

## Approaching Science From Asymmetry, Irregularity and Subversion

An interview with Richard Levins,\* a scientist who never accepted divisions between disciplines, nor between science and other human activities, such as politics, for example.



*The work you have published over several decades, at least those published individually and with Richard Lewontin, are methodologically and conceptually built around dialectics. Could you briefly walk us through the principal characteristics of dialectic thought, as opposed to reductionist conceptions, in the study of living beings?*

The term “dialectical materialism” has acquired a bad name because of the way it was appropriated by Stalin’s group to justify decisions taken for other reasons and to wield as a weapon against opponents. However the term is accurate as a description of Marxist philosophy, and I would like to rescue it from its dungeon.

We can approach dialectics first as a polemic against both reductionism, the dominant bourgeois philosophy of science referred to in Marx’s time as mechanical materialism, and idealist holism, the leading criticism of reductionism. Reductionism postulates that the smallest parts of a system are the most “fundamental”, that if we can reduce something to its smallest parts we have understood it in principle, that the “parts” are themselves fixed, and that they interact externally, without changing anything important about them, to give “wholes” as a result. It is important to stress that reductionism is not the same as reduction a legitimate research tactic for approaching what something is made of.

The British communist J.B.S. Haldane in *Marxist Philosophy and the Sciences* (New York, Random House 1930) warned of the difficulties in applying Marxism to contemporary science:

*I have tried to apply Marxism to the scientific problems of my own day as Engels did over many years and Lenin in 1908. I do not doubt that I have made mistakes. A Marxist must not be too afraid of making mistakes.*

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*Such an attempt as mine invites one of two criticisms. If one confines oneself to well-established scientific facts, one is told that it is easy to apply Marxism after the event, and with sufficient ingeniousness, one can find a quotation from Marx or Engels that is apposite to any piece of recent scientific work. If on the other hand one ventures into speculation, one is certain to be wrong on points of detail, if not on more fundamental matters. Nevertheless, I think it is worthwhile to demonstrate the kind of speculations into which Marxism leads a scientist. (Haldane 1930: vii-viii).*

Or if we attempt to formulate it as “laws”, it comes across rigid and dogmatic. I prefer to consider dialectical principles as warnings about the common types of errors in interpreting the world.

Hegel’s principle that the truth is in the whole becomes the warning: things are bigger than we imagine; there is always more out there; a problem must be posed big enough to fit a solution or else we arrive at the trivial answer that the phenomenon is caused by several external factors to which we assign statistical weights, but not dealing with where the external comes from.

Things are connected. This is different from the spiritual tradition’s assertion that “we are all one”. We are not all one. Things are differentiated; all things are heterogeneous internally, so look at the internal dynamics as well as external “factors”. If they really interact with our objects of primary interest, then they should be included in a larger whole.

The primacy of process over things: “things are moments in the life of processes, snap fotos when a temporary balance of opposing processes allows for some transient stability that warrants a name. Further, not only is nothing permanent but it is even different where it is assigned the same name. Sometimes these differences are crucial, sometimes trivial. For instance “the market” is not the same when campesinos bring their maize to market as when Monsanto, Cargill, ADM and a few others control the international markets they operate in. Nor are elections always the same, and may be examples of capitalist democracy, or the rituals of fraud that prevents change.

Or when problems are examined only on their own level. For instance organisms, populations, ecosystems. None of these is more fundamental than any of the others. Each has its own “laws”, categories and regularities that depend on the adjacent levels that act as constraints, but having their own autonomy. Major errors are made when problems are treated only within their own levels. Thus heart disease is a phenomenon of fluid dynamics in the circulation of blood, but connected to stress, nutrition, kinds of employment, aging (contradiction).

## Complexity and Dialectics

*Which do you think are the insights and limitations of the new schools of complex thought that have emerged in the biological sciences?*

The new schools of thought that try to cope with complexity don't go all the way. They make extensive use of computation and simulation, so they come up with descriptions and predictions about the same original variables, the small parts that are allowed to affect the wholes but are not transformed by them. The interaction among levels is considered unidirectional. And they especially avoid looking at social (class) relations as affecting the individual organisms or ecosystems. Thus, functional medicine is marvelous for linking parts of physiology and even behavior, but stops at the skin. AIDS is regarded as a problem of virology and human behavior but does not consider land tenure as relevant. They are held back from a fully dialectical approach by the political economy of science, the institutional fragmentation of disciplines, and the dominant philosophy that sees reductionism as the height of objectivity. Few authors of works on complexity even acknowledge the dialectical tradition. Their principal contribution is to place complexity on the agenda of science.

## Classifying That Which Is in a Process of Evolution

*Could you talk to us about the concept of interpenetration, and how we can use it to understand quantitative-qualitative changes in nature?*

My starting point is that the categories that are regarded as mutually exclusive in fact interpenetrate. When we counterpoise heredity and environment, physiology and psychology, biology and society, or quantity and quality we are pruning away the boundary regions of greatest potential. When we ask questions such as how does temperature affect the populations of fruitflies, we have to make further distinctions.

Since temperature dessicates flies, larger size would be adaptively advantageous. But the direct developmental effect of high temperature is to accelerate development and give us smaller flies. Another species of *Drosophila* shows neither size gradients nor acquired temperature tolerance. It is just better at avoiding the heat! So, there is a complex interaction among physiology, behavior, and natural selection that makes "temperature" per se not a good environmental concept. We have to ask, on what time scale, in relation to the spatial and temporal pattern of temperature, and more. Flies in warm, dry regions are selected for larger size and impacted by their environment directly to produce smaller size. But in hot wet climates, selection and the physiology of development push the size in the same direction. Biogeography has to link physiology with population dynamics and behavior.

When we turn to our own species, new problems arise (they always do!). Traditional zoology differentiates animals by what they eat: herbivores, carnivores, omnivores, or perhaps finer subdivisions such as detritivores, insectivores, fructivores and so on. So, what kind of vore are we? In one sense, we are omnivores, like bears and relatively few other terrestrial animals. That omnivory can explain the pH of the mouth as against the stomach. But we not only gather our food, we transform it, carrying out part of the digestive process outside the body by cooking and turning the inedible into edible. We even produce our own food for the last 10,000 years or so by agriculture. So physiologically we are omnivores but socially productivores. This greatly expands our niche, making it possible to invade habitats where otherwise we would starve.

Another catch arises: it is no longer adequate to say “we”. “We” have been divided now for several millenia into classes, and these differ in what they eat or don’t get to eat, how they see their surroundings, how they act on their surroundings affecting the habitability or not of our world, what they believe and aspire to.

*Could you explain briefly the role played by the concepts of contradiction or opposition in dialectical thought, when applied to biology?*

Objective and subjective is one of the most difficult distinctions, but it is clearly possible to study subjectivity objectively and not possible to avoid the subjectivity of our experience. Someone else’s subjectivity becomes an object of our study, while all of our senses impose a subjectivity on the objective world we encounter.

In mathematics there is a bias toward quantification and measurement. This has played an important role in the development of physical science, where fine measurement has allowed us to differentiate between opposing hypotheses. But the point of careful measurement is to make qualitative decisions that educate our intuition toward grasping the world at a glance. Sometimes simulation shows us phenomena that we have to explain, or qualitative analysis creates new objects to measure.

Perhaps the sharpest conflict between dialectical thinking and formal logic is around contradiction. Formal logic of the sort shown in Venn diagrams presents logical propositions as static sets. The inclusion of one set within another allows the inner set to imply the outer one. “Imply” is a static relation. Earlier dialecticians saw implication in a more dynamic way. In the Socratic method propositions are stated, confronted, contradicted (literally, spoken against) and discarded to move on. Formal logic removes the dynamics from contradiction except in the mathematical proof by contradiction. For dialecticians, dynamics can be restored. Contradiction becomes the opposition of processes within

systems that moves them on. It is no longer the set-theoretic static relation of “implies”; “Implies” is formally equivalent to the more dynamic “leads to”.

This poses the hypothesis: to explain something, look for the opposing processes within it.

In answer to your question, to study evolution we should ask about the organism/environment relation; the confluence or opposition of physiology, behavior, and selection that makes each aspect of an organism the environment for the other parts, directing natural selection; how communities create each others’ environments and the dynamics of their demography. And when we study the wellbeing of our species we have to look at its divisions into classes with overlapping and opposing interests.

## On Models and Realities

*In what ways can we link modelization in biology to dialectics?*

In its broadest sense, modeling is the creation of objects we study instead of the object of original interest. We want our models to capture essential qualities of the original, but be more manageable and easier to study. Thus, rats are models for people in the study of medical physiology and pathology. A wind tunnel is the model for an airplane in flight, and so on. The next steps are abstract models, usually mathematical, that are supposed to capture essential ingredients of the original. But models can also mislead. A dialectician would look at the modeling process itself and ask, what has it captured of the reality and what has it distorted? It is crucial at the start of modeling to decide what to include and what to omit. Here is where philosophy enters. Social models in the US omit classes, pathology models may omit nutrition, evolutionary models may ignore climate change, climatologists may omit how vegetation affects the insect communities, models may look at demography of species but not their genetic heterogeneity, or their genetic make up but not the age distribution although fitness is connected to age. To avoid terrible errors we should ask, what else is out there? Why were previous models set up the way they were? Why do some things seem obvious to us and others too far out to consider? We also ask mathematical questions: are observations close enough together to use continuous models or are reports such as monthly bulletins from district labs to a national center so far apart that it is better to use discontinuous difference equation models? Thus, the crucial step is to recognize that the modeler is part of the model.

There is also the question of what does a model tell us? As long as we expect the world to be orderly, we search the model for equilibria, what starting points lead to these equilibria, the number of equilibria, whether they are stable or not,

whether a trajectory fluctuates with regular periodic oscillations (in which case the period rather than the equilibrium point is the object of study). Or what if it does none of these? What if we observe irregular, non-periodic, oscillations? This was seen as frustrating, a departure from good Christian behavior, and so labeled chaos. These days, irregular oscillations may be observed by simulation and called chaotic. But chaos as an outcome of a difference or differential equation is not structureless or arbitrary. We can change the question from the period to the interval between peaks. Note that in the original gene frequency models (logistic equations) we can prove “chaos”, which allows oscillations of all periods or no period. But the interval between peaks (or the semicycle, the number of consecutive steps on one side of equilibrium) is still bounded by the pre-images of the equilibrium. Categories such as the basin of attraction, semi-cycle and interval between peaks are new, more interesting objects to identify. Further, most mathematical models ask about the “eventual” behavior of an equation. But there is much less interest in the transients long before the end points are approached because initial conditions are viewed as arbitrary. The special sensitivity to change inclines dialecticians to think more about the transient behavior of systems that are buffeted about by external influences or internal dynamics, and the study of pre-images as a tool for this kind of analysis.

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CARDINAL VOICES

### Marx, Engels and Dialectics

*What is your point of view concerning the opinions elaborated by various Marxist authors who accuse Engels of using a different dialectics, at odds with Marx's, and that he even “betrayed” Marxist dialectics? Do you consider that Engels' contributions in Dialectics of Nature are valid, especially in the field of biology?*

Marx and Engels had a complex working relation. They agreed that Marx should concentrate on the core economics while Engels explored a wider variety of issues. But both of them ran their drafts of articles past the other. In particular, Engels, who was more engaged than Marx with natural science, tells us that Marx read the manuscript of *Anti-Duhring* and approved of it. They influenced each other's thinking in many ways. It was Engel's companion Mary Burns who influenced them to rethink colonialism after their initial enthusiasm for rushing the development of capitalism (she was an Irish nationalist). Furthermore, some articles signed by Marx were in fact written by Engels.

Marx never wrote an explicit exposition of dialectics, while Engels attempted to, and gave us somewhat stiff sounding “laws”. They shared not only insights but also errors. For instance in his *Origin of the Family, Private Property and the State*, Engels accepted the bourgeois patriarchal assumption that men naturally have a stake in verifying paternity, a claim that modern anthropology

has been able to puncture. A careful intellectual history might show interesting facets of the interaction of the two friends and collaborators who shared a common philosophy and commitment but differed in their social origins, areas of special interest and life styles, but I see no special virtue in trying to pitch them against each other.

*Could you summarize your intellectual history and how, in the course of it, you came to Marxism?*

I think I should finish with some account of how my own work is related to Marxism. I first encountered dialectical materialism in my early teens through the work of the British Marxist scientists, Haldane, Bernal, Needham, Levy, and others. It grabbed me as exciting and esthetically pleasing. In ninth grade we were taught Mendelian genetics, but it seemed so rigid and formalistic compared with the fluidity of Lysenko's attempts to combine development with genetics and his invoking of dialectics in his viscious debates. I was an eager Lysenkoist for several years, until I finally realized that not only did he misuse a lovely, complex, dynamic philosophy to impose disasterous conclusions on science, but was also a reductionist in claiming that speciation was a problem of developmental biology while I already saw it as a population phenomenon and decided that perhaps I could contribute to science. I was still interested in the inheritance of acquired characters, but now from the viewpoint that if populations adapt to their environments, what if the next generation faces different conditions? Now my mathematical and biological interests, previously in parallel tracks, came together and I began to explore the structure of the environment, how natural conditions varied while organisms responded. Meanwhile, the best friend of my teens came on a visit from his refuge in Denmark (Bernhard Deutch, a victim of MacCarthyism) to my mountain retreat on my farm in Puerto Rico and after a night of wide ranging discussions of science and politics ended with telling me "you have to write up your ideas". So I did, and began to find my way back to science. From then on I always combined political and scientific activism. Dialectics for me was always an aesthetic as well as intellectual experience. I loved asymmetry, non-linearity, interactions among seemingly unrelated phenomena, opposing phenomena within systems, questions of the "but what if it isn't?" type. My contributions to evolutionary ecology were mostly of this kind: the interpenetration of organism and environment, of levels (local environments embedded in biogeographic regions), the structure of ecological communities. And the same way of looking at the world guided my political activity in the Puerto Rican Independence movement, Marxist education, and anti-war activism. Here I was fortunate to have the collaboration of Richard Lewontin. We had quite different techniques of choice and problems we chose

to study, but all within a common framework of philosophical and political commitment.

## To Be in History

*You refer to subjective/objective as one of the false dichotomies, but all your answers are in the objective domain. What about the subjective side of being a Marxist?*

There are two parts to my answer: ethical and aesthetic. The ethical is the imperative to act on the conclusions of an analysis about society, the recognition that as scholars we are in institutions developed to advance capitalist profit making and rule, to make people comfortable with the way things are. Therefore we have to develop a strategy of “one foot in, one foot out” with relation to our employment and profession, or as St. Paul expressed it, “*in but not of*” this world. But this requirement is not simply the moral obligation to act on our understanding. I have found that political activism enriches my understanding and helps to undermine the pervasive pessimism of my community. It leads to working hypotheses: that when good valid arguments lead to opposite conclusions about a problem, the problem has been badly posed (usually too narrowly or static and unhistorical); that when two movements for justice clash, they are both asking for too little (example: lumber workers fear ecologists’ protection of owl hábitat, but it is not owls that kill jobs, greed kills them both); and all theories that promote, justify, or tolerate injustice are wrong.

I have had the privilege to encounter dialectics quite young, so that it played a major part in forming my aesthetic sense. While physics was glorying in symmetry in the particle world, I felt a preference for asymmetry. I delighted in the overthrow of parity and the recognition that matter and anti-matter are not quite mirror images of each other, or wondered what math would look like if  $A \text{ times } B$  is not the same as  $B \text{ times } A$  (I had not yet met matrices).

Idealists have often used evidence of uncertainty and chance as refuting the rational, predictable world of reductionism (what Marx and Engels referred to as mechanical materialism). Thus quantum theory, with the uncertainty principle, was a devastating blow to mechanism, a support for the irrationality of the world following the shock of World War I when educated white men slaughtered each other before getting back to the business of dividing up the world. A book popular in my teens was *The Dice of Destiny. An Introduction to Human Heredity and Racial Variation*, Long’s College Book Co., Columbus, Ohio, 1945, which made the irrelevant argument that a large number of diverse molecules mixed in a bowl would not produce a “man”. Marxism was caricatured as reductionist, with communists supposedly looking at love as chemistry (the movie *Ninotchka*



tells of a Soviet bureaucrat woman being saved from her rigidity by finding true love with a Westerner).

Gödel's theorem hit my teenage leftist circles as a sharp divider. Generally, my social democratic friends saw it as disaster, destroying the expectation of science eventually reaching truth. But the Marxists in the group were delighted. We saw it as showing the pervasiveness of contradiction even within the most abstract logical structures and a vindication of science as being an unending search. None of us really understood Gödel but were guided by our different aesthetics.

The irruption of mathematical chaos was another such episode. Once again, liberal socialists saw it as refuting the arrogant certainty of predicting the future that they ascribed to Marxists. But we felt it as almost orgasmic, the affirmation that if not all processes eventually reach equilibrium or periodic oscillation, then a whole new world of things to explore opened up for us. My own mathematical work then shifted toward exploring the transients of processes along the way to "eventual".

Dialectics also made process rather than stability the most beautiful things to look at. I never had interest in an eternal after life, and could not feel with the poets for whom images of undying love were immovable mountains and eternal seas. My aesthetic thrilled to the workings of erosion and earth crust movements, the moments of political awakening, extinctions and emergence. Emersion in this aesthetic filled my sleepless nights and directed my research and my politics, always seeing the priority of the long view and fueling my doubts that victory was imminent. Coming from five generations of subversives, I never expected the quick fix or imposed utopian expectations on victories. Our task is replacing a 40,000 generation detour through destructive class societies that leaves open the question, are we a successional species preparing the way for our own replacement? Rather, I see a long, often disappointing and frustrating struggle that has given me a life that is intellectually challenging, aesthetically energizing, ethically in struggles consistent with my deepest values and aiming toward a society playing a supportive role in our ecosystem, where it makes sense to be kind, and bringing me together with people I love. ■