh and Spiti and highly successful cluster of 150 Solar PV pump sets at Auroville are almost bypassed, even though reasons for success are different from SELCO's.

As regards the role of external funding (it is lending and not funding), it is overtly highlighted (p. 187). It has helped government-controlled programmes, but has skewed voluntary efforts in terms of loss of initiative and cost intensity escalation by a factor of 3 to 4 in terms of already matured technologies. Not a single relevant high-end technology such as manufacture of evacuated tube collectors (ETC), parabolic trough collectors (PTC), etc. has been inducted. Instead of building capacity for manufacture, stress has been on marketing of finished products (including overseas ones). There is hardly any attempt to increase the buying capacity in rural communities, except through people-to-people bilateral NGO funding. Subsidy for industries and clean development mechanism are useful only for funding big projects. But for two other equally important sectors, usefulness of energy supply companies (ESCOs) needs specific mention in light of requirements of trained staff for installation and maintenance of RETs. Success of Barefoot College in training local youth and the participation of local population in decision making, has been crucial to the success of voluntary efforts in backward and far flung areas. Their absence has been the single cause of much advertised failures of target-driven government controlled programmes. This can be easily corrected by proposing that certification and evaluation centres could also act as diagnostic and remedial centres for a small service charge and by manufacturers providing risk insurance policies. Suggestions for NGOs to build community mechanisms for RETPs, rather than highly politicized and overloaded panchayats is a courageous appreciation of ground realities, but is fraught with grave political risks.

Suggestions for green rating and green pricing mechanism for upper income communities and support by incentives for low income sections such as prizes, recognition and media exposure as in the recent case of rainfall harvesting will be helpful in promoting RET realistically and effectively. There is already a widespread awareness on information level throughout the country, but credibility needs to be built up. Scales for manufacture for RETs imply volume and not large

size (the 135 Mw solar thermal plant in Rajasthan is only 20 per cent solar) of single units. The lament of the authors, that hardly any measurable data exist for assessing performance and impact of RETs in India is sadly true. But in a highly emotional atmosphere surrounding energy choices in India (evidenced by nuclear lobby, Dabhol fiasco, Narmada dam height) complete transparency could invoke murder of RETs. Once this fear is removed and national vision is clear, this transparency can lead to success of RETs, better systems' life and performance and reduced energy embodied in the manufacture of RET devices.

This book, on the whole, is an independent and comprehensive overview of renewable energy technologies in India and their positive implications for India's future environment, as also the present status and its evaluation. All energy decision makers should find it profitable to go through the book and all students in various energy courses would find in it a mine of data and information. Through its well-structured boxes of presentation, informed and intelligent public at large can derive much profit.

C. L. GUPTA

Solar Energy Unit,
Sri Aurobindo Ashram,
Pondicherry 605 002, India

Making Water Everybody's Business – Practice and Policy of Water Harvesting. Anil Agarwal *et al*. (eds). Centre for Science and Environment, 41, Tughlakabad Institutional Area, New Delhi 110 062. 2001. 456 pp. Price not mentioned.

Good quality water is increasingly becoming a rare commodity. People have lost faith in municipal water supply and those who can afford to pay have taken to bottled water, which is available at a price. The average urban dweller, however, has to be satisfied with any type of water, taps remaining dry for most part of the day and life in rural areas has become a daily struggle to fetch water. The scientific community has shown scant interest in solving this problem of the poor. Rainwater harvesting, recharging of the groundwater reservior and desalination of brackish water are areas in which no research organization in the country is seriously engaged. A host of engineers are employed in the construction of major dams and in transferring water over long distances, but collection of rainwater where it falls and storing it for local use has not interested them.

Anil Agarwal, well-known environmentalist based at Delhi, has been waging a lone battle against the policies of past and present-day governments. His first report on the state of India's environment was issued in 1981, nearly twenty years ago, and it focused attention on the degradation of India's environment through the unwise policies of the government and people's neglect. Subsequent reports have been issued at five-yearly intervals on aspects like food self-sufficiency, floods and flood plains. The last book, *Dying Wisdom*, released in 1997, draws attention to the water-harvesting systems in practice in ancient and medieval India. These books have made an impact both on the bureaucracy and the people, creating an awareness of what needs to be done for conserving our water resources, preventing their pollution and making water available where it is most needed.

The present volume under review, also issued by the Centre for Science and Environment (CSE), New Delhi, under the direction of Anil Agarwal, summarizes the proceedings of the three-day conference held at Delhi in October 1998, which was inaugurated by K. R. Narayanan, President of India. Water harvesting activists, builders, policy makers and academics from India and abroad are stated to have participated in the conference.

The objective of the conference was to make water harvesting a mass movement and thereby diffuse the water crisis which is building up at an alarming rate in most parts of the country. There is heavy extraction from rivers as well as groundwater reserviors, resulting in significant lowering of the water table. With too much dependence on the State, which has no money to invest in new projects and is unable to supply water at highly subsidized rates, the only alternative is for the people themselves to take the initiative and revert to and improve the ancient practice of harnessing rainwater by capturing it where it falls. The book advocates water harvesting in houses and farms by funding small projects in both rural and urban areas and media participation is felt necessary in giving a new fillip to this movement.

The bulk of the book is devoted to demonstrating that rainwater harvesting, widely practised in India in earlier times, is feasible and can be successfully implemented, thereby making people self-sufficient in this most essential of commodities – water. The book, with the most appropriate title, is intended to involve everyone in the process of ensuring water supplies.

Chapters 2 and 3 of the book narrate remarkable success stories of the work turned out by villagers of Ralegan Siddi under the leadership of Anna Hazare, Sukhomarji under P. R. Misra and the numerous villages in Alwar district, Rajasthan by *Tarun Bharat Sangh* under the leadership of Rajendra Singh. Many traditional water-harvesting systems in Rajasthan, Bundelkhand, Madhya Pradesh and other parts of the country are outlined. Their re-emergence as crucial sources to meet the growing water scarcity in many rural parts emphasizes the need to revitalize the numerous tanks by desilting them and restoring them to their original state.

A heartening development in this direction is the mushrooming of voluntary organizations in different parts of the country, whose work and success stories are narrated in a number of papers. Spectacular results obtained in parts of the Thar desert and the Western coastal plains and revival of the river Aravai in Rajasthan are illustrated by many excellent photographs in colour, bearing ample testimony to the success of the programme.

A silent revolution seems to be sweeping across Rajasthan through voluntary organizations like the *Tarun Bharat Sangh*, which has constructed 3000 water-harvesting structures in 760 villages, regenerating 0.65 million hectares of land! *Pani Yatras* organized by CSE have helped to spread the message of rainwater harvesting and its conservation far and wide.

A quite promising development is the promotion of roof-water harvesting, especially in salinity-affected areas (Chapter 4). When once the success of roof-water harvesting spreads, the construction of underground storage reservoirs will be

undertaken and will go a long way in solving chronic shortage of water in cities. Chennai has set an example in this respect by amending building laws to make it obligatory for all new constructions in the city to have rainfall harvesting structures to store water. Such stored water could be used for flushing toilets, washing and gardening.

Chapter 5 outlines technology available for water harvesting such as remote sensing and geographic information system, groundwater recharge designs, computer databases and waste-water recycling. Significant advances in these fields are possible provided the scientific community applies its mind to effect improvements in traditional technology.

The need to make water everybody's business is emphasized in a group of papers assembled in Chapter 6. Reasons for decline in traditional technologies are analysed. Official preoccupation with mega projects implemented with borrowed money and neglect of tanks has resulted in too much centralization and the consequent neglect of traditional technologies based on self-reliance. Another glaring factor is the lack of interest shown by research institutes in tackling problems of the poor in rural areas.

CSE and particularly its leader Anil Agarwal are to be congratulated for having rendered great service by forewarning the people of the bad days looming ahead – the spectre of water famine – threatening to overtake them and suggesting measures for combating the menace.

The attractive part of this educative book under review are the numerous photographs in colour and the large number of line drawings specially drawn to convey its message to everyone. Scientists in our research institutes must take note of this publication and help in organizing sanctuaries within their campus, where models can be created and the effectiveness of the technologies aimed at rainwater harvesting and pollution control are demonstrated.

State water is heavily subsidized and thus under-priced leading to adoption of wasteful practices and squandering of a precious resource. We have more wealth in water than Arabia in oil. This resource therefore, has to be conserved and used with great care if future crises are to be avoided. Our scientists should develop technologies aimed at converting our water resources into real wealth through efficient conservation and use and thus build a future based on the enduring past of India. The book under review is a step in that direction and deserves to be closely studied by our administrators, scientists, the intelligent public and all those concerned with public welfare.

B. P. RADHAKRISHNA

Geological Society of India,
No. 63, 12th Cross, Basappa Layout,
P.B. No. 1922, Gavipuram P.O.,
Bangalore 560 019, India
e-mail: gsocind@bgl.vsnl.net.in

PERSONAL NEWS

A link with the past: Divya Darshan Pant (1919–2001)

On 9 May 2001, India lost an eminent botanist, an excellent teacher, a distinguished visionary, researcher and a fearless critic in the demise of Divya Darshan Pant. Pant was the founder of a strong school of research in palaeobotany and morphology of plants in the Department of Botany, Allahabad University. Beginning his career as a lecturer in 1945, he became Professor and Head of the Department of Botany in 1966. When he was at the helm of affairs from 1966 to 1981, the department achieved international fame for both teaching and research.

Divya Darshan Pant was born on 18 October 1919 in the pine-dotted picturesque surrounding of Ranikhet in Kumaon Himalaya. His father Ambika Dutt Pant was a highly respected Ayurvedic physician and Editor and Publisher of a magazine, *Himalaya*. After his early school education in Ranikhet and Nainital, he moved to Lucknow where he graduated and later received his post graduation and research training under Birbal Sahni. In 1946, he married Radha Pant, a biochemist who later headed the Department of Biochemistry and Home Science in Allahabad University.

The blending of interest in living and fossil plants and combination of facts with interpretative ideas were Pant's main distinctions. His work enables us to peep into the plant world of Gondwana and Pre-Gondwana times through the modern window. On the basis of his important research contributions on the reconstruction of plants of glossopterids, diversity of the floristic elements and reproductive biology, he was recognized as an authority on *Glossopteris* flora. His interpretation of the compressed organs of *Glossopteris* and related genera, including their vegetative parts and fructifications have been vividly confirmed by the subsequent findings of permineralized fossils. He was the first to propose the existence of mycorrhizic gametophytes in Rhynie Chert by his interpretation of gametophytic and mycorrhizic nature of *Rhynia gwynnevaughanii* and strongly advocated it against criticisms throughout his life. However, this work induced others to discover various gametophytes in Rhynie Chert like *Lyonophyton* and *Sciadophyton*.

On the basis of his work Pant established that the members of the *Glossopteris* flora had very diverse woods, megaspores, fructifications and seeds. His work on Gondwana conifers, particularly *Buriadia heterophylla* suggested that these could either be regarded as coneless prepinophytes or may be altogether assigned to new group of plants. His work also shed light on Lower Gondwana structurally preserved pteridophytes. Apart from the peninsular part of India, he had extended his studies on extra-peninsular Lower Gondwana and Pre-Gondwana (Lower Carboniferous) flora of Punjab–Kashmir Himalayas, where he found an admixture of Cathaysian and