Shanahan explores in detail the debate about individual and group selection. He provides a valuable summary of the work of V. C. Wynne-Edwards, who proposed that there must be some signal associated with crowding that leads crowded organisms to adjust their reproductive rates downward. The powerful counterargument to Wynne-Edwards’s view, based on individual selection, is that a cheater who is unaffected by the signal will outreproduce other members of the group. Shanahan also examines the various types of selection for altruistic behavior, including mechanisms such as kin selection, which Darwin was the first to explore. He concludes, in agreement with current evolutionary thought, that while group selection may be important in instances such as the selection of virus populations in individual hosts, Darwin’s insight that individual selection is overwhelmingly important still holds.

The second section of the book, on the changing meaning of adaptation, ventures further into the realm of the philosophical. Although Darwin fully realized that no organism can be perfectly adapted to its environment, he and his contemporaries were guilty of using the term “perfection” more often and more loosely than they should have done. It is clear, as Darwin gradually began to conclude through succeeding editions of *Origin*, that adaptation is not the only source of evolutionary change. Shanahan examines the tendency of evolutionists to construct just-so stories about adaptations, and the difficulties that have resulted, though he does not make the point (an important one, I think) that the proper way for science to proceed is to suggest a just-so story as a hypothesis and then to test it. The ability to test such stories, through clever field and laboratory experiments, is one of the ongoing triumphs of the neo-Darwinian synthesis.

Shanahan performs a valuable service by tracing the history of the question of what constitutes the unit of selection—the gene, the organism, or the population. He summarizes the arguments of many biologists that this, too, is an artificial division. If a chicken is an egg’s way of making another egg, in Samuel Butler’s memorable phrase, it is equally true that an egg is a chicken’s way of making another chicken. Evolution cannot take place on genes in the absence of organisms, or vice versa, and of course changes in populations are the ultimate result of evolution. Shanahan summarizes: “Because biological entities are causally connected in complex ways, perhaps the only truly accurate account of natural selection includes biological entities and their causal interrelations at a number of different functional levels, and treats entire biological systems as subject to selective forces.”

The last part of *The Evolution of Darwinism* deals with evolutionary progress. Just as Darwin tended to use “perfection” in a poetical rather than a scientific way, his writings are full of the use of the term “progress.” But Shanahan, following in the footsteps of others such as Michael Ruse, shows clearly that Darwin was conflicted. He knew that simple organisms have changed very little since the beginning of life, so that any evolutionary tendency toward greater complexity has not affected them. And yet organisms such as humans are so complex, with so many new and emergent properties, that surely there must be some tendency toward the selection of such complexity under some circumstances.

The book’s last section is an excellent summary of the conflicted thinking of many evolutionists about this question. But it does not quite come to a resolution. One can perhaps reach such a resolution by abandoning the term “progress” entirely. In the course of evolution, organisms simply adhere to the philosophy of Tammmy boss George Washington Plunkitt, who memorably said, “I seen my opportunities, and I took ‘em.” The opportunities available to complex organisms have increased during the history of life—it is unimaginable that humans could have appeared, or survived, on Precambrian Earth.

This is a thoughtful and clearly written book that serves as a fine introduction to the ways in which evolutionary thought has itself evolved since the time of Darwin. I learned a lot from it, and I feel confident that anybody who is fascinated by these centrally important ideas will also take something useful away from it.

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**HOPE FOR MIND ON EARTH**


This is a hopeful work. Hope shines through despite the litany of worldwide environmental worries that the book documents. Hope chimes out despite the conclusions of many contributors that the biosphere is so highly nonlinear and supercomplex that we—the human enterprise—will have to make tough decisions about the future in the face of tremendous uncertainty and limits to our analytic and predictive powers.

The volume is the edited product of a Dahlem workshop held in Berlin in 2003. Dahlem workshops gather top scholars for week-long interdisciplinary retreats that avoid formal presentations so that the 40 lucky participants can jump into the depths of their collective knowledge, using previously circulated position papers as springboards. Published papers resulting from these workshops are put through a rigorous review process, as are the group reports, which in this case are outstanding.

Readers of *BioScience* will be familiar with the title concept of sustainability, which Clark, Crutzen, and Schellnhuber, in the introduction, call the “most recent big idea in the history of the Anthropocene.” (“Anthropocene” proclaims a new geologic epoch in which humans are a planetary force.) But what about the other term in the book’s title, “Earth system analysis”? This conceptual frame-
work treats the biosphere as a self-organized, interconnected whole that is simultaneously biological, chemical, and geological. What’s new here, to my mind, is the full inclusion of humans (also called the “anthroposphere” in this book) within Earth system analysis. The result is a suite of papers that range from the origins of life and astrobiology to requirements for new forms of human institutions and, in a sense, even new forms of mind.

The four papers of the first section tackle such questions as these: Is life an inevitable planetary phenomenon? And what are the major transitions in evolution? The effects of life on the chemistry of the biosphere (or Gaia system) are seen primarily as by-products of local selection (Volk 2003). But as the evolution of new kinds of metabolisms affected the global chemical matrixes of air and water, these matrixes in turn affected the subsequent evolution of life. Uncertainties in dating make it problematic to discern causes and effects in the coordinated system of biological and geochemical events over Earth’s history. Yet overall, the group report about this coordination, by British biogeochemist Tim Lenton and coauthors, is the best state-of-the-art statement I have read.

The second section focuses on the Earth system during the late Quaternary, a period that roughly covers the last of several glacial cycles of 100,000 years each. In the group report, led by oceanographer Andy Watson of the University of East Anglia, we are treated to a picture of the Quaternary Earth as a system as complex as any symphony, with harmonies played out by vegetation, carbon dioxide, methane, dust, ocean circulation, and other system properties that rise and fall (or fall and rise) along with the global ice sheets. But just as we stand in awe trying to imagine the process by which Beethoven or Mozart composed, so the experts stand in awe before the dynamic, cyclic Earth during the ice ages. Indeed, the group report concludes that a main lesson gained from scientific efforts to understand the Quaternary Earth as a system is that we are now “aware of our own ignorance.”

Paul Falkowski and Dan Tchernov of Rutgers University take us headlong into the Anthropocene in the third group of papers, with their intriguing piece called “Human Footprints in the Ecological Landscape.” It is perceptive of them to emphasize the awareness of death as a factor in the evolution of culture (Volk 2002), a factor still, of course, in play today. This, as well as several other factors they cite, such as the desire to accumulate wealth, may have created the high degree of human cooperation that has led to humanity’s runaway success story. We now not only rival natural processes as a biogeochemical force, as detailed by other papers in this Anthropocene section. We also threaten the stability of those natural processes.

The book’s fourth and final section moves into sustainability itself, and thus into issues such as the relationship of science to public policy, institutional reform, and crises caused by globalization’s
impacts on ecological interdependence. For me, one of the most interesting pa-
ners in the volume is Wolfgang Lucht’s “The Mental Component of the Earth System.” Lucht, at the Potsdam Institute for Climate Impact Research, proposes a “tetrarchical loop” between four mental components, which he calls GeoScope, GeoGraphy, GeoMind, and GeoAction. The loop involves large-scale social prop-
erties, such as observation and theory, knowledge and social contexts, govern-
nance, and identity (Lucht dares to sug-
gest that we—again, the human enterprise—need to ask who we are and
what we want to be in the future). Thinking about ourselves and using metacog-
nition to examine the process of cognition is what truly made us, in an evolu-
tionary sense, human (Terrace and Metcalfe 2005). If the unconscious cou-
ping of desire and cognitive powers is a large contributor to global environmen-
tal problems, then becoming more conscious of our cognition and its effects is
indeed what we need.

Environmental problems require men-
tal solutions. We need to internalize the planet, to bring the biosphere home
(Tomashow 2001). Developing meta-
cognition on a global scale is also em-
phasized in the final group report by
Arizona State University urban ecologist
Ann Kinzig and coauthors, who use terms such as “global self-awareness” and “global will.” Sustainability will require a com-
plete Earth system analysis that takes into account not only biology, chemistry,
and geology, but psychology and sociology as well.

Who is this book for? Who will bene-
fit? Direct your favorite students, gradu-
ates, and bright undergraduates to this book and let them feast on their areas of
interest. A few papers are too technical for
anyone but disciplinary experts. Most,
however, are excellent for an overview
of a field, especially if you want to catch
up on some ideas related to but not ex-
actly coincident with your own.

In this book, great minds have assem-
bled ideas into a system that reflects the complexity of the biosphere itself. Many
of the authors reveal a sense of awe, hu-
mility, and concern, to which they have been led by their understanding. The
mixture of expertise and emotion is
heartening. The human mind is here on
the physical Earth, and we can all hope it is here to stay. This can best be ensured
by directing our minds to Earth as a field
of knowledge—and to ourselves, because we are now part of the biosphere sys-
tem. So doing will foster hope. In the
closing words to this volume, our “dreams
tell us not merely to persist but to thrive.”

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References cited
Terrace HS, Metcalfe J, eds. 2005. The Missing Link
in Cognition: Origins of Self-reflective Con-

Tomashow M. 2001. Bringing the Biosphere

the Cycle of Life. New York: John Wiley and
Sons.

———. 2003. Gaia’s Body: Toward a Physiology of the

FIGHTING TO STAY ALIVE

Striper Wars: An American Fish Story.
Dick Russell. Island Press/Shearwater
$26.95 (ISBN 1559636327 cloth).

Make way, Clive Cussler and Nevada
Barr. In Striper Wars: An American Fish
Story, environmental journalist Dick
Russell writes a page-turner of a natural
history tale every bit as suspenseful as
the best murder mystery. In Russell’s
story, though, the victims are fish. And
we’re the perpetrators of the crime.

For the past 20 years, Russell has writ-
ten books and articles on crises facing
the world’s oceans. A long-time sport
fisherman, Russell is deeply involved in
the battle to save the striped bass (Morone
saxatilis).

In his latest book, Russell takes us into
watery depths where striped bass have
narrowly escaped death, not once, but
several times. In the 1960s, striped bass in
New York’s Hudson River began to die by
the millions. Dogged marine biologists
and fishers-turned-investigators braved
threats of bodily harm to find out why.
The culprit turned out to be the water in-
take system of the Indian Point nuclear
power plant, a finding that prompted a
near riot and led to the cancellation of a
proposed pumped storage facility at
nearby Storm King Mountain.

By the 1980s, striped bass were in such
decline that the fish seemed destined to
join the bald eagle on the endangered
species list. But through the efforts of
fishers like Russell to curtail striped bass
landings, a population estimated at about
4.6 million in 1982 reached a historic
peak in 2004 of some 56.7 million fish.

The striper’s remarkable, albeit tem-
porary, comeback has become part of
modern conservation lore. It’s hailed
from coast to coast as an example of a fish
with a management plan that—for a
while—worked: Stop overfishing, and
the fishery will rebound.

Striper Wars: An American Fish Story is a
behind-the-scenes look at what Russell
calls “a story about a magnificent fish
and those of us who have fought against
commercial interests and government
bureaucrats to bring it back from the
brink.” Although set mostly along the
US East Coast (the “striper coast”), the
book is also important reading for those
concerned about threatened and endan-
gered fish throughout the world’s oceans,
including cod, salmon, and all too many
others. Chapters like “How the Striped
Bass Stopped a Highway and Eluded the
Mob,” “Showdown at Friendship
Airport,” and “Revolt of the Biologists” in-
troduce us to the villains and heroes of
this piscine tale. Throughout, the striped
bass themselves valiantly try to swim on,
despite the political mongering taking
place ashore.

From providing a mainstay in the
diets of early Native Americans to in-
spiring the nation’s first conservation
law, striped bass have been part of our
history. Indeed, stripers play an important
role in human culture in river cities and
coastal towns all along the Atlantic
seaboard. Today, “to several million sport
fishermen like me,” writes Russell, “it is
the premier game fish to pursue: intelli-
gent, crafty, the ultimate challenge.”

References cited
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References cited
Terrace HS, Metcalfe J, eds. 2005. The Missing Link
in Cognition: Origins of Self-reflective Con-

Tomashow M. 2001. Bringing the Biosphere

the Cycle of Life. New York: John Wiley and
Sons.

———. 2003. Gaia’s Body: Toward a Physiology of the

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$26.95 (ISBN 1559636327 cloth).

M

References cited
Terrace HS, Metcalfe J, eds. 2005. The Missing Link
in Cognition: Origins of Self-reflective Con-

Tomashow M. 2001. Bringing the Biosphere

the Cycle of Life. New York: John Wiley and
Sons.

———. 2003. Gaia’s Body: Toward a Physiology of the