Kosambi's Vision of Science

A Critical Appreciation

M G Narasimhan

Damodar Dharmananda Kosambi (1907–1966) was an eminent mathematician, scientist, innovative Marxist, a maverick scholar, and historian of contemporary India. Combining both versatility and a certain sense of virtuosity Kosambi made seminal contributions to a wide variety of disciplines spread across from pure and applied mathematics to archaeology and Indology. In the course of these writings he provided an incisive analysis of various developments in science and technology and novel perspectives on many topics related to mathematics (especially in number theory and statistics), genetics and India's past history, present concerns, and future growth.

Narasimhan is presently working as Deputy Programme Coordinator in NIAS. Apart from coordinating various DST sponsored programmes, he works in history and philosophy of biology with special interest in studying theoretical and applied aspects of evolutionary biology.

1. The Making of a Scientist-Savant

Born at a time when major transformations had begun to shake the world at large in scientific, political and economic terms, Kosambi's early life and education were shaped by an unusual set of influences and factors. Kosambi's father Dharmananda Kosambi was a redoubtable Buddhist and Pali scholar, whose ascetic personality was characterized by a deep commitment to a life of learning, scholarship and total disinterestedness in matters of acquiring riches and fame [1]. Kosambi was deeply influenced by his father's dedication and always strove to emulate him in terms of excellence of scholarship.

Early in his life, i.e., in the later part of the second decade of the last century, Kosambi accompanied his father, who had to go to America to work in Harvard University on a project related to Buddhism. Before his trip to America, Kosambi had received elementary education in The New English School in Pune. Even at that early age he clearly displayed his precociousness, although initially he was found to be weak in mathematics! Thus the most formative phase of his education was secured for Kosambi in a

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country where, in terms of his words, "(t)he libraries were unquestionably the best in the world for accessibility and range of books"[1]. It was here that Kosambi received his formal and informal education right up to graduation in mathematics and science.

Kosambi wished to pursue technical education initially, but due to a fortuitous combination of indifferent health and high intellectual potential, he shifted to a study of science from which he never looked back. Kosambi pursued his education in science and mathematics in the most conducive climate of Harvard University as that place according to Kosambi's biographer C D Desmukh was charged with science and technology[1] . He observes, "Damodar could discern how progress in these fields enabled America to advance in leaps and bounds. Plenty of literature in science and technology was available. Excellent books were stacked in best of libraries, waiting to be read. What more could Damodar expect? Endowed with a fond interest and an incredible speed in reading coupled with a photographic memory he read voraciously covering as many fields of knowledge as possible" [2]. In Damodar's own words, "Innumerable outlines made it easy to learn something about every branch of science"[1]. Desmukh adds, "Damodar made the best possible use of them all. *His impetuous, scientific, materialistic outlook was the result of this surcharged atmosphere. Since his adolescence he preferred the nature based philosophy of science to spirituality based on speculation regarding the world*" [1].

[1] [2], Note 2, p.10

Apart from this exposure to the secular world of popular science, Kosambi's early education was influenced by two other factors. First was the opportunity he had in meeting many erudite professors who were his father's colleagues. Of these early contacts, the friendship with Norbert Wiener was very important. Norbert was a child prodigy and became a world renowned mathematician and a founder of Cybernetics.

Second, as mentioned earlier, Kosambi's father also influenced his son's growth in terms of developing a proper outlook on

research and pursuit of knowledge. It was in this environment that Kosambi drew his inspiration and appreciation of the progressive and liberatory character of science. So widely read and deeply impressed did Kosambi become that he referred to the work of Einstein, Freud, Pasteur, and Barnard with awe and called them, especially the latter, as the real rishis and bodhisattavas of modern time. Thus located as he was in a conducive environment for education and equipped with his own desire for knowledge and learning, Kosambi performed very well in all the tests he had to face en route to his degree from Harvard University. In fact he had proven to be an outstanding undergraduate and therefore on graduation he received his 'Summa Cum Laude' and was also made a member of the Phi Beta Kappa Society. On completing his training in mathematics and deeply committed to it, Kosambi took to teaching and this was his main occupation till the end. In his capacity as a professional mathematician, Kosambi wrote more than 50 papers on various aspects of mathematics and statistics, perhaps not considered prodigious by today's standards, they were nonetheless, contributions of which he was quite proud. We will return to this point later.

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Although Kosambi shifted his attention to such disciplines as history, archaeology and Sanskrit studies, his training as a mathematician never quite left him and indeed enabled him to handle these subjects in a unique manner. As Romila Thapar observes, "Mathematics and not History was his primary discipline. However, the mind of the mathematician is evident not only in his application of statistics to some kinds of data, but even more in the search for clarity in organizing the data and the logic of the argument" [3]. In her view studying Kosambi repeatedly (which he deserved), one could experience, "the thrill of being provoked into thinking historically. But his thinking was not limited to the historical alone. It was enveloped by the perceptions of a firmly independent intellectual with a remarkably creative mind"[2]. In passing it may be noted that Thapar is not the only person to be impressed by Kosambi's original mind. The noted French mathematician André Weil was to describe Kosambi as a young man

[2] [3], Note 5, p.51.

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with an original turn of mind and that he was fresh from Harvard where he had begun to take an interest in differential geometry.

2. Kosambi's Contributions to Mathematics and Science

Writing in his autobiographical essay 'Steps in Science', which tells us about his journey from his choice of science as a critical area of study to social aspects of science and technology via reflections on natural philosophy and other topics, Kosambi gives a lucid account of his choice of mathematics and science as his domains of life-long study and enquiry [1]. In its explication of science as a problem-solving enterprise, Kosambi's approach to science is akin to Popper's philosophy according to which "All life is problem solving" (the title of a book in Popper's name). Kosambi's selection of science as his area of study and intellectual pursuit was both philosophically and politically oriented choice. In philosophical terms for him "solving scientific problems was as necessary as breathing"[3]. In terms of its political implications, the problem solving approach was necessitated in view of the fact that in a country (like India), where in spite of its millennial culture, progress was either non-existent or too slow and hence was in a state of decay.

[3] [1], Note 1, p.1.

The kind of scientific problems taken up for study was particularly dictated by the fact that in Kosambi's view, "age-long speculations on religious philosophy and theology, speculations entertained by the intellectuals had led to "persistently ignorant, backward and progressively enslaved conditions"[3]. He observed, "No advance was possible out of this decay without a modern technique of production, towards which the *intellectuals*' main contribution was through science,"[3]. It is in this context that Kosambi offers his original definition of science. According to him, "*Science is the cognition of necessity; freedom is the recognition of necessity*"[3]. Further, he observes, "*Science is also history of science. What is essential is absorbed into the general body of human knowledge, to become technique*" [3].

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Marxism, which he had imbibed from his father and he had studied critically. As a result he subscribed to its principle idea of Dialectical Materialism, the basic tenet of marxism. Kosambi's adherence to Marxist philosophy was singularly free from blind attachment. This is clearly demonstrated by his modification of Marx's well-known definition of history. For Marx, "History is the development in chronological order of successive changes in the means and relations of production". Kosambi arguing that this definition is unsuitable in the Indian context, modifies it accordingly. In a similar manner after referring to the classical Marxist definition of freedom wherein "Freedom is the recognition of necessity", Kosambi adds, the aforementioned definition of science. Along with this definition linking three crucial concepts – science, necessity and freedom – Kosambi provides a historical perspective within which the growth and development of scientific knowledge needs to be studied.

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Kosambi's reference to necessity in the context of freedom is linked to Hegel's well-known statement, 'Freedom is the recognition of necessity' and 'Necessity is blind in so far as it is not understood'. Engels (Marx's collaborator and friend), while drawing attention to this point made by Hegel, offers his own explication: "Freedom is knowing what the laws of nature are and how we can use them "towards definite ends." This is true both for the natural (or external) realm (physics, chemistry, etc.,) and for the inner or mental realm. These two sets of laws can be separated conceptually (the physical and mental) but they are actually one set in reality. "Freedom of the will therefore means nothing but the capacity to make decisions with the knowledge of the subject". In addition what this means is, "The more knowledge you have, the more educated you are about things you are dealing with, the FREER you are in dealing with them and at the same time the more NECESSITY comes into play... i.e., of knowing what necessary actions must be done to attain the goal sought". Engels says, with respect to the will, "the uncertainty, founded on ignorance, which seems to make an arbitrary choice among many different and conflicting possible decisions, shows precisely by

this that it is not free, that it is controlled by the very object it should itself control. And since freedom increases with knowledge of the world it, like equality, and law and morality, is "necessarily a product of historical development" (cited in Riggins [4]).

In the light of these observations we can see that Kosambi's pursuit of mathematics and science was inspired by a kind of purposiveness right from the start of his career. Kosambi's first paper titled 'Precessions of an elliptical orbit' was published in the *Indian Journal of Physics* in 1930 and his last unpublished book was on number theory in pure mathematics.

Of the several topics which attracted and engaged Kosambi's attention statistics occupied a very important position. At this point it would not be amiss to mention the fact that statistics was one of the leading scientific endeavours in the country during the first half of the 20th century as can be witnessed in the pioneering contributions made by P C Mahalanobis*, C R Rao and J B S Haldane#. In his autobiographical essay Kosambi explains the need for statistical analysis of various aggregate entities such as aggregates of living and non-living matter. Kosambi's work in statistics was based on his understanding that as far as human society was concerned, the net behavior of the group smooths out the vagaries of individual action. He adds that "modern statistical method can be an excellent guide to action. It extends the assurance of exact science to biological and social sciences".

*See *Resonance*, Vol.4, No.6, 1999.

#See *Resonance*, Vol.3, No.12, 1998.

Kosambi's biographer Deshmukh draws attention to the fact that, not withstanding Kosambi's abiding commitment to his favourite discipline, he did not achieve full acclaim as a mathematician par excellence. In accounting for this failure Deshmukh comments, "(d)espite his deep and lasting interest in mathematics, Kosambi failed to make many solid contributions in that field" [5]. One of the principal reasons for Kosambi's failure was the fact that he was interested in too many pursuits without focusing attention on his subject, a tendency which he had developed (much to the chagrin of Prof. Birkoff) even as a graduate student in the US.

While Deshmukh's comment is quite correct, a couple of papers were successful in influencing further research in diverse fields. In particular, Kosambi's paper, "The estimation of map distances from recombination values", published in *Annals of Eugenics*, 1944, has proved to be very influential in the field of genetics, especially in the area of Quantitative Trait Analysis. The paper was also responsible for eponymously establishing the 'Kosambi Map Function' in the field of genetics. Reflecting on this "unexpectedly successful" paper, Kosambi notes with some satisfaction that, "It seems to have given a new lease of life to genetical theories…"[4].

[4] D D Kosambi, Steps in Science, Note 1, p.7.

Another significant achievement of Kosambi was in the area of applying geometrical approach to statistics. As C K Raju points out, Kosambi seems to have been the first person to have discovered what is today identified as Proper Orthogonal Decomposition and also known as in the Karthunen–Loeve Expansion [6]. This is a mathematical procedure widely used in fluid mechanics and the study of such complex phenomena as turbulence. Paradoxically, those disciplines such as history and archaeology on which Kosambi worked later benefitted from his novel approaches and techniques, so that it can be said that mathematics' loss turned out to be history's outstanding gain. It is for this reason that Kosambi the historian is better known than Kosambi the mathematician.

3. Kosambi on the Nature of Mathematical and Scientific Knowledge

As technical aspects of Kosambi's contributions to mathematics and science would be covered by other scholars, I will focus here on his 'meta-mathematical' and 'meta-scientific' observations which he offers in the light of his own theoretical position and practice.

We have seen that Kosambi describes his primary motive for choosing mathematics as his basic field of study, in terms of its rigour and clarity. He confesses that he was drawn to mathematics

because he could not resist its fascination. From his view point, "mathematical results possess a clarity and give an intellectual satisfaction". Added to this aesthetic aspect, Kosambi states in an almost platonic vein that mathematical results, "have absolute validity in their own domain, due to the rigourous logical process involved, independent of experimental verification upon which applications to the exact sciences must depend"[5]. Mathematics, Kosambi avers in a language reminiscent of Galileo's famous description of the book of nature as having been wriiten in mathematical language and invokes a quotation from Roger Bacon to make a similar point. According to Roger Bacon "*Scientiarum clavis et porta*", meaning "Mathematics is the door and key of Sciences".

[5] D D Kosambi, 'Steps in Science', Note 1, pp.3–4.

Having arrived at an explicit leitmotif for his work, Kosambi offers several interesting observations concerning the nature of mathematical and scientific knowledge. Due to constraints of space it is difficult to do justice to Kosambi's insightful comments in this context. Here I wish to focus on two important issues emerging from Kosambi's observations. Firstly, I have already referred to Kosambi's definition of science and his historiographic perspective within which scientific knowledge needs to be studied. In his essay '*Science and Freedom*', Kosambi offers several important observations on the nature of science. According to him, "Science is direct investigation of properties of matter, hence materialistic" [7]. From a Marxist view point, this is an important statement. He further states, "Science knows only one test – that of validity – of material proof. Science is nothing if it does not work in practice"[6]. From this it can be seen that scientific results are autonomous, in the sense, that they are independent of the individual who carries out the experiment, i.e., the same action gives identical results. In addition, scientific inquiry relates to the search for causes and effects and hence for this reason it is cumulative, i.e., "Science is the history of science". The cumulative nature of science is seen in the fact that every major discovery in science is absorbed into the body of human scientific knowledge, to be used thereafter. As an

[6] D D Kosambi, 'Science and Freedom', Note 17, p.21.

illustration for his argument, Kosambi points out, "School boys can repeat Galileo's experiments, and first year college students learn more mathematics than Newton knew". Commenting on the relations between theory and practice in science, Kosambi declares that the two concepts cannot be separated or divorced. What this implies is that scientists, while prone to holding a wrong theory, keep on "making better and better approximations to the truth, knowing that there is no final truth simply because the properties of matter are infinite and inexhaustible"[6].

The second point that Kosambi refers to is concerned with the distinction made between the exact and descriptive sciences. The basis for this distinction is linked to the question whether they are based upon a mathematical theory or not. Kosambi qualifies this statement by admitting that this distinction no longer holds because the biological sciences have begun to feel the need for exact numerical prediction, whereas physics and chemistry have discovered that at the level of individual particles such exactness or precision is not possible. So in order to get this need for precision fulfilled, both have found "the new mathematical theory of probability"[7], a theory which would provide solutions to their problems. Given these reasons one can say that "Science acts by changing its scene of activity"[7]. And that "there is no science without change"[8]. In addition to these observations Kosambi refers to the interrelation between scientific experiment, production and necessity. Arguing that, "science is not mere accumulation of experimental data. No experiment is great unless it settles some disputed theory; no theory is a striking advance unless it explains puzzling experimental data, or forecast the results of unperformed experiments"[9], Kosambi points to a nexus between science and production in context of the emergence of the scientific center of Europe. In the majority of observations that Kosambi provides, he emphasizes the role of socioeconomic forces and institutions in influencing and moulding the nature, structure and function of scientific knowledge as can be clearly seen in this passage:

[7] D D Kosambi, Science and Freedom, Note 17, p.28.

[8] D D Kosambi, Science and Freedom, Note 17, p.29.

[9] D D Kosambi, Science and Freedom, Note 17, p.23.

"We observe, then, that to recognize the necessity implies scientific experiment; in addition there is a technical level which cannot be divorced from the experimental. Finally there is a social structure, that is not only intimately connected with the technical level, but also conditions the freedom of the individual by introducing a *social* necessity that in the abstract seems unnecessary but exists nevertheless"[10].

[10] D D Kosambi, 'Science and Freedom', Note 17, p.19.

4. Conclusion

The above discussions demonstrate the formidable scholarship combined with a wide variety of analytical skills and arguments, which Kosambi brought to bear on many critical issues. They also prompt us to ask whether there is an explicit or implicit Weltanschauung (a comprehensive worldview) associated with his analysis and critique. It can also be asked whether Kosambi's view, specially the political ones, have the same significance or relevance, it had earlier, under the vastly altered conditions where we are confronted with the fall of the erstwhile Soviet Union and the emergence of the United States of America as the sole arbiter of ideology and development in the world at large. The same set of questions of contemporary relevance can be asked in the current context of such revisionist movements as 'Post-Marxism' and 'Postmodernism'. All these questions need carefully considered responses. However, it is possible to respond to these issues in a limited way. As has been suggested, Kosambi was a deeply committed Marxist thinker. His understanding of Marx was quite different from others whom he derisively called as "Official Marxists". A clue to what could be considered as Kosambi's position is seen in the quotation from Nehru which can be found in his collection of essays 'Exasperating Essays'. In this excerpt from his autobiography, Nehru observes, "The whole value of Marxism seems to be in its absence of dogmatism, mode of approach, and in its attitude to action.... The success or failure of the Russian social experiments do not directly affect the validity of the Marxian theory, [8]. How one does wish that this understanding of Nehru could be made

available to all those who felt that with the collapse of the erstwhile Soviet Union, Marxism also fell apart.

In conclusion, a deep study of D D Kosambi's life, work and accomplishments show that he was a brilliant and original scientist who was committed to the idea that knowledge in whatever form one pursued and acquired should not be treated as an end in itself, but made to sub-serve such emancipatory goals as social and political transformation which would make available the best that human mind and ability could offer to humanity.

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Suggested Reading

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Address for Correspondence
M G Narasimhan
National Institute of Advanced Studies
IISc Campus
Bangalore 560 012, India
Email: narasimhanmarehalli@gmail.com