Dialectics of Science

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Modern science, as people know it today, is the daughter of the European Enlightenment. That age of intellectual ferment beginning in the early 18th century established “reason”, instead of divinely ordained revelation, as the basis of knowledge. At its core was the questioning of traditional institutions, morals, and customs which had previously upheld the supremacy of the church in the intellectual sphere, and feudal relations in the social sphere. In this intellectual atmosphere, science, the process of systematic pursuit of knowledge, underwent a huge qualitative change from its earlier reliance on scriptures and classical Greek authorities like Aristotle, into a methodology dependent on reason, critical questioning, and establishment of a clear relationship between cause and effect by direct observation. As Rene Descartes, one of the intellectual giants of the Enlightenment, famously declared, and Karl Marx, probably the most complete intellectual offspring of the Enlightenment, adopted as his favourite motto, “de omnibus dubitandum”, that is, “Doubt everything”, became the reigning methodology of scientific enquiry. Based on this methodology of critical questioning emphasized by the rationalists like Descartes, Spinoza and Leibniz, and the complementary methodology of direct observation emphasized by empiricists like Locke, Berkeley and Hume, modern science was born, and further developed over the period of three hundred years. Therefore science, as is it today, is considered to be an objective understanding of nature, a system of knowledge that explains the material basis of reality, independent of the nature of the observer and transcending the social or political conditions of the time. Modern science is one of the greatest intellectual triumphs of humanity, as man has taken a giant leap forward from the infancy of his curiosity, when every natural phenomenon bore divine or diabolical agency, to an age where all of his questions seem to be answerable under the powerful illumination of science. Science seems to have revealed objective truths about material reality, truths independent of the time and space of their discovery, truths for all ages, truths that give science the aura of transcendence. And attesting to this power of science has been the great advances of technology that have sent humans to the moon and given the world insights into the very basis of life.

As practicing scientists, this aura of objectivity of science gives people a sense of destiny, makes them feel that they are in the pursuit of understanding material reality as it is, independent of the subjective conditions around them. And to the lay person this makes science appear to be infallible and all powerful, representative of ultimate truths. However, this objectivism in science also opens the door to a mechanical materialism as science is now thought to deal with objective properties of matter that transcends the subjective conditions that might be a result of human activity, although science is essentially a human activity. It also gives rise to reductionism and determinism, where the properties of smaller and smaller parts of matter are thought to solely influence the properties of “wholes”, in increasing orders of magnitude. Marx, who had also arrived at a materialist conception of the world, however rejected this mechanical materialism, instead insisting on a dialectical analysis of nature that recognized that humans and nature exist in a

coevolutionary, and interactive, relationship. Engels' *Dialectics of Nature* was an unfinished attempt in this direction which was advanced by a generation of British scientists in the 1930's, who were committed to a historical materialist and dialectical philosophy. These scientists, Hyman Levy, Lancelot Hogben, JD Bernal, Joseph Needham, JBS Haldane, and historian/philosopher of science Benjamin Farrington—struggled to retain within the emerging natural sciences the possibility of dialectical uncertainty and opposed their reduction to the mechanistic materialism which has been the reigning philosophy of science. Growing out of the work of these early critical intellectuals, though undeveloped and still at times insufficiently dialectical, a more developed science grounded in materialist dialectics came to the fore in the 1960s and 1970s with the work of Marxist-influenced biologists—particularly Richard Lewontin, Richard Levins, and Stephen Jay Gould at Harvard, then the leading center of evolutionary biology. Their work provided a genuinely dialectical materialist approach to science that questioned some of the long-held beliefs about the transcendence of science and suggested that science, and its understanding is a product of the dialectical relationships between humans and nature and between humans and their social condition.

To understand this dialectical nature of science, one needs to look at the socio-economic context in which modern science was born and have henceforth developed. At the time when the Enlightenment was changing the intellectual horizon of Europe, the socio-economic conditions were also being fundamentally and irreversibly changed by the birth of a new mode of production, capitalism. As the Enlightenment was questioning the traditions that upheld the feudalistic relations of production, capitalism was breaking down the same production relations. The two processes were so complementary, that looking at it from the basis of historical materialism, one can understand that the material basis for the intellectual ferment that gave rise to the Enlightenment was actually the change that was happening in the way in which the productive property was owned and controlled, combined with the corresponding changes in the social relations between individuals based on their connection with the process of production. As the feudal nobility and the church was losing the ownership and control over the means of production and the serf, previously bonded to his feudal master and his estate, was becoming an agent free to sell his labour, the intellectual climate that had upheld these relations for the past five hundred years or so, was also disappearing. The idealism inherent in the philosophical thought of the previous centuries had looked at the world as an idealized place, divinely conceived and maintained, where man's relationship with nature, just as his relationship with other members of the society, was static and ideal. These ideas of stasis and stability were being fundamentally changed into a notion of natural and social evolution. Change was in the air, and change was in the thoughts of the intellectual giants of the time. And out of this ferment was born modern science, with the imprint of the times as its birthmark. Therefore, if the Enlightenment is the mother of modern science, the father is undoubtedly capitalism. And the new science, as it developed, carried the indelible marks of this birth, such that science, as people understand it today, is capitalist science. The concept of change, of impermanence, which was so important to the process of replacement of feudalism by capitalism, also became a central tenet of science. Just as the ideas of change in society were formalized and

systemized by Marx in his historical materialism, the concept of change in nature was ordained as the central tenet of the theory of evolution by Darwin, undoubtedly one of the greatest scientific achievements of all times. The idea of the constancy of change, rather than constancy itself, has become a central idea of science, and especially of biology.

Capitalism also put the individual as the central player in society. It was no more the church, or the nobility, or the royal families that owned the means of production in society. It was no more the serf tied to his master and his land by ancient feudal relations who was required for the mode of production that capitalism was engendering. Instead, it was the free individual, freed from the age-old ties of kinship and loyalty, from the hierarchy of the church, free to sell his goods and labour power, the bourgeoisie and the proletariat, who was the motive force behind the capitalistic mode of production. This new emphasis on the individual was celebrated in John Locke's Two *Treatises of Government*, where he stated that individuals in society had "natural rights", including the right to property. Locke's writing had great influence on the bourgeois revolutions of the 18th century, the American and French revolutions. This celebration of individualism in the social sphere left its imprint over scientific thought, in the form of Cartesian reductionism. Descartes contributed the idea of studying smaller and smaller parts of matter to understand the nature of material reality, and this methodology called "reductionism" is universally followed in science today. Reductionism placed the atom in the centre of the physical world, just as the individual occupied the centre of the social. This idea of the freely-interacting atom, free to make and break bonds with other atoms, gave birth to the atomic theory of matter and the to fields of nuclear physics, and to quantum mechanics, areas that have defined scientific enquiry in the 20th century.

Reductionism has also played a very influential role in biology. The rediscovery of the laws of heredity, originally formulated by the Austrian priest Gregor Johann Mendel, in early 20th century, gave birth to the field of genetics. Later, the discovery of the material basis of heredity, the gene, showed that it was this all important molecule, the DNA, which transferred genetic information from the parent to the offspring, and suggested that it could determine every property of an individual, from his height to his intelligence. The gene was accorded the same place in biology that the atom had been accorded in physics and chemistry. This gave rise to what is referred to as "genetic determinism", which, more to the awestruck common man than to the practicing biologist, meant a determination of every human trait and behaviour by the genes one carried. Bourgeois ideology, which sought to justify existing social hierarchies, has utilized genetic determinism to justify and rationalize social and economic inequalities in terms of domination that was biologically derived and teleologically predetermined—whether in terms of racism, sexism, or differences in intelligence. Posited against this, and somewhat as a reaction to extreme formulations of genetic determinism, has been a sort of superorganic holism, mainly in ecology. This holism preferred to look at entire ecosystems, at the sum total of the interactions between individuals or between individuals and the environment. These two schools of thought in biology, at many times in opposition to each other, went on along with the nature versus nurture debate that rages on in biology, where the

contention is whether it is the genes or the environment which controls and determines human traits and behaviour.

The above-mentioned biologists, Lewontin and Levins, and Gould, rejected these one-sided notions of mechanical reductionism and superorganic holism and the hierarchical conceptions of life and the universe that they both generate. Instead they suggest a dialectical and materialist approach that understands that the world "is constantly in motion. Constants become variables, causes become effects, and systems develop, destroying the conditions that gave rise to them". They propose that "things change because of the actions of opposing forces on them, and things are the way they are because of the temporary balance of opposing forces". This introduces a dialectical understanding of relations between organisms and nature. This is very important for biology, as biology is at the same time at the cutting edge of science today and is also close to lives as individuals and species. Understanding of biology influences people's responses to multiple issues of vital importance to the well being of the society and the world, from the Nazi conception of racial superiority, to the caste divides that still render the society apart, to the religious fundamentalist opposition to the teaching of evolution in US schools. An understanding of the dialectics of biology allows both practicing biologists and lay people to formulate responses to such issues without being overawed by the objectiveness and infallibility which are claimed for science.

The field of biology where the dialectical approach might probably play the most important role is evolutionary biology. Evolution by natural selection is the grand unifying theme of all modern biology and its proposition by Charles Darwin in his 1859 book *On the Origin of Species* was a monumental achievement in the history of science. However, Darwin's theory of natural selection was also formulated in the backdrop of the socio-economic context of his times, marked by the intense class struggle between the bourgeoisie and the working class in the well developed capitalist economy of contemporary England. Indeed, the Darwinian idea's of the struggle for survival and the survival of the fittest was influenced by the ideas of Thomas Malthus, who in his *An Essay on the Principle of Population* suggested that as the rate of increase of the population is greater than the rate of increase in available resources, there is always a competition for the limited resources which results in a segment of the population being relegated to poverty. Darwin's theory of selection between the individuals of the same species, based on their "fitness" or the ability to leave the maximum number of offsprings, was therefore a product of the intellectual climate of that heyday of capitalism. However, to suggest that the theory of evolution by natural selection was the product of a certain socio-economic context certainly does not detract from its validity as the most appropriate, and proven, explanation of the diversity and complexity of life.

Darwin elevated the conditions of existence—external selection pressures—to primacy in explaining evolution, so as to establish natural selection as the dominant force behind the evolution of species. However in this process, he established a view of natural selection as predominantly one-sided—i.e., the external factors were seen as largely determining the evolutionary process, and not as equally the consequence of the evolution of life. Whereas this ultra-Darwinian view of evolution focuses nearly exclusively on the external, modern evolutionary biologists often focus nearly exclusively on the internal in their

acceptance of genetic determinism. Lewontin and Levins suggested a third, a dialectical approach to understanding the interactions of internal and external factors in determining evolution, stating “natural selection is not a consequence of how well the organism solves a set of fixed problems posed by the environment; on the contrary, the environment and the organism actively codetermine each other.” This focus on interactions, transformation, and historical constraints over the process of natural selection is immensely important in developing a dialectical understanding of the process of evolution.

Every epoch in human history is marked by its own intellectual tradition. Therefore, the Enlightenment, and the revolution in scientific thought that it engendered, marks the epoch of capitalism. It does not mean that science becomes subjective, but the imperatives before science, the questions scientists ask, and the methodologies adopted to answer them reflect the dominant socio-economic relations of the time. Therefore, the transition to a socialist society must be accompanied by a revolution in scientific thought that would result in the development of a “socialist science”. This new science would be based on a clear dialectical materialist understanding of the relationships between man (and all organisms) and nature, and between man and society. The failure to bring about this revolutionary change in scientific thought and practice was one of the major failings of the socialist experiments of the 20th century, and contributed in no small part to their collapse. Yet for sometime in the 1920s and early ’30s, a materialist and dialectical approach was the intellectual foundation for many prominent Soviet scientists, such as V I Vernadsky, N I Vavilov, and Alexander Oparin, in their various research projects regarding the creation of the biosphere, the original centers of the agricultural world, and the emergence of life. All of this subsided, however, with the tightening grip of Stalinism in the 1930s. A more rigidly mechanistic approach became dominant in Soviet science (taking the name of “dialectical materialism” while vacating it of any meaning), putting an end to the early stages of a hopeful and exciting investigation that had begun to mark the birth of socialist science. The most adverse, and long-lasting, effect of this approach was the rise of Lysenkoism, which pretty much destroyed biology in the Soviet Union and barred the way for the budding revolution in scientific thought. Trofim Lysenko, who was in charge of agricultural affairs in the Soviet Union, practiced a form of Lamarckism, which derived from the theories of heritability of acquired characteristics and had already been disproved by Darwin’s theory of evolution by natural selection. With the blessings and active support of the Stalinist establishment Lysenko went about imposing these non-scientific practices, mainly in agricultural science and genetics, and denounced practicing geneticists as proponents of “fascist” or “bourgeois” science, leading to the execution of many and the imprisonment of Vavilov, the greatest Soviet biologist. Lysenkoism replaced a proper dialectical understanding of heredity and evolution by a forced belief that heredity had a limited role in evolution and changes could be brought about in organisms by human intervention which would be inherited in subsequent generations. Although these ideas were mainly adopted in agricultural practice, leading to processes like “vernalization” of wheat, it had a wider ideological implication that Soviet practices could actually purge humans of “inherited” bourgeois instincts and lead to the creation of the “socialist man”. Lysenkoism marked a complete failure of understanding the dialectical approach to science, instead adopting a

mechanistic approach based on pseudo-scientific theories. When Lysenkoism was finally discarded in 1964, Soviet science tried to return to the mainstream of western scientific practice, any attempts at developing a truly dialectical approach to science having been long abandoned. A socialist science never came into being in the Soviet Union.

As the internal contradictions of capitalism are becoming more glaring, the scientific thought processes that have been the product of the capitalist era would also become insufficient for explaining, and managing, the various challenges confronting humanity. Just as science of the feudal era was replaced by capitalist science, the latter would have to be replaced by a socialist science. A dialectical understanding of science is needed in order not only to comprehend how the world came to be, but also to understand how it can be changed. □□□