BOOK REVIEW

Sacred Bovines - the ironies of misplaced assumptions in Biology

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DIALOGUE
Science, Scientists, and Society

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This is an interesting book dealing with the Sociology of Science. The origin of experimental science in the modern sense can be traced to the 15th century Renaissance period. Of course, scientific inquiry was being conducted in many civilizations much before the European Renaissance. Through colonial rule, this post-Renaissance European science, also called western science or Modern science, spread to the rest of the world. Though sometimes defined in the pure sense as a deductive logic-driven (hypothesis driven) activity, science in practice, however, employed many other additional approaches including inductive reasoning, reflective thinking and others. This curiosity-driven activity was named Natural Science to distinguish it from Natural Philosophy. Natural Science is akin to Philosophy as both seek the TRUTH.

Science deals with natural phenomena. It seeks patterns and mechanisms (cause and effect) underlying natural phenomena including living processes or biological phenomena. In the last 500 years, science and technology have grown enormously and attained central importance in dictating and driving national development in many countries. Many thinkers have analyzed this activity called Natural Science and have commented on it. Rationality-driven science has also come into conflict with socio-economic-cultural characteristics of societies, which practice and apply science and technology in solving societal problems and to fulfil national aspirations. Many sociologists have reflected on the mutual interaction between science and society (read educated layman).

The art of doing science has become a technology by itself. This is more relevant in the field of Biology. Ethical problems also crept in when science became an enterprise, especially in the developing countries. Douglas Allchin reminds us that even in the advanced countries which gave us science, ethical problems have arisen. Public perception of science and scientists also got increasingly romantic or hostile depending on perceptions. In many cases, scientists themselves were to blame for hostile reactions from the society. Scientific breakthroughs were being presented as stories of heroes and results of extraordinary intuitions. Certain scientists and pharmaceutical manufacturing industries made unjustifiable and false claims as well.

This book discusses over twenty-five scientific research reports, all of which have had a large impact on research and education in the field of Biology. Some of them were perceptions

transmitted through oral (teaching) or written (reviews of fields and ideas) routes. Some were conceptual breakthroughs and brought about a 'paradigm shift' in our understanding of those areas of Biology. The author has taken great pains to obtain anecdotal details about each of these major developments in Biology and related areas. Two aspects of these discoveries/developments have been analyzed in detail by the author. First, in terms of assigning academic credit, Allchin has shown that someone who got recognition and awards and were in limelight did not deserve more than some others who may or may not have gotten their due recognition. The author carefully distinguishes 'recognition by peers' and 'recognition by award committees.' Second, in some cases, the author tries to prove that society (peers) misunderstood and misrepresented a particular research work. The fallout has been misleading to the public as well as experts in the area. He particularly cites Darwin's work and how some peers misinterpreted some of it to promote their own ideas, thus creating a social dilemma and 'mental unrest' in the public.

This book discusses, through case studies, one such abnormal behavior among some scientists and teachers of science. This refers to 'sustaining certain misplaced assumptions' leading to what almost amounts to 'myth construction' among elite scientists as well as among non-experts. This book of 28 and odd chapters is divided into 7 sections, each of which conveys a 'misconception of science' in popular mind (read educated layman including teachers of the domain knowledge). The book is a set of essays written with great care about many 'misconceptions' in Biology which are propagated, as the author says, through teaching, even by great teachers. It is an easy read. There is nothing to contest as all the case studies are true. However, the mindful reader should know that 'good and critical-minded teachers' do not carry these misconceptions/misunderstandings' in their minds. The critical minds are constantly on the vigil to correct their lecture notes in the light of new developments or new research findings as well as historical aspects of a research work in a particular domain. A good teacher does not simply exchange second-hand information. He/she also studies the domain from many perspectives i.e. how factual is the information/idea, or how to avoid making value judgments, finding out any differences in the textbook from the actual content in the original paper(s), etc. In summary, a good teacher distinguishes, after investigation, content from the intent and does not exaggerate the importance of a finding and does not convey misconceived 'facts.'

There are some chapters that do not seem to fit into the theme of this book. One such is chapter 3. This is about the famous cell biologist Alex Novikoff. The author has convincingly demonstrated that Novikoff's work, including the discovery of Lysosomes and GERL, was influenced by his belief in Marxism or dialectical materialism i.e. the synthesis of opposites (in this case Organicism and Reductionism, the two mutually exclusive perspectives of what is Biology) to understand biological functions/processes. Academic institutions have to be insulated from political interference is a generally accepted idea. It is applicable to any creative activity. That does not imply that academic people should or should not be associated with political parties. I can think of another brilliant scientist, J D Bernal who was a staunch believer in Marxism and whose monumental work 'Science in History' has influenced many people including scientists. Bernal's celebrated student Dorothy Hodgkin went on to receive the Nobel Prize for her work on X-ray crystal structure of biomacromolecules. Both Novikoff and Bernal paid a heavy price for their beliefs. But what does all this mean? Is the sacred

bovine the misconception that scientists should keep a distance from politicians or political philosophies?

The famous Meselson and Stahl experiment in Molecular Biology is discussed in chapter 4. The author asserts that many messy experiments preceded the final elegant experiment that is part of textbooks. As is presented in textbooks, this breakthrough work which provided elegant proof for the semiconservative mode of DNA replication in the area of Molecular Biology is a typical hypothesis-driven experimental design and execution whose results were consistent with the hypothesis. The author is unhappy that books do not tell us about the mess and confusion that exists in the minds of the scientists preceding the final results of an experiment. The author gives anecdotal historical details of how the final experiment was not conducted in one go and nor was it designed and conducted in a day's work. Two scientists met by chance. One had a technique and the other had a problem. Wrong ideas were given by some mentors. Through mental agony, failed explorations and chaotic results, clarity eventually emerged on the choice of technique, and the correct answer, elegant and self-consistent, came out. The sacred bovine that is alluded to is the habitual presentation of scientific breakthroughs as simple, easily conceived and successfully executed clean experiments. We know that this is far from the truth. The author asserts the same idea. The sacred bovine is the habit to present science as a series of inspired work by superhumans endowed with extraordinary insights.

In chapter 5, the author attempts to show that the canonical deductive logic is not the only way science is done. Nobody, of course, denies this. Inductive reasoning, reading, consultation, collaborative experimentation, discussions, etc., are all part of doing good science. The author attempts to show that the pursuit of science, in reality, is far from being idealistic and patterned work. There is nothing new in this revelation. It is not very clear what is the sacred bovine in this context.

In chapter 6, the author refers to a well-known sacred bovine i.e. 'Social Darwinism.' Herbert Spencer coined the phrase 'survival of the fittest.' Darwin did not use this phrase. Observing that the fittest people only survive in a modern human society in a struggle for existence and that invariably such successful people are deficient in morals and values in life, people tried to generate support for various supremacist ideologies in Darwinian ideas on the evolution of organisms. Obviously, this is a very naïve understanding of Darwin and his idea of evolution. To misunderstand the implications of Darwinism and then to blame Darwin for 'perpetuating falsehood' is, to say the least, not being fair to the great man. The author refers to a number of social thinkers who misinterpreted Darwin's sayings and applied them to human behavior and socio-political prescriptions. Darwin has written volumes on the inevitable evolution of morality in all eusocial groups. It is a consequence of living in groups (society), i.e. social organization of living. One can observe the same phenomenon in eusocial insects and other animal groups. Social instincts automatically become transformed into moral principles. Darwin wrote about four conditions for the evolution of morality. Individuals may be selfish but social good overcomes this. It is a learnt behavior that can eventually appear like instinct. Darwin always advocated compassion towards the weak. He had ten children whom he treated equally. The author has done great service in bringing out the fallacy in drawing wrong conclusions from the idea of 'Selfish Gene.' Social Darwinism is not Darwin's idea.

Malthusian ideas on competition for resources led to appropriating Darwinian ideas of evolution by Natural Selection and applying to human behavior. The author has done well in denouncing this aberration and mischievous interpretation labelled Social Darwinism – "another sacred bovine" in the words of the author. In fact, the author has coined a new phrase 'Amplification of the Adapted' instead of the 'survival of the fittest.'

Another sacred bovine that the author deals with is through the discussion of the work of Joseph Priestley, Ingenhousze and others in the context of the discovery of Photosynthesis. Priestley observed that plants restore good air by removing the bad air caused by putrefying dead mice in a closed jar. Plants can make a candle burn for a longer time in such model systems. Many people including Priestley could not reproduce these results later but had received the Copley medal from the Royal Society by that time. Later, Priestly made another mistake by claiming that sunlight alone can do the same job; plants are not necessary. It was Ingenhousze who corrected all the details and showed that plants in the presence of sunlight can restore good air. It led to the discovery of photosynthesis. The author calls Priestley's work as a comedy of errors. He names many more like Linus Pauling, Francis Crick, James Watson, Paul Boyer, Peter Mitchell, Szent-Gyorgyi, Paul Ehrlich and Ilya Mechnikov, who were celebrated scientists but had made wrong claims for which they were not censured. The author says that sacred bovines like these (i.e. the mistakes they committed wasting huge amounts of public taxpayers' money) are never told in the books. They are hidden from the public knowledge. Thereby a myth is created that these scientists are infallible. Let us remember that all these great scientists deserved their honours. Their overall contributions make the few mistakes they made and admitted to, insignificant. It does not lessen their greatness. What the author wishes to say is that Nobel Laureates also make mistakes. Of course, all of us know this. Many more examples of such mistakes can be brought out (Arthur Kornberg, Severo Ochoa, Theodore Winnick, Christian Anfinson, etc.). Further, many Nobel Prize-winning works have been shown to be wrong by other scientists in later days. The fact that science is self-correcting is of utmost importance. Others correct errors or clarify misunderstandings. It becomes a sacred bovine if we continue to honour certain scientists for the mistakes they did! No good teacher or scientist would only blame them for the errors and not respect them for their contributions!

There are many chapters in the book that deal with some aspects of science in practice but these do not deal with the central theme of this book and hence are not commented upon. These chapters, in fact, deal with unethical practices in science. That deserves a separate book! But these tragic stories have to be told. Ignaz Semmelweis introduced the practice of hand washing for all doctors handling childbirths. He had observed that most of them directly came from theatres where cadaver dissections were being conducted. Though the idea of infection or germs was not there, Semmelweis, for hygienic reasons, advised handwash procedures. The number of child deaths during or after birth drastically came down. Yet his colleagues harassed him, insulted him, and made him leave the hospital where he was employed. The author has hinted at racism having a role in this sad episode. This is not an example of sacred bovines but an ethical problem. The author has also written about pseudoscience practices by many quacks who advertise about miracle cures!

A particularly disturbing sacred bovine is hiding the contradicting data from scrutiny by peers or even laymen. In the area of Evolutionary Biology, a famous research work taught as an illustrative example for Natural Selection is the story of peppered moth from England. The story has been told in black and white in the book. Before the Industrial Revolution, peppered moth was dominantly visible, while after the Industrial Revolution, it was melanic moths. The story in this chapter explained that predation by birds was the selection force. If one were to examine all the publications and all data, one does not get the popular version (what is in the textbook) of this story! In another equally, if not more significant case, Mendel's work on pea plants, and subsequent work by others had shown no such clear dominance inheritance pattern or numbers especially in the case of round vs. wrinkled seeds. Mendel had studied more than 20 phenotypic characteristics. He had actually rejected many that did not segregate clean in the F2 generation nor gave clean ratios like 1:2:1. But the textbooks do not write about all this. In fact, Bateson, Correns or Tchermak could not reproduce Mendel's patterns. How did Mendel become the icon and hero and father of Genetics, asks the author! Why is then the ideal story being repeated in textbooks? This is the real sacred bovine that scientists have to answer!

Many other misconceptions have been discussed by Allchin in this book. An interesting case is about William Harvey who is credited with the discovery of blood circulation. Malpighi actually saw capillary network joining arteries and veins. Literature quotes him as saying that he only confirmed Harvey's prediction but Harvey neither could see capillaries with naked eyes nor predict their existence. He wrote about closed circulation without discussing where arteries end and how veins get blood into them!

Allchin writes about another sacred bovine in chapter 21. This time it is about the misplaced credit to Alexander Fleming for the discovery and use of Penicillin - the wonder drug. During that period, many scientists were looking for antibiotics. Chances of a penicillium mold spore landing on the bacterial lawn plate in Fleming's lab from the air was zero as the author recounts. It must have come from a neighbouring lab. Many others made similar observations. Fleming had actually thrown that historically important culture plate into the sink for washing in detergent! Fleming never believed that penicillin can be produced in enough quantities to take to human trials. But for Ernst Chain and Howard Florey, penicillin would never be known as a wonder drug. It is their confidence and conviction that made them produce large quantities of the antibiotic for clinical trials. Fleming never attempted. The author hence, for justified reasons, believes that a myth was built around the whole work and Alexander Fleming was presented as a hero with extraordinary intuition. The author calls it a 'myth-conception.' A myth-conception, the author says, "constitutes an effort to naturalize an imagined ideal into the history of science." I must add that for large-scale production of Penicillin and saving thousands of American soldiers in World War II, another scientist deserves equal credit if not more, and that is Dr. Yellapragada Subbarow, the greatest medical researcher of all times and who deserved not one but six Nobel prizes. He did not get any!

In summary, Douglas Allchin brings two sacred bovines to our notice. One, that there is a lot of misrepresentation in textbooks and classrooms about scientists or scientific breakthroughs. Some are outright myths that continue to be. We should ponder on the ways in which these

stories sustain and a large section of scientists/teachers is not aware of the facts. And two, a large number of cases where undeserving scientists have gotten credit/recognition while the real heroes have died unsung and unrecognized. While we know that science, as a philosophy, has built-in safeguards against falsehood. It is a self-correcting system. It is like a living organism that is self-regulating, self-referring and self-replicating energy system. Reproducibility of results/observations eliminates all falsehood. Lysenkos cannot last long. There is a lot to be done to improve the running of the scientific enterprise, especially in the third world countries. Much of the problem can be solved if we nurture a healthy peer review system. It should be made both competent and honest. In every branch of science, especially in Biology, interpretation has changed over the years, but the data remains the same. Many scientists who said something and were recognized have either themselves revised their stand or have been proven wrong by others. Hence, any expert or a good teacher corrects his/her understanding. However, public (educated layman) memory is rooted in the past. That does not get updated or revised. To blame the original scientist for this is being unfair. Science is self-correcting, undoubtedly. The author has misunderstood this as a self-made correction. Big scientists do not give up their pet ideas. But the system corrects the faults in the due course of time. For instance, Koch's idea of cholera toxin being an endotoxin remained for 75 years until S N Dey disproved it.

This book is highly readable and very educative. In the words of Karl Popper, a non-falsifiable knowledge is not science. There are built-in checks and balances. To quote Thomas Kuhn, "Science progresses by *paradigm shift*." Sometimes new data come which demand new interpretation of old data. History of science is very interesting to read but very difficult to write upon. Let us also remember that history is a social construct. Facts, however, do not change. No honest scientist intentionally misleads others. I recommend this book to the students of advanced science and those who are interested in the History, Philosophy and Sociology of Science.

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