

ical states (as that would make them ontologically of the same stuff as brain states) and do not reduce readily and simply to a form of matter (although they would surely have some properties that are material because otherwise the causal relationship they have with brain states would not be understandable in natural science). If Smythies does adopt this form of Dualism (call it non-traditional Cartesian dualism), it would raise a question of just what Smythies means when he says he is a materialist, as he does on page three. For those of us who find materialism objectionable, the term designates the view that mental events are no more and no less than brain states or biological states caused by brain states. On this view, consciousness and the whole of human personality disappears with the death of the brain. It may seem obvious to some that human consciousness, and, by implication, at least some part of a person's identity disappears with the death of consciousness. I take it, however, that that is just what Descartes was intent on denying. Is that what Smythies sees as implied by his proposal offered in the last chapter, should it prove to be confirmed in natural science? If so, then consciousness or mental events really are just part of an unseen lobe of the brain but no different in kind than any other lobe to be found there. That's classical materialism straight up and on the rocks. I suspect that Smythies' view is the sophisticated form of Cartesian Dualism not unlike C. D. Broad's later view and allows for the *post mortem* survival of human consciousness — and to the extent that one's consciousness is identifiable with one's personality, human personality.

But all this is just chatter. This is a wonderful book and I strongly recommend it to anybody interested in the nature of human personality and what is implied and promised by all the available views.

*Robert Almeder*  
*Department of Philosophy*  
*Georgia State University, Atlanta GA.*

**How the Leopard Changed its Spots** by Brian Goodwin. New York: Charles Scribner's, 1994. 252 pp. \$23 (c).

(Brian Goodwin is professor of biology at the Open University, England, and author of *Temporal Organization in Cells and Analytical Physiology*, and co-author with Gerry Webster of *Form and Transformation: Generative and Relational Principles in Biology*.)

The beginning of modern biology can be dated with some precision to 1859 and the publication of Darwin's *Origin of Species*. For 125 years, the mechanism of natural selection, Darwin's vision of life as a chance variation in the hereditary material of organisms and the preservation of better variants in "survival of the fittest", has served as the only explanatory thesis for life on earth — for its array of forms and behaviors, its origins and extinctions. To paraphrase Keats, "Darwin is truth, truth Darwin. That is all ye know on earth, and all ye need to know."

Such is no longer the case. The "leopard" in the title is the science of biology, today poised for a massive change in theoretical perspective. Here Brian Goodwin, described by colleagues as "the poet of theoretical biology," proposes an alternative to the modern synthesis of Darwinism and twentieth-century genetics. Goodwin rigorously and clearly demonstrates the flaws in the quasi-religious fervor with which Darwin's theory of natural selection is defended, and presents another, equally powerful engine for the origin and diversity of species.

The consequences of this altered perspective are both scientific and metaphorical. The images of Darwinism that color so much of modern life — survival of the fittest, selfish genes, survival strategies — "a war of all against all" — are incomplete, says Goodwin. If we regard organisms as more than survival machines, they take on an intrinsic value, with worth in and of themselves. Darwinism has short-changed us, scientifically and ethically, for more than a century. This book demonstrates that organisms are every bit as cooperative as they are competitive, as altruistic as they are selfish, as creative and playful as they are destructive and repetitive. Erudite and elegantly written, accessible to the layman, this book gives a brilliant application of the laws of physics to the study of life, an exposition of the powerful force — not Darwinian selection — that shapes life on earth and a meditation on the evolution of complex forms. "There is always a price to be paid for excessive preoccupation with one aspect of reality. Modern biology has come to occupy an extreme position in the spectrum of sciences, dominated by historical explanations in terms of the evolutionary adventures of genes and an associated single-level molecular reductionism of gene products" (preface). We face another curious consequence of Darwin's way of looking at life: despite the power of molecular genetics to reveal the hereditary essences of organisms, the large-scale aspects of evolution remain unexplained, including the origin of species. There is "no clear evidence... for the gradual emergence of any evolutionary novelty," says Ernst Mayr, one of the most eminent of contemporary evolutionary biologists.

It is here that new theories, themselves recently emerged within mathematics and physics, offer significant insights into the origins of biological order and form. Studies of highly diverse systems are called "sciences of complexity", and offer characteristic types of order that emerge from the interactions of many different components. A particularly striking property of these complex systems is that even chaotic behavior at one level of activity — molecules, cells or organisms — can give rise to distinctive order at the next level — morphology and behavior: order emerges out of chaos. The consequences of this altered perspective are considerable, particularly in relation to the status of organisms, their creative potential, and the qualities of life. Organisms cease to be mere survival machines and assume intrinsic value, having worth in and of themselves, like works of art. These are not romantic yearnings and utopian ideals. They arise from the rethinking of our biological nature that is emerging

from the sciences of complexity and is leading toward a science of qualities, which may help in efforts to reach a more balanced relationship with the other members of the planetary society.

In his book, Goodwin follows the development of a gene-centered biology and its logical consequences, the predominance of the genetic program as an explanatory model. Yet the question remains: what kind of physical process is capable of generating a level of organized complexity, defining the dynamic context within which genes play an important, but limited, role? The physico-chemical experiments responsible for the making of patterns (chemical waves, the Belousov-Zhabotinsky reaction) are discussed in detail. Order and chaos in space-time is presented for brain waves as well as EEG measurements on olfactory bulbs, and even models of ant colony. The author devotes much attention to the living form in the making, and the extraordinary variety of structure and form in living systems, which leads him to consider the role of morphogenetic fields and generic forms. The evolution of generic forms is related to fundamental laws of mathematics, such as the Fibonacci series and the Golden Section. Homeotic transformations (based on similitude) are discussed, as well as gene-activity patterns and morphogenesis, particularly in the case of limb formation in animals. Similarity of forms in evolution, and even the origin of the eye postulated as the result of random variations, reveal many unanswered questions.

These considerations lead the author to search for new directions and new metaphors, agents and causes: the evolution of emergent order with life at the edge of chaos. Modern physics and new mathematical concepts open new perspectives, such as "Alchemy" (for Algorithmic Chemistry), ideas on self-reproducing networks and on the origin of life.

Goodwin's final conclusions deal with the science of qualities, of relationships which cannot be reduced to a simple, quantitative description. His reflections on the quality of life and the biological foundations of health indicate that "a science of qualities is necessarily a first-person science that recognizes values as shared experiences, as states of participative awareness that link us to other organisms with bonds of sympathy, mutual recognition and respect" (p. 237). The book has both a useful index and bibliography.

*Z. W. Wolkowski  
University P. and M. Curie  
Paris*