

BOOK REVIEW

Sunil Sen Sarma, *Kauṭilya's Arthaśāstra in the light of modern science and technology*, D.K. Printworld (P) Ltd., New Delhi, 2001, pp. xiv+271, three appendices, glossary, bibliography, index, six tables, two maps and five photographs and illustrations. Price Rs. 450/-

The book under review is a welcome addition to the literature on *Kauṭilya Arthaśāstra*, abbreviated as KAS. Sunil Sen Sarma, the author, is a geologist of wide repute, having been the Director of the Geological Survey of India few years ago. He is an established scholar, inspired by Late Professor Debi Prasad Chattopadhyaya and Late Dr. Aruna Haldar. Prof. Chattopadhyaya had asked for, and received from Sen Sarma a short write-up on KAS, but apparently did not use it before his demise.

It is strange that Sen Sarma has quoted in the bibliography of his book neither Chattopadhyaya's celebrated Volume II of 1991, nor the excellent article penned by Ranabir Chakravarti on material milieu (600 BC to 300 AD) included in that volume, nor some of the other relevant literatures published during the 1990's. These gaps and omissions may somewhat attenuate the publisher's assertion in the book-jacket that Sen Sarma's book is 'veritably the first ever effort to examine *Arthaśāstra* from the standpoint of modern science and technology (S & T)'.

The author has focussed his attention on this single ancient literature KAS, and written six chapters:

I. Minerals, Gems, Ores: Identification and Occurrence. II. Prospecting, Mining and Metallurgy. III. Town Planning, Civil and Architectural Engineering. IV. Land, Agriculture and Irrigation. V. Environment: Natural and Civil, and then VI the last chapter, on Antiquity of *Arthaśāstra*. This book is adorned with useful appendices, glossary, tables, maps and illustrations.

The author firmly supports the traditional view that KAS was compiled by Cāṇakya or Viṣṇugupta, the minister of Candragupta (324-300 BC), but

does not adduce any new argument. He neither quotes Bratindranath Mukherjee, a celebrated authority on this topic, nor takes note of the *vaidūrya-marakata* argument, offered by A.K. Biswas (1994), to which we would allude later.

While discussing the 4th-3rd century BC text, Sen Sarma feels free to bring in archaeo-metallurgical data of 2000-1200 BC (pp. 46-53) and developments in the area of civil engineering in India for the period of 500-1900 AD (pp. 193-194). He is so excited about the glory of S&T in ancient India (all Indians should be justifiably proud of it), that he considers it in the light of modern S&T and goes so far as to certify ancient Indians' 'knowledge of organic chemistry' (p. 60) and that 'the concepts, practices and processes recorded in *Arthaśāstra* in different aspects of mineralogy, geology are found so advanced and not demonstrably different from the modern counterparts' ! (p. 61). The author of *Arthaśāstra* did not know 'crystal structure' in the modern sense (p. 11 and p. 18) nor was he aware of the quantitative implications of refractive index (pp. 14-15) and specific gravity (pp. 19-20), nor could he articulate the mathematical expressions of the excellent engineering design (pp. 189-196). The suggestion that KAS was almost modern is hardly acceptable.

Sen Sarma must be applauded when he agrees (in p. 1 itself) with Kangle that the basic problem in working on ancient texts such as KAS, lies in its vocabulary; 'there are numerous technical terms that are not defined'. That is the problem. We do not have a comprehensive technical Sanskrit-English dictionary. That is why late Prof. Chattopadhyay solicited help of scientists and science-historians.

Sen Sarma has quoted Volume II of Biswas and Biswas's *Minerals and Metals in Ancient India* (1996), but did not follow their methodology. This point needs some elaboration. Sen Sarma has merely listed 161 Sanskrit words without any comment, and provided annotations of only 39 terms out of which only 10 are of some novelty, and the rest had been commented upon by earlier workers. On the other hand, Biswas and Biswas (1996) provided annotations on 176 terms of KAS alone, in the backdrop of technical terms present in the *R̥gveda* (90 in number), other Vedic literatures (49), Panini's *Aṣṭādhyāyī* (229) and in the post-KAS Sanskrit literatures (218).

These were in the context of minerals and metals only, whereas Sen Sarma aspired to cover the entire gamut of science ! There was the continuous evolution of technical vocabulary in Indian S&T throughout the ages. Many technical terms used in KAS had been earlier defined by Paṇini, and many other terms were invented and used after the era of KAS. It seems that Sen Sarma missed this vital point, and failed to assess the KAS scientific vocabulary in the wider context.

Nevertheless, he makes a valient effort for 'reconstruction' of technical terms in Appendix 3 (pp. 225-241) and some of his observations need to be specially commended: *drona* for the amount of rainfall (pp. 226-227), *vaidyutena bhasmana...*(1.20.4) as pozzollana or pumice brick, *tkṣṇa mūtra kṣāra* (2.12.8) as ammonia (the present reviewer thinks that it may be saltpetre in its early stage of formation), *artani* (2.5.7), *aṭṭālaka* (2.3.10-13) etc. He has missed an important term: *nālika*, a measure of time (2.20.35).

Specially commendable is Sen Sarma's effort in explaining the sūtras 2.12.1-3 in terms of selective coagulant *rasah kāñcanika*, juice of a plant, beneficiating 'gold-bearing liquid' or colloidal gold in suspension with mud and dirt (pp. 55-59 and p. 247). He rightly observed that there were *caraka pānsuṃ dhavakaḥ* (2.13.33 and 4.1.49) or itinerant gold-washers in the era of KAS.

Though a geologist, Sen Sarma has sadly missed or ignored the deliberations of Biswas and Biswas (1996) on many vital mineralogical and metallurgical terms mentioned in the *Arthaśāstra*. We may provide a few illustrations on this point.

KAS has been the earliest literature in the world to mention *kuruvinda* (corundum), *bālasūryaka* (balas ruby) etc. Corundum, an abrasive, was widely used to polish hard architectural stones such as Aśokan pillar sandstone. This used to be exported from India to the Roman empire. The present reviewer has been the first to suggest that the name of the crimson coloured balas ruby from Badakshan, Afghanistan, was derived from *bālasūryaka* (morning sun ruby) of KAS, and this suggestion has been internationally accepted (Susan Strange, "The Myth of the Timur Ruby", in *Jewellery Studies*, 7 (1996) 5-12, reference no. 2)

KAS mentions green *vaidūrya* (beryl) of Pāṇiṇi and Patanjāli, but not greener *marakata* (emerald) or *masāragalu* (Egyptian gem) which was later introduced in India through import. While articulating the etymologies and traditions of *vaidūrya* and *marakata*, Biswas emphasized (1994) that the non-mentioning of the latter in KAS is an additional evidence in favour of early antiquity of the said text. Why did Sen Sarma refer to emerald (p. 18) which is not at all mentioned in KAS ?

Sen Sarma rules out the possibility of later day interpolations in the manuscript of KAS. We would not be so emphatic. He justified the mentioning of China and Arabia in KAS (p. 163 and p. 166) as normal on the ground that the Chinese people, Chinese silk, the Huns etc. were mentioned in the *Mahābhārata* (2.23.19 and 2.47.19-22). So what does it prove ? For that matter, *Mahābhārata* text contains several references to *marakata* or *masāragalu* (Egyptian gem) and in such contexts, king Yudisthira is stated to have sent his ambassador to Rome (2.28. 49-50).

Sen Sarma missed out on *ārakūṭa* or brass, the use of the word in KAS indicating close contact with Greece (the Greek equivalent is *Oreichalcos*). Later the term was Sanskritized as *pīta tāla* (yellow alloy of copper and zinc) or *pītala*. KAS does not record it, but there are incontrovertible evidences that during Kauṭilya's era, India was definitely manufacturing metallic zinc (*rasaka*, later called *yaśada*) by reduction-distillation method. Sen Sarma could have consulted the exhaustive treatment of A.K. Biswas (1993) on the primacy of Maurya era India in brass and zinc metallurgy, and also his Indian Museum Bulletin paper (1997, 1999) on the Mauryan Era S&T.

The author attempted to cover the subjects of agriculture, horticulture etc. but missed R. Thapar's (1963) and L.P. Pandey's (1996) masterly treatments on *Arthaśāstra*. Regarding irrigation he could have mentioned the inscriptions related to the Mauryan era dams.

The author's treatments on soil mechanics, foundation pillars, buildings, and towns, civil engineering, architecture are commendable. The present reviewer admires Sen Sarma's treatment (Chapter 5) on environmental science in KAS, and his 1998 paper in the *IJHS*.

It is disheartening to note that despite his firm commitment to philosophy of science, Sen Sarma does not comment on the most vital and

crucial term in KAS: investigative philosophy or *āṇvīkṣīkt* which is derived from *anveṣaṇ* or search for truth.

Whereas the followers of Manu considered philosophy as a subject subserving the Vedic lores, Kauṭilya asserted that *āṇvīkṣīkt* was supposed to investigate, by means of reasoning, not only the hazards of economics and politics, but also *dharmādharmau trayyām* or 'what is spiritual good and evil in the Vedic lore'. It was boldly proclaimed that 'philosophy is ever thought of as the lamp of all sciences, as the means of all actions and as the support of all laws and duties' (KAS, 1.2.2-12). In his Appendix 2, Sen Sarma should have quoted some of these *sūtras*. Kauṭilya's scientific attitude shines brilliantly in his sharp criticism of the obsession for astrology: 'what can the stars do to guide one's destiny?' (9.4.26).

In conclusion, we re-iterate the most important point, which we have already made. Joseph Needham and Debiprasad Chattopadhyaya initiated a golden era of collaborative research in the arena of history of science, and this should be sustained. In the context of S&T in ancient India, we need joint efforts of historians, archaeologists, linguists and scientists of the calibre of Sunil Sen Sarma. His book on KAS is a remarkable contribution which deserves to be kept and used in all libraries devoted to history of S&T in India. A few references however in the context of the Review will be of interest.

Bag, A.K. (edited), *History of Technology in India* (Antiquity up to 1200 A.D.).

Vol. I, INSA. 1997. Some of the thirty chapters are related to mining, minerals, gems, metals, textile, agriculture, irrigation, building, transportation, architecture, social factors related to technology etc., relevant to the Mauryan and other eras.

Biswas, Sulekha and Biswas, A.K., 'History of Science in India in Search of a Paradigm', *Indian Journal of History of Science* abbreviated as *IJHS*, 29.3 (1989) 193-200, contesting the anti-Vedic propositions of Chattopadhyaya (1986).

Biswas, A.K., 'The Primacy of India and Ancient Brass and Zinc Metallurgy', *IJHS*, 28.4 (1993) 309-330.

Biswas, A.K., '*Vaidūrya, Marakata*: Etymology and Tradition in Ancient India', *IJHS*, 29.2 (1994) 139-154.

- Biswas, A.K., *Minerals and Metals in Ancient India*, Vol. I. Archaeological Evidence, D.K. Printworld, New Delhi: 1996. Sen Sarma quoted only Vol. II. Literary Evidence by Biswas. A.K. and Biswas, Sulekha, in general terms and not specifically mentioning its Chapter 5 on KAS.
- Biswas, A.K., *S & T in India during the Mauryan Era*, vide Indian Museum Bulletin, Special Issue, 1997 and 1999.
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- Chakravarti, Ranabir, *Material Milieu in Ancient India (600 BC-300 AD)*, in Chattopadhyay 1991, Vol. II, pp. 305-330.
- Chattopadhyaya, Debiprasad, *History of S&T in Ancient India*. Vol. I, Firma KLM Pvt. Ltd. Calcutta, 1986. Sen Sarma quoted this volume but not the subsequent volumes (more relevant) II and III.
- Chattopadhyay, Debiprasad, *History of S&T in Ancient India*, Vol. II (1991) containing the article of Ranabir Chakravarti, also Vol. III, (1996) Firma KLM Pvt. Ltd., Calcutta.
- Indian Museum Bulletin* Special Issue 1999, incorporating the proceedings of the February 1997 Seminar on 'Maurya and the National Integration', 26 very useful articles including one by A.K. Biswas, *S&T in India during the Mauryan Era*, pp. 216-243.
- Mukherjee B.N., 'A Note on the Date of *Arthasāstra*', in *Vajpeya*, K.D. Bajpai Felicitation volumes, Agam Kala Prakashan, Delhi, Vol. 2, pp. 303-305, 1987.
- Mukherjee, B.N., *The Character of the Maurya Empire*, J.B. Enterprises and Progressive Publisher, Kolkata, 2000.
- Pandey, Lalita Prasad, *Botanical Science and Economic Growth*, Munshiram Manoharlal, New Delhi, 1961. Chapter II entitled 'Development of Botanical Science in India (5th century BC—3rd Century AD)' contains many references to *Arthasāstra*.
- Thapar, Romila, *Aśoka and the Decline of the Mauryas*, Oxford University Press, 1963. Second edition 1996.