

Reviews

Evolution at a Crossroads: The New Biology and the New Philosophy of Science. Edited by DAVID J. DEPEW and BRUCE H. WEBER. Cambridge, Mass.: MIT Press, 1985. 267 pages. \$25.00.

Evolutionary and genetic theory came together in the neo-Darwinian synthesis which gained much of its momentum when empiricism dominated the philosophy of science. The influence of empiricism caused the neo-Darwinian agenda to be highly colored by reductionism, the attempt to explain theories and laws in one scientific field through the terms of another presumably more fundamental one. Thus high value was placed on explanations of evolutionary changes on the species level or higher, which were based on measurable changes in allelic frequencies on the genetic level. The sociobiological research program (e.g., E. O. Wilson's work) as well as Richard Dawkins's theories (see *The Selfish Gene*, New York: Oxford Univ. Press, 1976) represent modern articulations of evolutionary theory linked to a radical reductionism. However, Thomas Kuhn (*The Structure of Scientific Revolutions*, Chicago: Univ. of Chicago Press, 1962) challenged empiricist theories, emphasizing the paradigms (general perspectives or frameworks) which scientists use in their interpretation of data. This view rejected the accumulation of scientific knowledge and described the commitment to a particular paradigm as one similar to a religious or political commitment.

Evolution at a Crossroads: The New Biology and the New Philosophy of Science is an excellent collection of essays edited by David J. Depew and Bruce H. Weber (in the Philosophy, and Chemistry and Molecular Biology Departments respectively at California State University, Fullerton). The book highlights the problems raised by the marriage between evolutionary theory and philosophical reductionism, and it suggests what the editors call a new philosophy of science, in place of empiricism and Kuhnian conventionalism. This new philosophy seeks "a view of science that retreats from reductionistic ideals without sacrificing the possibility of scientific truth and progress" (p. 241).

The introductory essay ("Perception, Interpretation, and the Sciences: Toward a New Philosophy of Science" by Marjorie Grene) offers a major outline of this new philosophical understanding which provides a helpful foundation for the other essays in the volume. Grene advocates a comprehensive realism with an understanding of science as historical process rather than logical reconstruction. Crucial to this new perspective is her understanding of perception. Following M. Merleau-Ponty and J. J. Gibson, Grene views perception ecologically: humans are active perceivers, exploring the environment dialectically through perceptual categories which orient experience while being modified by experience. Science then always includes interpretation along with statements of fact: the hermeneutical circle arises out of the dialectic of perception. Yet the critique and refinement inherent in this historical process insure that science remains realistic. "True, science is something people do or it is

[*Zygon*, vol. 22, no. 3 (September 1987).]

© 1987 by the Joint Publication Board of *Zygon*. ISSN 0591-2385

nothing at all. But, more than that, science is something people do in order to try to find out the truth about some natural process—or it is not science” (p. 17).

The subsequent contributors to this volume do not always agree on the fine points of the philosophical discussion. Indeed, the difference among the authors emphasizes well the fluidity and diversity of thought concerning evolutionary theory and the philosophy of biology today. Space permits a look at only a few of the individual essays in this volume.

Robert N. Brandon explores the rationality of evolutionary explanations in his essay “Adaptation Explanations: Are Adaptations for the Good of Replicators or Interactors?” Replicators are entities of which copies are made—genes, memes, and so on—while interactors are entities whose interactions with the environment cause differential replication—for example, organisms, chromosomes, and groups. Contrary to Dawkins, Brandon argues that, when an adaptation is said to be “for the good of something,” that something is an interactor, *not* a replicator. Because adaptation explanations in biology, as opposed to those in other sciences, answer what-for questions, they concern the *causal history* of a particular trait evolved due to natural selection. Since natural selection works on phenotypes, adaptation explanations will always refer to interactors. If selection indeed occurs on various interactor levels (i.e., groups and species as well as organisms), then adaptation on these levels will occur as well. Thus by carefully analyzing the language of evolution, Brandon makes three important claims: first, interactors are the ultimate units of selection; second, a hierarchy of levels is biologically significant; third, purposiveness has a place in biological explanations.

C. Dyke critiques reductionist programs from a different angle in his article “Complexity and Closure.” Dyke defines closure as the establishment of sufficient boundary and control systems so that only certain *alternative outcomes* are possible in an investigation. He argues that the high degree of complexity in biological systems renders closure very difficult. While neo-Darwinians have achieved great success by assuming a simple closure in terms of a reduced mechanistic system, they have in Dyke’s opinion limited the extent to which they will understand evolution because they have not faced squarely the complexity of the phenomena they study. For example, Dyke reviews the application of game theory to evolutionary problems, demonstrating why serious *treatment of hierarchical complexity and closure*—often lacking in sociobiological treatises—is necessary for the fruitful use of such theories. In addition, he outlines problems with classical selectionist explanations which assume that situations of scarce resources act as single-level closure conditions. This serves as a warning that the extension of laboratory results to nature is a problematic maneuver in evolutionary biology. Dyke, like Brandon, underscores the importance of a hierarchical understanding of biological systems and also lifts up difficulties with some of the root assumptions of Darwinian evolutionary theory.

John H. Campbell argues that the organism plays an active role in the evolutionary process in his essay “An Organizational Interpretation of Evolution.” This critiques classical Darwinian theory which assumes that organisms remain passive in the selection process caused by environmental change. Campbell cites recent evidence showing the ways in which genetic elements forward and direct evolution. He suggests how adaptation could anticipate evolution in some instances, preparing the organism for future environments. This perspective on evolution, radically different than that of the neo-

Darwinians, even questions the Central Dogma of genetic theory: genetic information always passes *unidirectionally* from DNA to RNA to protein.

A book of collected essays as diverse as those in this volume might be frustrating without a clear integrating vision. Depew and Weber provide this integration in the final article "Innovation and Tradition in Evolutionary Theory: An Interpretive Afterword." This essay is quite an achievement, bringing into focus the major issues raised by the articles in the book and showing the similarities and differences among the various authors. Incorporating their own insights as well as significant information from other sources, the authors offer their assessment of the significant questions in evolutionary theory and the philosophy of biology, and ponder the future of Darwinism.

Evolutionary theory and reductionism are controversial within and outside the biological sciences. Both continue to influence theology. This book does not explicitly pursue theological topics, but its insights will be helpful to those interested in relating evolution to theologies of nature, human nature, and creation, as well as to those interested in sociobiology and its critique. A. R. Peacocke's *Creation and the World of Science* (Oxford: Clarendon Press, 1979) provides an interesting corollary, since it discusses the theological implications of some of the philosophical points raised in this book (e.g., teleology and hierarchy). Although the articles are clearly written, they are not for beginners: some prior knowledge of evolution and the philosophy of science would be necessary. However, the first and last essays provide an extremely helpful interpretive context for the particular issues raised by the various contributors, making this a very approachable and enlightening collection.

STEPHEN G. GOETZ
Theology Department
Xavier University

Biophilia: The Human Bond With Other Species. By EDWARD O. WILSON. Cambridge, Mass.: Harvard University Press, 1984. 157 pages. \$15.00.

This is a remarkable book. We all know who Edward O. Wilson is. He is the author of *Sociobiology: The New Synthesis* and several other works. He is the man who thinks that we are genetically determined machines—puppets dangling at the ends of strings manipulated by selfish DNA. He is the man who thinks that women, blacks, and homosexuals are biologically inferior, and who would like capitalist morality enshrined in stone as (he believes) it is undoubtedly enshrined in flesh. He is . . .—but, we all know how the litany goes on. As it turns out, he is also a man with a passionate love of the living world, with a deep commitment to ecological conservation. He is the author of *Biophilia*, an immensely moving personal tribute to his subject of biology, to his fellow workers in the field (especially to his collaborator on his seminal theory of island biogeography, the late Robert MacArthur of Princeton University), and to the animals and plants around him whose study has been Wilson's lifelong avocation.

[*Zygon*, vol. 22, no. 3 (September 1987).]

© 1987 by the Joint Publication Board of *Zygon*. ISSN 0591-2385

Wilson's critics accuse him of being an arch-reductionist. In fact, they could not be more mistaken. He is the most holistic thinker I know, seeing everything as part of an interwoven whole; to rip some element from the unity is to mar the order and to make incomprehensible the fragment. This makes it almost impossible to give an adequate review of *Biophilia*, for to review is to dissect and destroy. In this book Wilson tells us of his childhood and of his growing love of nature. He tells us of his travels in pursuit of his beloved ants. He tells us of his hopes and fears for the Brazilian rain forests. He does not do this in any hard logical order but, rather, as an older naturalist might tell a younger colleague, as they lie in their hammocks at the end of a day in the field, looking at the shadows cast by the fire. Ideas flow and ebb, a thought is chased and dropped and then chased again, an important idea is mixed with trivia—a forgotten scent—and then the naturalist is musing about something else. To pull this meditation apart is to spoil its beauty.

However, philosophers are insensitive brutes, especially when they have reviews to write. Let me pick out two (related) ideas: one where I think that Wilson is absolutely on target and one where I am not so sure. The question at issue is humans and their relationship to the living world. Should we practice conservation? (Of course, the answer is that we should—but why?) Is there an argument based on nature itself which forces us to argue for a conservation ethic? Wilson argues that there is: at least, he offers two arguments, one pointing to an obligation with respect to the present and the other pointing to an obligation with respect to the future.

For the present, Wilson argues that it is part of our evolved nature that we require life around us. It is not just an aesthetic response which makes us recoil from plastics. Rather, those of our would-be ancestors who harmonized with life survived and reproduced better than those without such a need or ability to harmonize. We cannot do without the living world any more than we can do without food or sleep. Hence, we simply must practice conservation, or we who are living will wither and die.

I find this a powerful and convincing argument. More cautiously, since obviously this is a sociobiological argument and like all sociobiological arguments today there is much yet to be established, I find this a powerful and convincing way to start thinking about conservation. I am not sure that Wilson is establishing a *moral* obligation. At least, he does not establish one for myself although there may be such an obligation for my fellows. Still, he certainly shows that life about us is more than simply a preferred option, like air-conditioning in the summer, which is nice to have, but not essential.

Yet, what of the future? Here, also, Wilson thinks nature makes demands. Because we have evolved, because we go on evolving, we have an obligation to the unborn generations. This includes the world about us. We are not just users; we are guardians for the future. The world is on loan to us. It is not ours to keep and to destroy. "For if the whole process of our life is directed toward preserving our species and personal genes, preparing for future generations is an expression of the highest morality of which human beings are capable. It follows that the destruction of the natural world in which the brain was assembled over millions of years is a risky step" (p. 121). Why is this a moral question? I cannot see that I have a *moral* obligation to untold future generations. I have one to my children and grandchildren, certainly. However, does it make any sense to talk of moral obligations to the denizens of Canada in the year 3,000—even if they are my descendants (and vanishingly near to me in the perspective of evolutionary time)? My feeling—my strong suspicion—is that

Wilson is caught on a shaky limb of the tree of evolutionary ethics. He thinks that meaning and value emerge naturally from the evolutionary process, and hence (and without further argument) we have an obligation to help life's path. All I can say is that this does not follow at all. One has an unacceptable leap from "is" to "ought."

However, I will not end on a critical note. What a sweet, beautiful book this is.

MICHAEL RUSE
Professor of History and Philosophy
University of Guelph

From Aristotle to Darwin and Back Again: A Journey in Final Causality, Species, and Evolution. By ETIENNE GILSON. Translated by JOHN LYON. Notre Dame, Ind.: University of Notre Dame Press, 1984. xx + 209 pages. \$11.95 (paper).

Etienne Gilson was among the foremost historians of philosophy of the twentieth century. He died in 1978 at the age of ninety-four, with approximately 700 published titles to his credit, 100 of them dating from after his seventy-fifth birthday. He wrote the present study in his mid-eighties. His two best-known works are *The Spirit of Medieval Philosophy* (Gifford Lectures 1930-31, New York: C. Scribner's Sons, 1936) and *The Unity of Philosophical Experience* (William James Lectures given at Harvard University in the first half of the academic year 1936-37, New York: C. Scribner's Sons, 1937). After World War I he was professor of the history of philosophy at Strasbourg until 1921, when he became professor of medieval philosophy at the Sorbonne. During the late 1920s he was a visiting professor at Harvard. In 1931 he was appointed to the Collège de France and in 1947 was elected to the Académie Française. In 1951 he became full professor at the Pontifical Institute of Medieval Studies in Toronto, where he taught until his retirement.

The title of the present work reflects its order of treatment. The first chapter ("Aristotelian Prologue") describes Aristotle's position on purpose or teleology in living things. The next two chapters ("The Mechanist Objection" and "Finality and Evolution") deal with the mechanist objection to teleology and with the theory of evolution as developed by Charles Darwin. The return to Aristotle, described in the last three chapters ("Bergsonism and Teleology," "The Limits of Mechanism," and "The Constants of Biophilosophy"), is a renewal of natural theology, drawing on the thought of Henri Bergson and some contemporary scientists. There are two appendices: a short one in Latin giving Carolus Linnaeus's "Observations on the Three Kingdoms of Nature," and a longer one containing an analysis of Darwin's *Origin of Species*.

The problem considered in this work is perhaps the central question for the whole relationship of science and theology, and hence is of enormous importance for the readers of *Zygon*. A *methodological exclusion* of purpose or final cause from the explanatory framework of the physical sciences, as advocated by Francis Bacon and René Descartes, is quite legitimate; but it became for some a *denial* of natural teleology. Teleology, however, lies at the heart of theology and religion. For God is (most often) regarded as a wise, loving, and powerful Creator who makes and governs the world for a purpose; and religion involves

[*Zygon*, vol. 22, no. 3 (September 1987).]

© 1987 by the Joint Publication Board of *Zygon*. ISSN 0591-2385

accepting a relationship to God in pursuit of a transcendent goal in some way, goal in some way.

Gilson in sketching Aristotle's position notes that in asserting goal or purpose as the explanation of structure in living things he was actually opposing the prevailing mechanistic view of the philosophers of his time. Human agents, who act for an end, seemed to him not only to be imitating nature but to be particular instances of nature, which is at work in them.

When the purpose of science became largely practical rather than speculative and appreciative, final causes in nature ceased to be important, and the way was opened for a pure mechanism, although many great scientists like Sir Isaac Newton resisted this implication. At the opening of the nineteenth century, along with the denial of final causality as a concern of science, there was a general acceptance of the fixity of species as illustrated by Linnaeus. The shift to transformation of species is associated with two names: Jean Baptiste Lamarck and Darwin. Lamarck posited a simple adaptation to environment along with the inheritance of acquired characteristics as the source of transformism. Darwin's great contribution was "natural selection" as the cause for the origin of distinct species. (The expression *evolution* came from the philosophy of Herbert Spencer and was used by Darwin only in the sixth and last edition of his *Origin of Species*, and then only incidentally.) Thomas Malthus's insight into the struggle plants and animals for the available food supply gave Darwin a basis for the operation of natural selection. Although Darwin thought his position destroyed the reliability of the Bible, and hence of religion, he still saw a kind of purposefulness at work in the "descent of man." Yet he would not give this a theological value.

In response to all this Gilson deals with the thought of Henri Bergson on final causality, not because he thinks it correct or its subsequent influence important but because it renews the question of final causality and enables Gilson to propose what he considers the true and Aristotelian understanding of finalism in contrast to Bergson: "that of forms immanent in nature and working from within to incarnate themselves there by modeling matter according to their law" (p. 99). He repeats this in a somewhat different form two pages later: "... substantial form is a plastic energy operating in matter in order to realize there concretely the idea which it is" (p. 101).

Gilson contends that it is possible to raise the question about final causes and to observe their influence without making an implicit assumption about an ordering divine intelligence; this may well be a legitimate inference, but it is not a necessary presupposition. It is only necessary to recognize that the present activity of organized matter truly intends or points to some future state or result, in order to recognize and affirm the reality of final causes.

The thesis of this work is carefully argued, and it well rewards careful consideration. Unfortunately, many persons are so restricted by the scientific method that it is difficult for them to grasp the philosophic point being made here: we are confronted with a manifest phenomenon which "moving" causes (which alone sciences take into account) by themselves are unable to explain; that is, the very structure of living matter. Aristotle perceived that this structure has within it as the principle of its coherence an orientation or tendency to a goal or purpose or final cause. This is the term to which the present tendency of acting matter is relative. The organized matter that we name an acorn does in actual fact "intend" (though not, of course, consciously) an oak tree. *Chance* is simply the denial of any explanation of this structure, not itself an explanation of any kind.

The translation, on the whole, is quite faithful to the original. However, at one point where the original remarks that the name *soul* prevents us from forgetting its existence and even permits us to affirm it, the translation says that the name "warns us to forget its existence, while affirming the thing it names" (p. 127)—a statement which yields no tolerable sense.

There is one curious lapse that is not the fault of the translator but a mistake of the French original. Bacon is reported to have assigned material and formal causes to physics and final causes to metaphysics. It should have said that Bacon assigned material and efficient causes to physics and formal and final causes to metaphysics. The mistake becomes evident on the following page where we read, "After the critique of the formal cause comes that of the other metaphysical cause, the final one" (pp. 22-23).

The introduction by Stanley L. Jaki is generally helpful but has some misleading statements. He refers on page xvi to Chapter 7, whereas the book has only six chapters. On the next page he speaks of living things as organized from "nonheterogeneous parts." The "non" should be omitted, as is clear from many places in the text (see, e.g., p. 5).

It is important to observe that the thesis of this work in no way opposes science or the scientific method. It simply points to a reality which science by itself, by reason of a methodological limitation, is incapable of treating but which constitutes an important part of the intellectual context in which scientists must work. It supplies them with a perspective that enables them to transcend their specialized work and to relate it to the broader world of philosophy and religion. It enabled Lucien Cuénot of the French Academy of Sciences to observe, "It is not foolhardy to believe that the eye is made for seeing" (p. xx).

JOHN H. WRIGHT

Professor of Systematic Theology
Jesuit School of Theology at Berkeley

Beyond Mechanism: The Universe in Recent Physics and Catholic Thought. Edited by DAVID L. SCHINDLER. Lanham, Md.: University Press of America, 1986. 156 pages. \$22.75, \$10.75 (paper).

The title of this small, worthy volume is more comprehensive than the contents: it contains four Catholic responses to the philosophical views of the physicist David Bohm, as well as the response of one non-Catholic, John B. Cobb, Jr. While Bohm is a seminal figure, he cannot be taken as mainstream in recent physics. Further, some developments of cosmological interest—for instance, the anthropic principle—are not mentioned here at all. Finally, most recent Catholic cosmological thought, which is not surveyed in this work, proceeds independently of Bohm's thinking.

Still, this collection focuses on and aspires to comprehend a significant part of the whole designated in the title. Bohm presents a model of the universe as an unbroken and seamless whole, with responses by five critics. These papers are the result of a conference held at the University of Notre Dame in 1984. Prefacing the collection, David Schindler contrasts Cartesian mechanism with

[*Zygon*, vol. 22, no. 3 (September 1987).]

© 1987 by the Joint Publication Board of *Zygon*. ISSN 0591-2385

Aristotelian organicism, convinced that Bohm is recovering a "forming and finalizing activity" in nature (p. 4) long eclipsed by science.

Bohm gives a fine summary of what he calls the implicate order. "The universe is . . . an *unbroken whole in flowing movement*" (p. 18). That prior reality, the one, is unfolded into the many, the explicate order. "All matter, animate and inanimate, unfolds from a greater whole and folds back again into it" (p. 28). This world picture is available in more detail in Bohm's *Wholeness and the Implicate Order* (London: Routledge & Kegan Paul, 1980).

Cobb follows with a keen appreciation and criticism, especially of Bohm's determinism, in favor of openness in the implicate order (pp. 41-45). Cobb listens as carefully and criticizes Bohm as forcefully as anyone in the book. One begins to wonder whether, if the implicate order is significantly open, it can be fully characterized as an implicate order since much of what occurs does not simply unfold. Events of self-determination emerge along the way, within the options and constraints provided by the past. The world becomes more pluralistic and historical; the future is only partially implied by the past. There are surprises in the implicate order.

Continuing the effective criticism, Frederick J. Crosson analyzes diverse meanings that implication can have, meanings not always distinguished in Bohm's account. There are various senses in which parts are and are not implied in and from the whole (pp. 52-54). John H. Wright follows with an essay that owes more to Teilhard de Chardin than to Bohm; although Wright does not particularly criticize Bohm's account, he does offer an alternative and parallel.

William J. Hill examines "the implicate world" (p. 78) through a Thomist perspective that makes little contact with either Bohm or physics. Concluding a somewhat dense metaphysics, he realizes that Bohm's view needs to be enriched with a sense of history and narration (pp. 88-89). Kenneth L. Schmitz asks whether time itself embodies a sort of implicate order that is largely tacit, one that can be disclosed through metaphysical analysis. In a sophisticated analysis, congenial to but extending Bohm's thought with the irreversibility of time, he concludes that it can. Schmitz works from Edmund Husserl and Immanuel Kant, and there is, again, less contact with recent physics (for example, the relativity of time, or the lack of simultaneity at a distance) than one might expect in a volume with this title.

Bohm then replies to his critics, and there is, at the end, reprinted from *Zygon* 20 (1985):111-24, an autobiographical account of how he came to his views. Several authors find that mechanism did not remain in physics but infected philosophy and theology, fragmenting our modern world outlook. We make fragments of things and then find ourselves fragments in the world we inhabit (Bohm, p. 36). If physics has now moved beyond mechanism, as Bohm maintains, then, by parity of reasoning, philosophy can move to a more integrated world view, and this can be congenial with Catholic thought.

Bohm's holism is exciting, but it can get intense; the challenge is to keep it consistent not only with the evidence from physics but with our total world experience. Bohm claims, "All parts of the universe are connected by indivisible links, so that there is no way ultimately to divide the world into independent existent parts. . . . Since indivisible connection may extend even to distant regions of space, it follows that the very nature of each part may depend significantly on what is happening in places that are quite far from it" (p. 20).

Perhaps. Relativity and quantum theory do relate things, but they also disconnect things. Vast parts of the universe are in remote contact with each

other (involving thousands of light years of signal time), and some parts of the universe are out of causal contact entirely. There is no universal simultaneity. Bohm and his disciples prefer to give heavy weight to somewhat anomalous events that suggest instantaneous contact. "The evidence now is that this enfoldment is not limited to events in its light cone. It seems that information can be transmitted instantaneously" (Cobb, p. 45). However, that is no settled conviction in recent physics; it is a minority report. We certainly do not have much (any?) evidence that historical events on Earth are currently influenced by worlds outside our light cone—worlds with which we have never exchanged light signals—or even by worlds within our light cone that are light years away.

Leaving the cosmological scene and restricting our view globally to events on Earth, one can wonder whether Bohm's holism leaves enough room for the pluralism, novelty, and diversity displayed around the continents and across the centuries of history. "In the implicate order, everything is enfolded into everything. . . . The whole universe is in principle enfolded into each part . . . in different ways and in different degrees . . . but the basic principle of enfoldment of the whole is not thereby denied" (p. 26). Any particular thing—an atom in my hamburger, a tree in Brooklyn, the Ozark Mountains ecosystem—is explicated from this order. "Explicate orders emerge as sets of relatively autonomous, distinct and independent objects, entities and forms, which unfold from implicate orders" (p. 31). In each explicate part the implicate whole is (fully?) present; in the implicate whole each explicate part is (fully?) present.

Yet is this so? Snow leopards in Tibet live on the same planet with black-footed ferrets in Wyoming. They share some biochemistries historically and genetically inherited from the paleontological past; they both depend on photosynthesis; they breathe air that flows around the globe; a water molecule might somehow get transported from Tibet to Wyoming. But they also live in considerable isolation from each other. Each is a limited part of the story. It is hard to see how every earthen part can contain "in principle" all the cosmic implicate whole, as though snow leopards are in principle implicate in black-footed ferrets, or vice versa (though both no doubt obey some of the same laws). It is hard to see how there is an implicate whole that has all these parts forever determinate within it.

Relativity theory became explicate with Albert Einstein; was it somehow implicate when the Druids built Stonehenge? Moreover, is Stonehenge somehow implicate in Einstein? If not, what does "everything is enfolded into everything" mean? What "basic principle of enfoldment" is the key to understanding all these events?

Perhaps an organismic view is not the final word, left uncorrected by, for example, narrative, or historical, or communitarian models. Cobb begins to sense this when he worries that "Bohm goes too far in giving the primacy to the internal relation to the whole over the internal relation to other parts" (p. 48). The world of historical experience is a place of larger and smaller communities or societies, not always of organic wholes, with various stronger and weaker connections, and many disconnections—mixed dependence, interdependence, and independence. The scene is one of plural and unfolding story fragments, substories more or less valuable in themselves and more or less taking place integrated into longer story lines. The world is full of relationships and continuing stories, but it is also full of extinctions, chance events, statistical patterns, mutations, and the intersections of unrelated causal lines. Whether such a world is best comprehensively embraced as an explication of an impli-

cate order and how much authority physics has in this decision are still unsettled questions.

One wonders, reading Bohm's own story of discovering his views, his history, how much of his impetus for the implicate order is coming from outside physics. As he recounts his experience, Bohm was not satisfied with the picture he obtained in contemporary physics; rather he was dissatisfied with it because of its fragmentation, and he was driven to go beyond to posit an implicate order from which the fragments, parts, unfold (pp. 144-47). He was frustrated for a time, getting nowhere while working from the ideas that physics supplied. Later, from a study of order and human language he found ideas that he read back into physics (p. 151). Indeed, "the prime instance of the implicate order is consciousness itself" (Bohm, p. 129).

The picture of physics (if it is a picture) of particles as coming and going like vortices in a flow, or the analogies drawn with light waves where information about the whole scene is present at every point along the wavefront are all congenial to this model, but other evidence from physics was not so congenial. The model is really a metaphysical one, partially derived from physics but partially gained elsewhere and applied to it.

Minor blemishes mar the production of this book. An inexcusable typographical error occurs on page 56; book titles in references may or may not be italicized (cf. p. 64); there is prominent notice on the back cover of "other books of interest . . . by Nicholas Rescher," as if the one in hand were Rescher's.

In summary this collection is useful and stimulating, but not definitive.

HOLMES ROLSTON III
Professor of Philosophy
Colorado State University