

PLANNING, CHANGE AND DARWIN'S EVOLUTION:  
IS COMPETITION A LAW OF NATURE?

Draft Paper.

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Spring, 1994

OUTLINE.

I shall look at Charles Darwin's work on evolution in an effort to understand what his theories tell us, generally, about how change occurs in nature, and particularly, about what role the ideas of competitive struggle may have to play in the evolutionary process. In the first two sections, I introduce my intent more fully, and place it in the context of an ongoing progression in planning, to recognize complexity and interconnectivity. Then I show the context within which Darwin formulated and presented his theories of natural selection and of common descent, and describe some of the forces that shaped his thinking and inquiry. I name a distinction between the biological and scientific aspects of his work, and the societal inferences that followed. Then I show how the language of "struggle" and of "competition" derive from the strategy Darwin used to present his work to the scientific community of his time, rather than being formative in the theories themselves. Finally, I point to two instantiations, independent of this debate, one from gender science and one from Russian evolutionary thinking, of the contention that the explanations of nature to be found in

Darwinian evolution are not intrinsically contingent upon the ideas of competition and control.

#### INTRODUCTION.

To the extent that planning can be taken as the management of change, it must be centrally concerned with the ideas of efficiency, particularly as they relate to the efficient allocation of resources. In this, it is significantly informed, by various routes, from the late-18th century work of Adam Smith and his model of the "invisible hand." This places unfettered and informed competition center stage as an operating mechanism, sorting the efficient from the inefficient in the beneficial quest for fulfilled self-interest..

At the same time, how we think about change and how we go about creating it, must be greatly influenced by how we perceive change to occur in nature. In this, the mid-19th century work of Charles Darwin on evolution by a process of natural selection has taken deep root in our thinking. In its common conception, Darwinian evolution describes a process of natural selection from amongst many random variations. This selection is seen to operate under the pressures of a Malthusian struggle for existence, where competition, both between individuals and amongst species, is taken as the operational device, sorting the fit from the less fit.

It is not, I believe, unduly fanciful to suggest that, at some low level of resolution, there is some certain similarity between Adam Smith's conception of social change, and the folk model of Darwinian evolution. In the first, Adam Smith's "invisible hand" acts, under pressure of market operations driven by competition, to reveal the favorable course for society. In the second, Darwin's "natural selection" acts, under pressures of a struggle for existence powered by competition, to reveal favorable changes in nature. Then, not only is competition considered beneficial in directing change in the human economy, but this is further validated by the folk model of Darwinian evolution, wherein competition is seen to be central in directing nature's own economy.

There is good reason to believe that this commensurability in the folk models may not be reflected from reality. In describing the worldview that prevailed upon Darwin at the time, Mayr [1991:102] says it was

...a Victorian worldview in which certain sociological ideas were used to develop a new social theory. It was based in part on the writings of Adam Smith, Malthus, and David Ricardo, and postulated that competition, struggle, and the increase in populations would result in progress.

At the same time, Mayr also points out that although Darwin was certainly conversant with these ideas, careful textual analyses reveal that "these ideas were not the source of

Darwin's biological ideas...as much as some political writers would want us to believe this."

However, to this extent at least, the work of Charles Darwin, as represented by his *Origin of Species by Means of Natural Selection or the Preservation of Favored Races in the Struggle for Life* [1859], can be taken to already inform, in some version, the theory and practice of planning.

My purpose here is to ask, to what extent, in fact, is competition an integral part of Darwinian theories of evolution. In studying the literature surrounding the content and the context of Darwin's theories, it becomes apparent that both the ideas of "struggle for existence" and of "competition" were well established in Victorian thought by the time Darwin took the first steps toward his subsequent work. Further, there is textual and historical evidence that Darwin introduced these ideas into his work after he had already formulated his basic theories, and while he deliberated on how best to present his work to the scientific community of his time. Thus, while the idea of competition clearly has a place in how nature organizes itself, it may not be central, in any formulative way, to Darwin's conceptions of how evolution, or change, occurred in nature.

#### THE CHANGING NATURE OF PLANNING.

Lakoff [1987] goes to cognitive anthropology to make a distinction between folk models and scientific models. Folk models are theories and beliefs about aspects of the world,

widely held by those outside of the domains of expertise relating to those aspects. Put differently, science as the organized advancement of knowledge, is first informed by such folk theories and then proceeds through the examination and testing of these theories against current knowledge.

Further, Blumenberg [1989] suggests that changes in theory occur through a processual reoccupation of questions. In his view, when the held answers to questions prove inadequate to our present understanding of reality, and the questions remain relevant to us, they will be reoccupied by new answers. These new answers bring with them potential theories which can then be tested against what we know of reality.

In this light, and over the past few decades, planning theory has seen a progressive reoccupation of many of its folk theories, as it has informed itself about diverse domains of expertise. This process has significantly increased the scope and range of our understanding of the problems faced in the practice of planning, in the conceiving and making of deliberated societal intervention. We are informed today, in planning as in science, by a fuller understanding of its essential tensions [Kuhn, 1977] between tradition and innovation, between depth and breadth, between global concerns and local needs, between the advantages of specialization and those of diversity, between competition and cooperation.

Perhaps, it is by this very process of recognizing and understanding these essential tensions, that the practice and theory of planning has been able to recognize the complex interconnectivities of the world we seek to intervene upon. The early calls to comprehensiveness and to interdisciplinary approaches [von Bertalanffy, 1968, 1975; Boulding, 1968] have begun to evolve into far more sophisticated and critical conceptions of what these terms should mean to planning [Churchman, 1979; Dyke, 1988; Verma, 1993b]. At the same time, other tensions such as those between means and ends, between theory and practice, between fact and value, have been thinned out by this very understanding of interconnectivity and complexity [Verma, 1993a].

It is as part of this progressive reoccupation of ideas that I propose planning theory should look more closely at what ecology theory has to say about Darwinian evolution and how change is presently known to occur in nature. There are at least two reasons why this may be advantageous. In the first place, there may be models or analogies that would help us to deal with the management of change in the making of human interventions.

Second, in the general context of planning (with its central concerns with change and efficiency, in which competition is considered a key strategy) and in the particular context of environmental planning (which is intimately concerned, under present legislative policy, with mitigation and remediation of adverse impacts of human

intervention upon the ecosphere) a better understanding of how change occurs in nature may help us to reduce the frequency and extent of remediation our interventions call for.

#### DARWIN'S EVOLUTIONARY THEORY.

Thomas Kuhn [1970] has argued that scientific revolutions rest not on the work of individuals or disciplines, but on the emergence of new agreements within particular scientific communities engaged in common purpose. The case of Darwin's *Origin of Species by Natural Selection*, then, becomes doubly interesting. Not only did Darwin's work take sufficient hold in the communities of, and after, his time to bring about such a revolution, but there is good reason to believe that Darwin gave considerable prolonged and explicit attention to a strategy for bringing this about [Ellegard, 1958; Young, 1985; Campbell, 1986, 1989; Mayr, 1991].

It may be important to recognize here that the primary debate, for Darwin, was not so much between science and theology, but rather within science itself. John Dewey, in his lecture *The Influence of Darwinism on Philosophy* [1910:2] delivered as part of a course of public lectures at Columbia University a half-century after the publication of Charles Darwin's *The Origin of Species by Means of Natural Selection* [1958], points out that

The vivid and popular features of the anti-Darwinian row tended to leave the impression that the issue was between science on one side and theology on the other. Such was not the case---the issue lay primarily within science itself, as Darwin himself early recognized.

Biographically, and briefly [Bowlby, 1990], Charles Darwin began, as a young gentleman of leisure, with the stated intention of entering theology. He began his formal education in medicine, but soon became increasingly interested in zoology and in science. In 1831 he was offered the opportunity to travel aboard the *HMS Beagle*, one of two ships engaged in charting the waters of the southern hemisphere, as a naturalist. His studies, observations, and collections for other experts during this four year voyage, coupled with his increasing dissatisfaction with theology brought about by his immersion into the methods of science, as well as his understanding of breeding in animal husbandry, become central to the subsequent development of his theories of evolution by natural selection and of common descent.

SOURCES OF DARWINIAN EVOLUTION: BACON, SCOTTISH COMMON SENSE, AND THE SCIENTIFIC METHOD.

Intellectually, if arguably, there are three works, contemporary to his time, that most directly seem to have influenced Darwin toward recognizing his theories. Certainly the work of William Paley, particularly his *Natural Theology*,

set the tone for the state of scientific thought in the debate between design and chance. This unhesitatingly accepted Bacon's conception of the essential unity between theology and science, postulating a picture of design in the whole and chance in the parts. As Campbell [1986:353] puts it:

Everyone agreed true science was inductive rather than deductive, everyone opposed scholastic "essentialism," and everyone agreed that the business of science was empirical investigation backed, wherever possible, by experimental tests. Most importantly, everyone agreed that true science and true religion were different facets of the one plan of the one God, whose aim was ever the same, whether his laws were to be studied in nature or in history.

Darwin came, very early, to reject this view, but recognized that his ideas must be set within the framework of natural theology if they were to have any impact at all. Campbell [1986, 1989] argues that Darwin set out, quite deliberately and with elaborate strategy, to exploit this Baconian vision, and that the primary reason his theories took root so widely, and within a decade, was that he used "the language of natural theology to undermine natural theology."

Methodologically, the work of John Herschel, particularly his *Preliminary Discourse on the Study of*

*Natural Philosophy*, articulating a method of science and advocating the hypothetico-deductive approach to inquiry, explicitly influenced Darwin's thinking at an early stage. However, as Mayr [1991:104] suggests, Darwin's own method was not strictly hypothetico-deductive, but rather grounded in induction and analogy [Young, 1985; Campbell, 1986], the method of his time, which, in turn, was informed as much by Bacon as by the Scottish Philosophy of Common Sense [Campbell, 1986:355], some key beliefs in which are

that the course of nature will be the same tomorrow as it is today; that there is intelligence in the effect there must be intelligence in the cause; that I am a responsible moral agent; and that man should help, not hurt himself and others.

The underlying notions of scientific method were rooted in the development of physics and mathematics from the 17th century. Mayr [1991:48] states that "philosophers from Bacon and Descartes to Locke and Kant entirely agreed with the physical scientists from Galileo and Newton to Lavoisier and Laplace that the ideal of science should be to establish mathematically formed theories that were based on universal laws. The possibility of proof and of exact prediction were the tests for the goodness of a scientific explanation." In this light, Darwin was faced with the task of meeting the mandates of both natural theology and of this scientific method. A related, if radical, development is to be found in David Hartley's 1749 work on associational psychology.

Even before Darwin, this doctrine of associational psychology had found application and extension into the early thinking on evolution. In fact, Darwin's grandfather, Erasmus Darwin, attributed much of his work to an extension of Hartley's thinking into other life forms. Young [1985] points out that the Utilitarian school of thought arising out of this postulation that associations with pleasure and pain provide the mechanism to shape and change utility and, thus, adaptation.

But the most direct, and perhaps necessary influence on Darwin's early thinking, and his subsequent theories, was the work of Charles Lyell, *Principles of Geology*, the first volume of which appeared on the eve of Darwin's departure on the *HMS Beagle*. Mayr [1991:4] asserts that this was the single most critical scientific work in shaping Darwin's subsequent thinking. Not only did it give "Darwin an advanced course in uniformitarian geology---a theory that changes in the earth's surface have occurred gradually over long periods of time---but also introduced him to Jean Baptiste Lamarck's arguments for, and Lyell's arguments against, evolutionary thinking."

Theories of organic evolution had been postulated well before Darwin. His own grandfather, Erasmus Darwin, had worked significantly in this area. But this Lamarckian version of evolution was bounded by a belief in fixed first and final states. Lamarck held to a strictly linear progression toward an increasing perfection in each species,

which were all created in their own particular forms, and any observed variations were induced merely by the use or disuse of particular parts or faculties. The extinction and emergence of species was simply not recognized, holding instead, at best, that apparent extinctions were merely the catastrophic transmutation of a whole species into a form unrecognizable in the previous.

Lyell's view of extinction, as a geologist dealing with much longer time frames, was informed by his recognition of dramatic changes in the conditions of the planet's development. Mayr [1991:16] shows the significance, for Darwin, of Lyell's contribution.

He believed that individual species became extinct one by one as conditions changed and that the gaps thus created in nature were filled by the introduction of new species through some presumably super-natural means. Lyell's theory was an attempt at a reconciliation between those who recognized a changing world of long duration, and those who supported the tenets of creation.

It may well be the case that the reason, later, Darwin was not overly concerned with the reception of his theories by the theologians, but rather by the scientific community, was that he felt such an explanation to be adequate to its time. At any rate, it was the unanswered question of how these new species happened that was to be the subject matter of his subsequent work.

CHANGING CONCEPTIONS IN NATURE: TYPOLOGIES, TAXONOMIES  
AND HIERARCHIES.

Dewey [1910:15] shows the centrality of the design versus chance debate to the scientific community of the time, and of the influence of our beliefs about the fixity or mutableness of "first and final causes," in how we think about change. In the transformation brought about by Darwinian logic,

Interest shifts ... from an intelligence that shaped things once (and) for all to the particular intelligences which things are even now shaping; shifts from an ultimate goal of good to the direct increments of justice and happiness that intelligent administration of existent conditions may beget and that present carelessness or stupidity will destroy or forego.

In one sense, the choice is between a single, final future and one that is mutable and affectable by our actions. There are two ideas, at least, that derive from this debate which are relevant to our thinking in planning today. The first of these is the notion of a "drive to perfection" typified most strongly in the work of Lamarck. A version of this remained very much a part of Darwin's own thinking. Campbell [1986] suggests:

Within the late Victorian worldview, the doctrine of progress, the historical guarantee of which

rested on nothing more than a half-secularized Christian eschatology, cushioned the impact of Darwin's ideas even for Darwin himself. Although Darwin was keen on denying that his theory in any way guaranteed directional change in nature, when it came to history he was a pure Whig. He assumed there had been progress, at least in the European races, he knew there had been progress in science, and he assumed that in the future man would be higher and finer than he was at present.

To the extent that questions of perfect or even preferred future states still engage our thinking, some thin version of this debate is still unfolding.

The second notion of relevance here is that of type, and thus of taxonomy. Briefly, the pre-Darwinian typological paradigm rests on the notion that there is a single correct taxonomy to nature, that species are most accurately defined by their type, by the characteristics and attributes that are essential to all individuals within that type. This relates, quite spontaneously, to the idea of a "drive to perfection," an assumption of fixed and ideal end, and to a foundational view of the world.

That such an essentialist, typological view of the world persists even today, in the face of all evidence indicating its limited usefulness in describing nature, points as much to the structures of our language as to the long lasting

stability of such basic types. Regarding the first, Mayr [1991:40] points out,

...(essentialism's) principle is anchored in our language, in our use of a single noun in the singular to designate highly variable phenomena of our environment, such as mountain, home, water, horse, or honesty."

In the matter of basic-level categories, Lakoff [1987:118] argues,

People have many ways of making sense of things--- and taxonomies of all sorts abound. Yet the idea that there is a single right taxonomy of natural things is remarkably persistent. Perhaps it arises from the relative stability of basic-level concepts... Since scientific theories develop out of folk theories, it is not at all surprising to find that folk criteria for the application of taxonomic models find their way into science.

Taken differently, the study of taxonomies moved in the early 19th century from the study and naming of types to the study and explanation of differences, from the classification of (fixed) types between species to the identification of differences between and amongst species, and to an understanding of the principles behind such differentiation. Mayr [1976:416] suggests that this shift was already starting to occur before Darwin left on his journey with the *Beagle*, and that it was the taxonomic problems he encountered, during

his voyage and later, that ultimately triggered his *Origin of Species*..

These changing views of taxonomy are inextricably linked to conceptions of hierarchy. In the typological view, hierarchy is taken to be linear, temporally branching, rank-ordered, and exclusive. The folk model of the food chain, what Krieger [1977] calls "big fish eating little fish," along with the implications, in Christian thought, of the notion that humans were created in the image of God [Young, 1985:8], leads spontaneously to the idea of ascending orders of perfection, organization, and superiority.

In speaking of the business of classification in ecology, Mayr [1976:459] makes a distinction between grouping, "of lower taxa into higher taxa," and ranking, "the assignment of these taxa to the proper categories in the taxonomic hierarchy." The typological view, which shows itself even today, derives from a unitary, branching, view of natural change, in which "the grouping of taxa simultaneously also supplies their rank... given automatically by time of origin, and the same rank must be given to sister groups."

Elsewhere, Mayr [1982:205] defines the two sorts of hierarchies associated with the pre-Darwinian and the Darwinian views of nature. The notion of a "scale of nature," which dominated typological thinking through the 18th century, is an exclusive hierarchy, one in which "(e)ach level of perfection was considered an advance (or degradation) from the next lower (or higher) level in the

hierarchy, but did not include it." The post-Darwinian conception he terms an inclusive hierarchy, and illustrates this with an example.

...dog-like species, such as wolf, coyote, and jackal, are grouped in the genus *Canis* (dogs); the various dog-like and fox-like genera are combined in the family Canidae. These, together with the cats, bears, weasels, and other related families, are combined in the order Carnivora. Class, subphylum, phylum, and kingdom are successive higher ranks in this hierarchy. Each higher taxon contains the taxa of the lower, subordinate, ranks.

As an aside, more recent developments in hierarchy theory [O'Neill, et. al., 1986] and in process-function ecology [Allen & Hoekstra, 1992] have begun to question the sufficiency of even this view. The arguments from the ecosystem approach suggest that the criteria for such rankings are both state and scale dependent. Thus changes in the scale of description and the choice of boundaries may themselves require changes in the criteria of categorization. In this, emerging view, we would require multiple descriptions and criteria to begin to understand the multiple orderings found in nature.

#### SHAPING *THE ORIGIN*: METHODS, MECHANISMS, MALTHUS.

It is useful to make a distinction between the biological aspects of Darwin's work on the one hand, and the

inferences he made from this of the organization and evolution of species and of humans, as well as the presentation of this body of his work to the scientific community of his time, on the other. In the former, he relied on the scientific method, choosing his contemporaries, Charles Lyell, Thomas Huxley, and Joseph Hooker as his correspondents, while the methods of inference and analogy were central to the latter aspects.

There is a twenty year gap between Darwin's first formulation of his theories upon his return with the *Beagle*, and the actual publication of his *The Origin of Species*. During this period he worked to pull together many of the strands that he had developed. Young [1985; Campbell, 1986] has shown that the root metaphor in Darwin's work was not "struggle," as is commonly thought, but rather "selection." A significant origin of Darwin's thinking rested in his study of the selection of superior stock by human breeders. In particular, he recognized the significance of pigeon breeding having given rise to a new species of pigeon. These instances of the human selection of traits were his first studies of variation within species.

During his voyage with the *Beagle*, Darwin was struck by the similarity of this with the processes of variation he observed in nature. Metaphorically speaking, then, Darwin saw an analogy between the artificial selection of human breeders and a natural process of selection. What he sought then, the missing piece, was a mediant, some way of making

the analogy believable. From the point of view of natural theology, what he needed was a device, a "contrivance" that would make the process work [Campbell, 1986:361]. Moreover, this mediant needed to be such as to not require any form of divine or super-natural design, theology being a position Darwin had, by now, moved away from.

Most scholars in this name 28 September 1838 as a key moment in this quest for a contrivance, when Darwin read Malthus's *Essay on the Principle of Population*. It was not the ideas in the paper themselves that served as a trigger for Darwin, but one sentence in particular. Mayr [1991:75] says this was subsequently identified as "It may safely be pronounced, therefore, that the population, when unchecked, goes on doubling itself every twenty-five years, or increases in a geometrical ratio." Bowlby [1990:223] suggests this ...impressed on him the relevance to his problem of something he already knew but had not applied: namely that, although every species produces very large numbers of young, its numbers do not increase correspondingly. That means that large numbers of each generation must die from starvation, predation or other causes, and extremely few live to breed successfully. Clearly what distinguishes the successful few from the rest is that in certain ways they are on average better adapted to survive in the environment in which they live than are the others.

In this view, the Malthusian struggle for life becomes, for Darwin, a contrivance---mechanically, as a pressure device on the process of selection, and symbolically, as an icon already well rooted in that time.

That Darwin strategized vigorously in the project of submitting his theories to the scientific community has been amply demonstrated in the literature [Campbell, 1986, 1989]. Given that metaphor and analogy were very much a part of the method of the day, his work relies on its translatability back into reality. Campbell [1986:365] points out,

The sticking point in previous arguments for evolution, at least as far as their popular success was concerned, was that they could never make a credible appeal to experience, that is they asked people to choose between two implausibilities: tissues flashing into life from invisible atoms or one kind of animal becoming another, neither of which were easy to imagine.

Darwin's use of human selection by breeders as analogy was both socially and historically conceivable. As Campbell puts it, "he not only made a Baconian appeal to experience, but he also made a specifically Scottish non-reductive appeal to the common sense of the plain man."

At the same time, he saw a need to circumvent, if not subvert the dogmas of his day in presenting his work. Campbell [1986:361] suggests that there is

...little doubt that Darwin meant to outflank natural theology by associating its conventional terms with his new evolutionary meanings. His practice seems aptly to illustrate what Kenneth Burke called "casuistic stretching," the process of "introducing new principles while theoretically remaining faithful to old principles."

In his subsequent analysis of the textual content of Darwin's work, Campbell [1986:361] shows that not only did Darwin use familiar terms in novel ways, but also that he introduced new terms for familiar ideas where he could not subvert the meaning.

#### COMPETITION AND EVOLUTION.

Within the context of the metaphorical strategy adopted by Darwin in the public articulation of his theories, and accepting the distinction proposed by Mayr [1991] between his biological work and his inferential work, it becomes more plausible to accept Mayr's assertion that the ideas of competition and struggle play no formative part in his theories about evolution. In this view, competition is acknowledged as a feedback mechanism, and struggle becomes the mental construct that allows us to make the transition from human selection to natural selection.

There are two further instantiations that might lead us to accept that competition is not an explanatory element in the occurrence of evolutionary change. The first of these is

underscored by Keller [1992] in her discussion of the “privileging of competitive interactions” in applications of the Lotka-Volterra equations. These equations represent efforts in mathematical ecology to model predator-prey dynamics and population cycles. She says [p123]:

...it is worth noting that the very same (Lotka-Volterra) equations readily accommodate the replacement of competitive interactions by cooperative ones, and even yield a stable solution...The full reasons for such amnesia (in forgetting this fact) are unclear, but it does suggest a strong prior commitment to the representation of resource consumption as a zero-sum dynamic---a representation that would be seriously undermined by the substitution (or even addition) of cooperative interactions.

A second, and perhaps more historical reason for rejecting competition as an explanatory aspect of change in nature is to be found outside of the conventional literature. This represents the work of the Russian schools of evolutionary thought, such as symbiogenesis [Khakhina, 1979; Margulis, 1991], which, in one simple version, holds that new species emerge in the formation of perfect (and thus, indistinguishable) symbiotic relationships. Todes [1989] points out that Russian thinkers explicitly and vehemently rejected the metaphoric formulation of Darwin's theories. This was due partly, he suggests, to a cultural discontinuity

that hindered the transfer of Darwin's metaphor of selection. But more than this, perhaps, it was because there had already been an ideological rejection of the societal implications of Malthusian thought, and thus the mediant chosen by Darwin failed to bridge the analogy he drew on selection.

Kropotkin (1914) argues that the idea of competition as the primary "law" of Nature is a distortion of Darwin's work on evolution, and that if any species is to progress there must first be mutual aid and support between individuals of that species.

Two aspects of animal life impressed me most during the journeys which I made in my youth in Eastern Siberia and Northern Manchuria. One of them was the extreme severity of the struggle for existence which most species of animals have to carry out against an inclement Nature ; the enormous destruction of life which periodically results from natural agencies ; and the consequent paucity of life over the vast territory which fell under my observation. And the other was, that even in those few spots where animal life teemed in abundance, I failed to find --- although I was eagerly looking for it --- that bitter struggle for the means of existence, among animals belonging to the same species, which was considered by most Darwinists (though not always by Darwin himself) as the

dominant characteristic of struggle for life, and the main factor of evolution." [p1].

Keller points to one significant implication of this displacement of competition as explanatory of change when she says that the replacement of simple competitive interactions by more complex ones, "either between organisms or between organisms and environment, lead to payoff matrices that are necessarily more complex than those prescribed by a zero-sum dynamic---payoff matrices that, in turn, considerably complicate the presumed relation between self-interest and competition, if they do not altogether undermine the very meaning of self-interest."

BIBLIOGRAPHY.

Allen, T. F. H., and Hoekstra, T. W. 1992. Toward a Unified Ecology. NY, NY : Columbia University Press, 1992.

Blumenberg, Hans. 1989. "Introduction" & "An Anthropological Approach to the Contemporary Significance of Rhetoric," in After Philosophy, eds., K. Baynes, J. Bohman, T. McCarthy. Cambridge, MA: MIT Press. p423-458.

Boulding, Kenneth E. 1968. "General Systems Theory: The skeleton of a science," in Buckley, Walter, ed., 1968. Modern Systems Research for the Behavioral Scientist: A sourcebook. Chicago, IL: Aldine Publishing Co.

Bowlby, John. 1990. Charles Darwin: A Life. New York, NY: W.W.Norton & Co.

Bowler, Peter J. 1988. The Non-Darwinian Revolution: Reinterpreting a historical myth. Baltimore, MD: Johns Hopkins University Press.

Campbell, John A. 1984. "A Rhetorical Interpretation of History," Rhetorica. v2.n3 Autumn 1984. p227-266.

Campbell, John A. 1986. "Scientific Revolution and the Grammar of Culture: The Case of Darwin's *Origin*," Quarterly Journal of Speech. v72.n4 Nov. 1986. p351-376.

Campbell, John A. 1989. "The Invisible Rhetorician: Charles Darwin's "Third Party" Strategy," Rhetorica. v8.n1 Winter 1989. p55-85.

Churchman, C. West. 1979. The Systems Approach and its Enemies. New York, NY: Basic Books.

Darwin, Charles. 1859. The Origin of Species by Means of Natural Selection or the Preservation of Favored Races in the Struggle for Life. [Edition, 1958]. New York, NY: Mentor Books.

Dyke, Charles. 1988. The Evolutionary Dynamics of Complex Systems: A Study in Biosocial Complexity. New York, NY: Oxford University Press.

Ellegard, Alvar. 1958. Darwin and the General Reader: The Reception of Darwin's Theory of

- Evolution in the British Periodical Press, 1859-1872. [Edition, 1990]. Chicago, IL: University of Chicago Press.
- Keller, Evelyn F. 1992. Secrets of Life, Secrets of Death: Essays on language, gender and science. New York, NY: Routledge.
- Khakina, Liya N. 1979. Concepts in Symbiogenesis: A Historical and Critical Study of the Research of Russian Botanists. [trans. 1992. Margulis, Lynn & Mark McMenamin, eds.]. New Haven, CT: Yale University Press.
- Krieger, Martin. 1977. Review of J. Linville & R. Davis, 1977, "The Political Environment," Town Planning Review v48.n3 July 1977. p308-309.
- Kropotkin, Petr A. 1919. Mutual Aid : a factor of evolution. New York, NY: Knopf.
- Kuhn, Thomas S. 1970. The Structure of Scientific Revolutions. [2nd ed.] Chicago, IL: University of Chicago Press.

Kuhn, Thomas S. 1977. The Essential Tension: Selected Studies in Scientific Tradition and Change. Chicago, IL: University of Chicago Press.

Lakoff, George. 1987. Women, Fire, and Dangerous Things: What Categories Reveal about the Mind. Chicago, IL: University of Chicago Press.

Malthus, Thomas R. 1798, "An Essay on the Principle of Population," [reprint] in Garrett Hardin, [comp.], 1969, Population, Evolution & Birth Control. San Francisco, CA: W. H. Freeman & Co. p4-17.

Margulis, Lynn. 1991. "Symbiogenesis and Symbiogenesis" in Symbiosis as a Source of Evolutionary Innovation : Speciation and Morphogenesis. Cambridge, Mass. The MIT Press. 1991.

Mayr, Ernst. 1976. Evolution and the Diversity of Life: selected essays. Cambridge, MA: Belknap Press; Harvard University Press.

Mayr, Ernst. 1982. The Growth of Biological Thought : Diversity, Evolution, and Inheritance. Cambridge, Mass.: The Belknap Press of Harvard Univ. Press.

- Mayr, Ernst. 1991. One Long Argument: Charles Darwin and the Genesis of Modern Evolutionary Thought. Cambridge, MA: Harvard University Press.
- O'Neill, R.V., D.L. DeAngelis, J.B. Waide & T.H.F. Allen. 1986. A Hierarchical Concept of Ecosystems. Princeton, NJ: Princeton University Press.
- Todes, Daniel P. 1989. Darwin without Malthus: The Struggle for Existence in Russian Evolutionary Thought. New York, NY: Oxford University Press.
- Verma, Niraj. 1993a. "Revisiting Rationality in Planning: Pragmatic Planning Theory," Draft paper.
- Verma, Niraj. 1993b. "Boxes and Arrows as Models of Systems." Paper presented at the meeting of the International Society for the Systems Sciences, Asilomar, CA, Oct 3-5, 1993
- von Bertalanffy, Ludwig. 1968. General System Theory : Foundations, Development, Applications. New York, NY. George Braziller.

von Bertalanffy, Ludwig. 1975. Perspectives On  
General System Theory : Scientific-Philosophical  
Studies. [reprint] in Edgar Taschdjian, ed. New  
York, NY: G. Braziller.

Young, Robert M. 1985. Darwin's Metaphor: Nature's Place  
in Victorian Culture. Cambridge, UK: Cambridge University  
Press.