Marxist, XXXIV, 4, October-December 2018

RAMKRISHNA BHATTACHARYA

Debiprasad Chattopadhyaya As Historian of Science and Technology in Ancient India

Some Distinct Traits

Debiprasad Chattopadhyaya (1918-1993) is best known all over the world as the explicator of materialist philosophy in India and his creative contributions to Marxism. His magnum opus is *Lokāyata* (1959). One of his last published works, *In Defence of Materialism in India* (1989), is also on the same topic.

Nevertheless, to view Chattopadhyaya as a specialist in materialist philosophy in ancient India is not only one-sided and unfair but also wrong. He was a man of various interests. Although a life-long student of philosophy (he graduated with honours and did his MA in this subject), his activities embrace such apparently disparate areas as writing poetry in his early youth and editing along with his elder brother, Kamakshiprasad, *Rangmashal*, a journal for juvenile readers. He himself contributed articles, novels and short stories for them in his own journal and elsewhere. However, he devoted the last years of his life in writing a three- volume *History of Science and Technology in Ancient India* (1986,1991,1996).

Paper presented at Thrissur, Kerala in EMS Smrithi 2018.

It is not exactly known why Chattopadhyaya changed the focus of his research from philosophy to the history of science. He has written nothing about it and his associates cannot say why he got interested in the *History of Science*. In between his *What is Living* and *What is Dead in Indian Philosophy* (1976) and History of Science and Technology in Ancient India (Vol 1 1986) there is *Science and Society in Ancient India* (1977). In the preface to this work he writes, "The present study is intended to supplement my recently published What is Living . . ." What is Living . . . was exclusively devoted to philosophy, as the title suggests. Even his *Science and Society*. . . 'was originally planned to have three parts – the third discussing the sources of the *Nyāya-Vaiśeṣika* philosophy in the theoretical fundamentals of ancient Indian medicine' (1977 p.iii). However, 'on later consideration,' he continues, "I have decided to publish the third part [the work consisted of two Books, Book I: *Science & Counter-Ideology* and Book II: *The Source-Books Re-examined*] in the form of a separate monograph, for it is too full of technical details to sustain the interest of the general readers" (1977 p.iii). The promised Book III, however, was never written.

With some people, appetite grows with eating. Chattopadhyaya's study of the two medical compendia, the *Caraka Saṃhitā* and the *Suśruta Saṃhitā*, led him afar from *Nyāya-Vaiśeṣika philosophy* to other branches of science, such as astronomy, botany, mathematics, etc. The promise of dealing with the *Nyāya-Vaiśeṣika* in relation to the above-mentioned works was not kept. He felt the need of writing a *History of Science and Technology in Ancient India*. The existing histories, he felt, were inadequate and left out much of archaeological data and such mundane matters as the formation of cities, use of iron and the like. This new interest in history resulted in, at first, in the two-

volume anthology he edited, *Studies in the History of Science in India in 1982*. He contributed a long introduction to the first volume which outlined his plan of work. Quoting a long passage (which ended with a resounding declaration, "Modern universal science, yes; Western science, no!)" from Joseph Needham's The Grand Titration, he told his readers,

The present book is intended to be a part on science in Indian history, on which we have been working. Before explaining the exact scope of the book especially as a preparation for the main project, it may be useful to have a few words on the relevance of the project itself. The main presuppositions of any such project, as explained by Professor Joseph Needham, are; ―(one) that human social evolution has brought about a gradual increase in man's Knowledge of Nature and control of the external world, (two) that the science is an ultimate value and with its applications forms today a unity into which the comparable contributions of different civilisations (not isolated from each other as incompatible and mutually incomprehensible organisms) all have flowed and flow as reverse to the sea, (three) that along with this progressive process human society is moving towards forms of ever greater unity, complicity and organisation. (1982 p.iii. The quotation is taken from Needham's *Science and Civilisation in China*, vol.4, 1962 p.xxxi.)."

His promise was fulfilled when vol.1 of his History, came out in 1986. So it is philosophy that led him to the *History of Science*. However, this new-grown interest proved to be all-pervasive and resulted in the formation of a team of scholars who would collaborate in working out a proper history of science and technology. The issue of epistemology in the *Caraka Saṃhitā* and the *Nyāyasūtra* along with *Vaiśeṣika* categories in the same text was left to his close associate, Mrinal Kanti Gangopadhyaya to work out (see History vol. 2 1991, Appendices 6 and 7, pp. 483- 528 and 529-540). It may be stated in passing that Chattopadhyaya used to refer to this collaborator of his for many decades always as 'my young friend and teacher,' much to the embarrassment of Gangopadhyaya.

What marks Chattopadhyaya's work on history of science and technology is his emphasis on technology on par with science. Unlike many other historians who confine themselves exclusively either to science and scientific ideas or to the development of technology, Chattopadhyaya refused to deal with science without reference to technology. Instead of starting off with the *Vedic* times, he began with the urban civilization of *Mohenjo-Daro* and *Harappa*, pointing out its salient features, particularly the absence of iron. He then moved over to the period of second urbanisation. As in his first work, he attempted to discover the material basis of Lokāyata, similarly in his History he sought to locate the material basis of scientific ideas. This is why, technology occupies such an important place in his last works. He did not think it proper to dissociate science from technology; 'how' was as much important to him as 'what' and 'why'. His study of the *Śulbasūtras*, that may be described roughly as proto- geometry, pays as much attention to 'brick technology' (Chattopadhyaya (ed.) 1984 p.v et passim, Chattopadhyaya 1986 p.196) as to the geometrical theorems that followed from the arrangement of bricks in the vedic sacrificial altars, variously called cit, citi, vedi, etc. (see Chattopadhyaya 1986 chapters 5-6).

The second distinctive mark of his History is the close link he forged between philosophical doctrines and scientific ideas that emerged in India over time. Instead of cataloguing all the wonderful discoveries and spectacular inventions made by ancient Indian scientists, he emphasized the unity of head and hand, thought and action, theory and practice. In order to understand Chattopadhyaya's approach one has to keep in mind his insistence on what he called the formation of the theoretical fundamentals of natural science, which is also the sub-title of the second volume of his History, vol. 2. The fourth, fifth and sixth chapters in vol. 2 are the most important ones. Here he deals

with the doctrines of *Time, kāla, Own Being, svabhāva*, etc., as mentioned in *Śvetāśvatara Upaniṣad*, 1.2, and the basic tenets of Buddhist and Jain philosophical systems, namely, Interdependent Origination *(pratītya-samutpāda)* which anticipates the concept of causality, and *the doctrine of somehow '(syādvāda). Uddālaka Āruṇi of the Chāndogya Upaniṣad* and the two fundamental texts of medicine and surgery, the *Caraka* and *Suśruta-Saṃhitās* engage his attention to a large extent. It was not so much because they constitute the acme of achievement in the field of science, but because of the scientific potentials inhering in the experimental approach of *Uddālaka* and the proclivity for free-thinking that characterizes the two medical texts. The form in which the two compendia has come down to us, they contain palpable additions of many antiscientific and superstitious ideas. Such interpolations and other kinds of alterations were made by those who had a stake in promoting irrationality. They could not but be the forces of reaction and regression fostered by the then establishment.

A CRUX IN THE ŚVETĀŚVATARA UPANIṢAD

It has been complained that "a good Sanskrit text cannot be interpreted without a commentary" (Kosambi 1956/1975 p.284). But there is no guarantee that the commentator can always be trusted. The text might have been composed several centuries before the commentator decides to write its glosses. The meaning of a word or words might have changed in the intervening centuries.

Secondly, the syntax of a passage in the original work might be convoluted: the apparent and easy-to-understand arrangement of words might not have been intended by the author. Our putative commentator might prefer the obvious to the intended one. Hence, the glosses might be misleading or downright wrong. The *Śvetāśvatara Upaniṣad* offers a case in point. The second verse reads as follows:

kālaḥ svabhāvo niyatir yadṛcchā
bhūtāni yoniḥ puruṣa iti cintyam |

The problem lies in the word yoniḥ. Apart from meaning womb, it also means – and most probably this was the original meaning of the word – the origin or cause. *Pseudo-Śaṅkara* an early commentator on this *Upaniṣad*, took the word in this sense, proposing that yoni connects all the alternatives mentioned: Time is the cause, Own Being is the cause, etc. Friedrich Max Müller accepted this view and translated the verse as follows:

"Should time, or nature, or necessity, or chance, or the elements be considered as the cause, or he who is called the person (purusha, vigñânâtmâ)? (1884 p.232)"

Pseudo-Śaṅkara stops at the word yoniḥ and explains the rest of the line separately. Two other commentators follow his lead (for details see Bhattacharya 2006 pp.48-49). Some later commentators, however, take the first two lines as a unit. Some translators, who form a minority, follow *pseudo-Śaṅkara* whereas many other translators prefer the explanation offered by some later commentators.

Should we regard it [brahman] as time, as inherent nature, as necessity, as chance, as the elements, as the source of birth, or as the Person? (Trans. Patrick Olivelle)

SEARCHING FOR THE FIRST CAUSE

Any reader interested in the proposals concerning *jagatkāraṇa* (lit. the cause of the world, that is, the first cause) has to resort to *Śvetāśvatara Upaniṣad* 1.2 and she/he faces the crux: Which commentator/translator is to be trusted? Chattopadhyaya had to face it twice: first in *Indian Atheism: A Marxist Analysis* (1969) and then again in his *History of Science and Technology in Ancient India,* vol.2 (1991). When he was engaged in analysing the atheistic tradition in India from the Marxist point of view, his attention was naturally drawn to the *Śvetāśvatara Upaniṣad*.

As he put it then (1969):

"The direct and obvious recorded evidences of the beginnings of Indian atheism are to be sought in those lines of thought which the earliest theists belonging to the Vedic tradition considered hostile to their own and which moreover suggested some principles other than God to account for the mystery of the universe, or, more particularly, the mystery of the origin of the universe. . . ." (1969 p.45. Emphasis in the original.)

The *Śvetāśvatara Upaniṣad*, Chattopadhyaya notices, 'refers to a number of alternatives to the theistic assumption and some of these were remarkably materialistic or near-materialistic.' (1969 p.45).

So far, so good. The trouble starts with the number of non-theistic doctrines recorded in the *Śvetāśvatara Upaniṣad* 1.2. Following Radhakrishnan and Hume, Chattopadhyaya mentions seven: *Time, Own Being, Necessity, Accident, the Elements, Womb, and a Male Person* (1969 p.47). Not only *S. Radhakrishnan* and *R. Hume* but also some other translators of this *Upaniṣad* (for instance, E. Röer and more recently Patrick Olivelle) have followed this interpretation of the verse.

But Chattopadhyaya does not agree with this interpretation, because he does not consider it to be 'the most logical one' (1969 p.47 n9). He also mentions Radhakrishnan's views that yoni alludes to 'the ancient *Sāṃkhya* view, according to which prakṛti or primeval matter, like the mother, gave birth to the universe: —*yoniḥ*: the womb, *prakṛti*, which is the mother of all possibilities in the world.' (qtd in Chattopadhyaya 1969 p.48). Chattopadhyaya agreed with this view, for unless yoni is taken in the sense of the female principle, any reference to *Sāṃkhya* will be lost. Chattopadhayaya, however, did not deny that *Own Being*, too, indicates a standpoint shared by *Sāṃkhya* (1969 p.48). In his *Lokāyata* (1959) he had argued on the possible origin of the *Sāṃkhya* view in the cosmogony according to which the world was born out of a female principle (1959 pp.269ff).

Thus, he preferred to follow Radhakrishnan in respect of what Wilhelm Halbfass called the 'competing causalities' (1992 p.291). Chattopadhyaya in this respect further refers to (1969 p.47 n9) the view of *Phaṇibhūṣaṇa Tarkavāgiśa*, who quoted *Śaṅkarānanda's Dīpikā* commentary (1333 *Bangla Sal* (1926-27), 4:147n = 1988 ed., 4:184 n1). Chattopadhyaya also refers to *Suśruta Saṃhitā*, *Śārīrasthāna* 1.11, which offers such a list of the rival claimants for the title of the cause of human birth (for a detailed study of the *Suśruta Saṃhitā* passage, see Bhattacharya 2007 pp.187-193).

Chattopadhayaya, however, altered his position drastically in 1991, taking a 180 degrees turn. Instead of following the majority of the commentators and translators of the *Śvetāśvatara Upaniṣad* he elects to follow *pseudo-Śaṅkara's* elucidation which he had previously refuted'. He does not take yoniḥ in the sense of female principle or prakṛti anymore; he now takes it in the sense of cause — 'that which gives birth to' (1991 p.46). The number of the rival claimants for the title of the first cause is thus reduced from seven to six: any reference to or even hint at *Sāṃkhya* is missing, although this was Chattopadhyaya's major concern in 1969. However, he writes in 1991:

"The difficulty crops up with the use of the word yoni which literally means the female generative organ. A number of interpreters are inclined to see in this a reference to the Samkhya view of prakrti or its prototype, the reason being that prakrti in Samkhya is considered essentially as a female principle. Such an understanding, however, has appeared to us as somewhat far-fetched. Our feeling, on the contrary, is that we have perhaps a more coherent understanding of the entire passage if the word yoni is taken in the sense of the ‗cause' – that which gives birth to'. From this point of view the word requires to be connected with the different alternatives suggested as time (*kala*), etc. Accepting such an interpretation we have a reference here to six possible anti-theistic views concerning the ultimate cause of the world. . . (1991 p.46)"

THE REASON FOR CHANGE IN ATTITUDE

What made Chattopadhyaya give up his original stand concerning the interpretation of *Śvetāśvatara Upaniṣad* 1.2? It is not possible to be certain about this turn-around. However, I may offer one possibility tentatively: so long as he was working in the domain of philosophy and religion (theism versus atheism) he had a stake to include *Sāṃkhya* (which, following Richard Garbe, Haraprasad Shastri, Heinrich Zimmer and others, he considered to be originally non-vedic. See Chattopadhyaya 1960/1980 p.29). On the contrary, when he came to look at the doctrines mentioned in the *Śvetāśvatara Upaniṣad* not as philosophy per se but as providing the theoretical fundamentals of natural science (this is a part of the sub-title of his 1991 volume), he chose to ignore the mystic view of the female principle. The passage in the *Suśruta Saṃhitā, Śārīrasthāna* 1.11 (mentioned above), too, was subjected to reinterpretation:

It may not be wrong to conjecture that what is referred to as the *Theory of Yoni* in the *Svetasvatara Upanisad* is more explicitly mentioned in the *Susruta-samhita* as the *Samkhya* view of the *prakrti* undergoing *parinama*, though we have taken the word to mean 'the ultimate cause' which seems to be more appropriate. (1991 pp.44-45)

This is how the theories of Time and Own Being (which he called the prototype of 'the laws of Nature') assume scientific dimensions in 1991; they are no longer treated as merely speculations. It is not that Chattopadhyaya was unaware of the importance of the Theory of Time vis-à-vis astronomy before this (see 1969 pp.51- 52). But he did not care much for it. The chapter on the theory of Time in 1991, however, ends with a quotation from *Vyāsa's* commentary on *Yogasūtra* 3.51, leading to the following conclusion:

"Thus, the concept of Time which had so much importance in astronomy, physics (as represented in the categories of the

Vaisesika system of philosophy) and rationalist medicine seems to lose relevance for a philosophy that had the withdrawal of interest from nature as its only ideal. (1991 p.54)"

A MILITANT HISTORIAN OF SCIENCE

Chattaopadhyaya was not just a historian of science but a militant historian. His work, *Science and Society* . . . (1977), exhibits an uncompromising attitude to the forces of reaction which is anti-science and promotes faith in premises that are not proved by observation and experiment. He had shown how the authors of the religious law-books (*Dharmaśāstras*) advocated cow-worship whereas the medical texts recommended the flesh of the cow and many other quadrupeds in their dietetics. It is, however, also true that the medical texts at the same time speak of devotion to the cow, the brahmanas, the gods, etc. Instead of leaving matters as they are, Chattaopadhyaya boldly put forward a theory of ransom, a kind of appeasement offered by the scientists to the powers that be, so that they could continue their work in their respective fields (astronomy, medicine, etc.). Later he also extended this theory to the case of the *Nyāya philosophy* as well (Introduction to Gangopadyaya 1982 pp.lxxxviii-lxxxix). It will be of interest if I cite a few instances.

Therapeutics suffered from an apprarently ineliminable ambivalence. The *Caraka* and the *Suśruta Saṃhitās*, having been redacted and revised over many generations, have come down to us in a strange shape: both science and its opposite appear to co-exist. The *Caraka Saṃhitā* is full of praise for gods, cows, brahmanas, preceptors, elders, adepts and teachers (1.8.18 and passim). People are warned not to speak against the brahmanas, nor to raise a stick against the cow (*na brāhmaṇān parivadet, na gavāṃ daṇḍa udyacchet*) (1.18.25). The premonitory symptoms of a particular form of exogenous insanity is said to be caused by the anger of the gods and others (2.7.11). What are the symptoms? They are the

proclivity to hurt the gods, cows, brahmanas and ascetics (2.7.11). There are so many other examples proclaiming the holiness of the cow in the *Caraka Saṃhitā* (see Chattopadhyaya 1982 pp.210-211).

Yet, beef is found to be recommended as the diet of the patients suffering from 'the loss of flesh due to disorder caused by an excess of vāyu, rhinitis, irregular fever, dry cough, fatigue, and cases of excessive appetite due to hard manual labour' (*Caraka Saṃhitā* 1.27.79-80).

This is only one of the many instances in which the flesh of cows, and of buffaloes, horses, goats, and even of elephants, are prescribed (see *Caraka Saṃhitā* 6.1.183). It is curious to observe that the learned authors of *A Review of 'Beef in Ancient India'* (1983) have taken no notice of the prescription of beef for patients in the *Caraka Saṃhitā*. The book is purported to be a refutation of Rajendra Lala Mitra's essay mentioned in the title. The omission of beef in dietetics in the *Caraka Saṃhitā* cannot but be deliberate. It may be pointed out in passing that the learned authors also bypass a passage in the *Bṛhadāraṇyaka Upaniṣad* (6.4.18) which advises a person, wishing to have a virtuous son, to eat, along with his wife, *'the meat of a vigorous bull or one more advanced in years' (aukṣeṇa vā"rṣabheṇa vā)*. The text and the translation of this passage are taken from Swami Madhavananda's *Advaita Ashrama* edition.

How could the recommendation of beef in the dietetics and the veneration of the cow on a par with the gods, the brahmanas and others be reconciled? One may speak of the special capacity inherent in the culture and civilization of India for admitting all discord and turn them into concord. Such a mystical quality, however, is not found when the powers that be, deal with what they consider to be heretical, heterodox, or downright non-vedic. So long as there is relative peace and prosperity, opposition to the mainstream ideas, is, or rather, can be, tolerated, at least up to a certain extent. The extent will be decided by considering the threat such opposition poses to the *varṇa* and *āśrama* system, the

model of social system in India formulated in the vedic literature and the *Kauṭilīya Arthaśāstra* (fourth century BCE). But when the ideas are irreconcilable, such as the protection of the cow and the recommendation of her flesh in the diet of a patient, the situation becomes precarious. The doctors could save their science only by paying lip service to orthodoxy, as did the astronomers. They, too, had to submit to the vedic view regarding the causes of the solar and lunar eclipses. *Brahmagupta* and *Varāhamihira* are cases in point. The worst was the fate of *Āryabhaṭa*. He had proposed a geokinetic hypothesis, as against the current geostatic view. Later writers on astronomy not only misinterpreted him; they also tampered the reading of the some of the crucial verses in the text of the *Āryabhaṭīya*, thereby making him say what he had never said, nor even intended to say (for the whole story, see R. Bhattacharya 1990-91 pp.35-47).

DEBTS NEVER DENIED

Chattopadhyaya was always ready to acknowledge the influence of several other scholars of the past. The first to mention is, of course, Joseph Needham (1900- 1995), who also wrote the *Foreword to History* (vol.1,1986, pp. v-viii). The veteran Sinologist exhibits his extreme modesty as also his appreciation of the team-work that went to the making of History. He stared off with these remarks:

"It is almost too much of an honour for me to be asked to contribute a foreword to this new book of Chattopadhyaya and the team of excellent scholars which he has gathered together to help him in the enterprise. When I was younger I thought I knew something about the history and the philosophy of India, but now I realise how little it ever was. Yet it is quite clear that the *History of Science and Technology in India* will bear comparison with that of all the other ancient civilisations, and I would like to congratulate the main author and all his colleagues on this

endeavour which they have brought to such a successful fruition. (dated June 15, 1986 in Chattopadhyaya 1986 p. v)."

Even before this, both Needham and Chattopadhyaya referred to and quoted from each other's works. As to the concept of the unity of head and hand, Chattopadhyaya was beholden to Benjamin Farrington (1891-1974), author of *Greek Science*, and a small book called *Head and Hand in Ancient Greece*. Chattopadhyaya also used J.D. Bernal's (1901-1971) *Science in History* as a handbook. He had the highest regards for V. Gordon Childe (1892-1957), not just as an archaeologist but as a polymath. When it came to the *History of Urbanisation*, Chattopadhyaya drew from Childe as also from Bernal. Mention must be made of George Thomson (1903- 1987), the Marxist classical scholar and historian of ancient Greek society, as also of the formation of Greek philosophy and science. The three volumes of Thomson's studies in ancient Greece,' *Æschylus* and *Athens* (1941, 1946), *The Prehistoric Ægean* (1949), and *The First Philosophers* (1955), served as a model to Chattopadhyaya. It was Needham, however, who wielded the greatest influence on him. He learned the necessity and value of team work from him.

ORIGINALITY IN APPROACH

Nevertheless, what is original in Chattopadhyaya is his penchant for linking philosophy to science on the basis of both philosophical and scientific texts. His intensive study of the two compendia of medicine and surgery in India provided him with a new insight into the working of the Indian social system. The custodians of the society demanded and successfully extorted the submission of science to credo. Such an enforced submission is epitomized in the faith in the infallibility of the Vedas. It was this subjection that led to the decline of science. This was a unique approach to the *History of Science and Technology*.

Although Chattoapdhyaya had learnt many things from his

mentors mentioned above (however, he had never physically met any of them except Needham and Thomson); he formulated a scheme which had no precedence in any history of science and technology of any country in the world.

Chattopadhyaya‘s plan was to work out the answer to the question raised first by Needham: Why didn‘t modern science arise in India and China despite their long and glorious tradition? Chattopadhyaya squarely blamed religious orthodoxy that stood in the way of further development of science in ancient and medieval India. It had doubtless been anticipated by P.C. Ray (1861-1944), a practising chemist and the first historian of chemistry in India. Ray held *Manu*, the law-maker, who showered contempt for manual labour and declared the human corpse to be impure. Ray further criticized *Śaṅkara*, the non-dualist *Vedānta* philosopher, who declared the visible world to be mere illusion; *māyā* (Ray 1903/1904 pp.192-196). What Chattopadhyaya did was to elaborate Ray’s thesis and prove with further instances how *Manu’s* view concerning the alleged impurity of the corpse ultimately led to the decline of surgery. He starts from the story of the ostracism of the two *Aśvins*, the Vedic gods of healing, by the rest of the gods. The reason was that the two brothers used to associate with humans, *manuṣyacarau* (for the whole story see Chattopadhyay 1977 pp.241-246). This democratic commitment of the physicians is also apparent in the *Caraka*- and *Suśruta-Saṃhitās*.

As to philosophy, Chattopadhyaya, too, considers the *Doctrine of Illusion (māyāvāda)* to have cast a negative influence. Instead of beginning with *Śaṅkara* he goes back to *Yājñavalkya*, the seer in the *Bṛhadāraṇyaka Upaniṣad*, who tried to convince king *Janaka*, his patron, that the objects of the visible world were no more real than those seen in dreams (4.3.9-13). Such an outlook, Chattopadhyaya concludes, can never be congenial or conducive to the spirit of enquiry into nature.

COLLABORATIVE WORK

The Appendices at the end of the first two volumes of *History* are contributed by a number of scholars, specialists in their own fields, such as archaeology, medicine and surgery, philosophy, technology, etc. Some of them are reprinted but most of them are specially written for this 'History'. Thus, a study of *Nyāya-Vaiśeṣika* system in relation to the *Caraka Saṃhitā* is printed along with a study of the use of iron and its relation to the second urbanization. The three essays by P. C. Mahalanobis (1954), J.B.S. Haldane (1957) and D.S. Kothari (1985) concerning the *Jain Doctrine of Relativism (Syādvāda)* reveal how old philosophical doctrines, as Engels asserted (1982 pp.30-31), can be of help in comprehending new thoughts, such as probability. Chattopadhyaya did not claim himself to be omniscient; hence he gathered round him as many authorities and researchers as possible. This gave his work a more complete appearance. He was also assisted by a number of young scholars who helped him by locating sources, both old and new, having a bearing on science and technology in ancient India. Thus, Chattopadhyaya's 'History' is a model of collaborative work. In this particular respect, he was doubtless indebted to Needham and Needham alone.

ACKNOWLEDGEMENTS

Sourav Basak, Tarun Basu, Amitava Bhattacharyya, Sunish Kumar Deb and Siddhartha Dutta. The usual disclaimers apply.

REFERENCES

Anon. 1983. A *Review of _Beef in Ancient India*. Gorakhpur: Gita Press, 1971. Enlarged second edition, Shree Krishna Janmasthan Seva-Sansthan, Mathura.

Bhattacharya, Ramkrishna. 1990-91. The Case of Āryabhaṭa and His Detractors, *The Indian Historical Review*, Vol. 17 Nos. 1-2.

Bhattacharya, Ramkrishna. 2007. Syncretism in the *Caraka- and Suśruta-saṃhitā-s*, Annali. AION – Università degli studi di Napoli L'Orientale, vol. 67 (published in 2011), pp.187-193.

Bhattacharya, Ramkrishna. 2006. Various views on *Svabhāva*: A Critical Survey, *Sambodhi*, vol. 30, pp.32-59.

Bṛhadāraṇyaka Upaniṣad. See EPU.

Caraka Saṃhitā, The. 1949. Ed. P. M. Mehta and others. Jamnagar: Gulabkunderba Ayurvedic Society.

Chāndogya Upaniṣad. See EPU.

Chattopadhyaya, Debiprasad. 1960/1980. *Bhāratīya Darśana* (in Bangla). Kalkata: K.P. Bagchi.

Chattopadhyaya, Debiprasad. 1982. Case for a Critical Analysis of the *Caraka-saṃhitā* (1979), in: Debiprasad Chattopadhyaya (ed.), Studies in the History of Science in India, vol.1, New Delhi: Editorial Enterprises.

Chattopadhyaya, Debiprasad. 1986,1991,1996. *History of Science and Technology in Ancient India*, vols. 1-3. Calcutta: Firma KLM.

Chattopadhyaya, Debiprasad. 1969. *Indian Atheism: A Marxist Analysis*. Calcutta: Manisha Granthalaya.

Chattopadhyaya, Debiprasad. 1959. *Lokāyata*. New Delhi: People's Publishing House. Often reprinted.

Chattopadhyaya, Debiprasad (ed.). 1984. Mathematics in the Making in Ancient India. Reprint of G. Thibaut's translation of the Baudhāyana Śulva-sūtra, edited with an Introduction by Chattopadhyaya. Calcutta: K.P. Bagchi.

Chattopadhyaya, Debiprasad. 1992. Prācin Bhārate Cikitsāvijñān (in Bangla). Kolkata: Paschimbanga Bangla Akademi.

Chattopadhyaya, Debiprasad. 2013. Science and Philosophy in Ancient India. Delhi: Aakar Books.

Chattopadhyaya, Debiprasad. 1977. Science and Society in Ancient India. Kolkata: K.P. Bagchi. Reprinted in 2014.

Chattopadhyaya, Debiprasad (ed.). 1982. Studies in the History of Science in India, vols. 1-2. New Delhi: Editorial Enterprise.

Engels, Frederick. 1982. Dialectics of Nature. Moscow: Progress Publishers

EPU Eighteen Principal Upaniṣads. 1958. Eds. V. P. Limaye and R. D. Vadekar. Poona: Vaidika Samsodhana Mandala.

Gangopadhyaya, Mrinal Kanti. 1982. *Nyāya* (trans. of the *Nyāyasūtra* and *Vātsyāyana's* commentary). Calcutta: Indian Studies.

Halbfass, Wilhelm. 1992. Competing Causalities: Karma, Vedic ritual, and the Natural World. Tradition and Reflection: Explorations in Indian Thought. Delhi: Indian Books Centre.

Hume, Robert Ernest. 1921. Trans. The Thirteen Principal Upanishads. London: Oxford University Press.

Kosambi, Damodar Dharmananda. 1975. An Introduction to the Study of Indian

History. Bombay: Popular Prakashan (first published 1956).

Mādhavānanda, Swāmī. 1993. Trans. The Bṛhadāraṇyaka Upaniṣad. Calcutta: Advaita Ashrama.

Marx, Karl. 1976. Capital, vol. 1. Harmondsworth: Penguin Books.

Müller, Friedrich Max. 1884. The Upanishads. Part 2. Sacred Books of the East, vol. 15. Oxford: Clarendon Press.

Needham, Joseph. 1986. Foreword to Chattopadhyaya, History, vol.1, pp.v-viii. Nyāyasūtra Vātsyāyana-Bhāṣya. See Gangopadhyaya, Mrinal Kanti and Tarkavāgiśa,

Phaṇibhūṣaṇa.

Olivelle, Patrick. 1998. Text and Trans. The Early Upaniṣads. New York: Oxford University Press.

Radhakrishnan, S. 1953/1990. Trans. The Principal Upaniṣads. Delhi: Oxford University Press.

Ray, Prafulla Chandra. 1903/1904. History of Hindu Chemistry, vol. 1, second edition. Calcutta: Bengal Chemical & Pharmaceutical Works.

Röer, E. 1979. Trans. The Twelve Principal Upanishads, vol. 1. Delhi: Nag Publishers (reprint).

Suśruta Saṃhitā. [1980]. Ed. Vaidya Jadavji Trikamji Acharya. Varanasi: Chaukhamba Orientalia.

Śvetāśvatara Upaniṣad with the commentaries of [Pseudo-] *Śaṅkara, Śaṅkarānanda, Nārāyaṇa*, and *Vijñāna-Bhagavat*. 1905. Poona: Anandasrama.

Tarkavāgiśa, Phaṇibhūṣaṇa. 1988. *Nyāyadarśana Vātsyāyana Bhāṣya*, vol. 4. Kalkata: Paschimbanga Rajya Pustak Parshad (first published 1333 Bangla Sal = 1926-27 CE).

Thibaut, G. See Chattopadhyaya (ed.) 1984.