Book Reviews

The 10,000 Year Explosion: How Civilizations Accelerated Human Evolution. Edited by Gregory Cochran and Henry Harpending. xiii + 288 pp. New York: Basic Books. 2009. $27.00 (cloth).

In the early 1970s David Frayer, who was to be my first Ph.D, was looking for references to evolution within early modern humans and was surprised to find that at the end of David Pilbeam's new book reviewing human evolution, *The Ascent of Man* (1972), there were none. The book ended with the first appearances of (what Pilbeam considered) the first modern humans. This was conventional wisdom; when modern humans appeared, evolution was essentially over. However, Frayer (1976) did not believe it. He researched this issue and subsequently wrote his dissertation examining patterns and rates of dental change in upper Paleolithic and Mesolithic populations of Europe. Later, he showed that the rates of dental change within the upper Paleolithic were greater than the rates of change between the Middle and upper Paleolithic (i.e., between European Neandertals and post-Neandertal populations, reviewed in Frayer, 1992). Frayer (virtually alone) had found that the rate of human evolutionary change had accelerated in the Late Pleistocene, but it turns out that even he really underestimated how much so.

In their highly accessible book, Cochran and Harpending show how much so, explaining the genetic basis for accelerating human evolution, and illustrating it with some—let's say—unexpected examples. Like many real advances in science, the prerequisites for their insight have long been before us, but only recently did the pieces fit together (Hawks et al., 2007). Their thesis is that human civilization greatly accelerated increases in the size of the human population. More people mean more mutations and thereby more opportunity for evolutionary change under selection because some mutations are favorable. The spread of rapidly expanding populations eventually outpaced the spread of favorable mutations under selection in those populations, so for the first time in human history favorable mutations could not disperse through the human species.

Why was this unexpected? The relation of number of mutations to population size has been known for a very long time, although there is been a certain amount of confusion about the suspension of selection when population size is expanding. The significant recent increase in human population size was established by archaeologists some time ago (c.f. Hassan, 1981), even the basic shape of the pattern of population increase—an exponential curve virtually flat for most of human prehistory and virtually vertical today—was well understood. But until now the link between a recent very large population increase and accelerated evolutionary change because of many favorable mutations was below the radar screen and took the discovery of the mutations themselves to establish. It was not obvious because of the two reasons why evolutionary stasis is still conventional wisdom. First, stasis is expected from the widely believed theory that modern humans appeared recently as a new species that replaced archaic species everywhere because they were better adapted. Second, stasis follows from the widely accepted belief that the technological innovations of the Upper Paleolithic and beyond, and the consequences of complex social organization that followed the Neolithic, relaxed selection (Brace, 1995), even though the association of domestication and disease evolution was well established (Cohen and Armelagos, 1984).

Cochran and Harpending bring this together in a highly readable form, starting with their own take on the conventional wisdom that asserts the evolutionary process stopped when modern humans appear. They rely on quotes from the elders, in this case Ernst Mayr, and Stephen Gould who explicitly wrote: "there's been no biological change in humans in 40,000 or 50,000 years. Everything we call culture and civilization we've built with the same body and brain" (p. 1). They begin their discussion of "how wrong this is" with the Neandertals and their understanding and presentation of the Neandertals' significance and fate is quite good. These authors "get it" when so many paleoanthropologist specialists don't seem to—the significance of Neandertal genetic contributions to the modern gene pool is found in the importance of the genes that persisted, not in their quantity. This reflects the clear understanding that natural selection is the central driving force of human evolution, one of the key insights and most constant themes of this book. But for natural selection to have a chance there needs to be favorable mutations, or favorable combinations of existing alleles. Cochran and Harpending concentrate on the former, and focus on the Neolithic as the beginning of the significant population size expansions that provide the mutations to accelerate genetic change. Infectious diseases are a well-known consequence of the Neolithic and a new source of selection, but the origins of many more genes have now been traced to this period, with effects such as regional differences in skin color and skeletal gracility. More controversial speculations are about mental functions and behavioral innovations. By 5000 years ago the authors estimate that adaptive alleles were coming into existence at a rate about 100 times faster than during the Pleistocene. This is the "explosion" of the book's title.

Yet, the most interesting aspect of this book is what follows—the interpretation of the subsequent history of (for the most part) Africa and Europe in a biological framework that emphasizes evolutionary change. The recent history of so many genes is now so accurately known that in many ways this is no longer an exercise in speculation, but one of interpretation. "Recent studies have found hundreds of ongoing [selective] sweeps—sweeps begin thousands of years ago that are still in progress today. Some alleles have gone to fixation, more have intermediate frequencies, and most are regional. Many are very recent . . ." (p. 75).

If natural selection is a key ingredient of the historic overview (from the genetic perspective), surely gene flow is another. From the progeny of Genghis Khan on, "history is full of examples expanding at the expense of their neighbors" (p. 155). Important biological aspects of dispersions and replacements are found in the role of selection. Perhaps the biggest example is the role of European infectious diseases, a consequence of domestication and urbanization, in the political domination of native populations

during the times of European colonialism. Other examples more directly relate success to selection, as in the case of Chapter 7's title: "Medieval evolution: How the Ashkenazi Jews got their smarts" (p. 187). As a grandson of Ashkenazi Jews who emigrated to America, I would be pleased to think of myself as a scion of such natural selection, were it not for (as the radio commentator Paul Harvey would say) the rest of the story, which became one of population replacement. Besides, whatever happened to those blood group studies that showed Jewish populations across Europe were always more similar to other populations in the region than they were to each other?

Selection? Gene flow? It almost seems like Multiregional evolution, but in reality it is not because the Cochran and Harpending hypothesis is addressing a different question, it's all about change. In this perspective, perhaps the most important thing I personally got out of this book is how this much recent and present accelerated genetic change provides a lucid explanation for what I have gradually and reluctantly come to accept—the present is a poor guide for understanding the past.

Some of the content is objectionable, especially defense of biological inequality and the reification of race at a time when most specialists reject the notion that there is anything "natural" about human races, or that human geographic variation reflects genealogical entities that subdivide the human species. Some of the history seems questionable, or at best oversimplified, at least to this author, and the continued confusion of IQ with intelligence is simply irritating. Still, my plea is don't throw the baby out with the bath. The thesis of this book, its central hypothesis, is quite insightful and most probably correct. It presents a revolutionary explanation for recent human evolution and biological variation, based on an exploding genetic data set that will provide a continued means of testing it. We can look forward to seeing just how this particular testing will work out.

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Genetic Effects on Environmental Vulnerability to Disease., *Number 293*. Edited by MichaelRutter. viii + 223 pp. Chichester, UK: John Wiley and Sons, Ltd. 2008. $90.00 (cloth).

For many complex diseases, researchers are intensively debating the role of genetic and environmental factors for the new onset of these illnesses. Many of these diseases run in families, but the underlying genetic variation does not follow Mendelian inheritance. Many studies have been undertaken to identify linkage signals in family studies and to investigate polymorphisms in candidate genes in various populations, but reproducibility of results has been low. The development of new technologies to screen hundreds of thousand of genetic polymorphisms spanning the whole genome in genome wide association studies has renewed the hope to find the causal genes for complex diseases. But the findings did not come up to one's high expectations, though some important new genes were discovered. The heritability of these complex diseases can only very partially be explained.

These results gave researchers defending environmental causes of complex diseases a boost. The rapid increase in the prevalence of complex diseases over the last decades and the pronounced disparities of its prevalence in populations with the same ethnic background but diverging environmental exposures are convincing arguments. Therefore, the manifestation of a chronic disease is very likely the result of an inextricable interplay of biological and environmental factors. Also our gene pool has not been developed *in silico*, but is a result of millions of years of adaptation to changing environments. Complex diseases may thus be seen as a consequence of maladaptation to changing environments.

The book *Genetic Effects on Environmental Vulnerability to Disease* addresses the challenges in performing gene by environment analyses. It summarizes talks and discussions at a Novartis Foundation symposium on "Understanding how gene-environment interactions work to predict disorder: a life course approach". Methodological aspects, public policy concerns and application to a number of complex diseases such as depression, breast cancer, infections, and lung diseases are discussed. The methodological chapters are interesting to any reader interested in gene–environment interactions, and some of the chapters relating to individual diseases may be specifically interesting for an audience working in that specific area of research.

Much can be learned from approaches in other medical disciplines as the challenges are rather similar across disciplines. Is a G $\times$ E just a "nuisance" term that should be removed from statistical analyses to adequately partition the variance into genetic and environmental components or does it imply biological mechanisms? Can we find other disease genes in the context of environmental exposures than in nonexposed populations? How robust must such interactions be to infer biological causes? How can we link up population based studies with experimental work to refute or confirm epidemiological observations? Are these linear relations or do we need more complex concepts of gene–environment interactions? What about gene–gene and gene–gene–environment interactions?

This book addresses a timely debate and includes interesting discussions following the various presentations. It

is well written and provides a stimulating overview across a number of statistical and medical disciplines.

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Vitamins and Hormones: Folic Acid and Folates, Volume 79, Vitamins, and Hormones Series. Edited by Gerald Litwack . xviii + 462 pp. New York, NY: Academic Press. 2008. $95.00 (cloth).

Folic acid, also known as vitamin B9, and its relatives, have been recognized for many years as a family of cofactors that participate in one-carbon metabolism and such important cellular pathways like purine, thymidylate, and methionine biosynthesis. It recently also became more evident that folic acid homeostasis is critical in the context of important pathologies, such as cancer and Alzheimer disease. It affects levels of toxic metabolic intermediates, such as homocysteine and deficiency negatively affects DNA methylation as well as DNA synthesis and repair. Overall the book provides a comprehensive in depth overview of folic acids and folates, including their biochemistry and their impact on general cellular metabolism but it also covers important aspects, such as their potential usage in medical therapies.

The editor organized the book into 15 different chapters, which are thematically grouped first by aspects related to general metabolism of folic acids (Chapters 1–4), second, describing function and structure of folate transporters and receptors (Chapters 5–8), and third, enzymes participating in folic acid and folate-related metabolism (Chapters 9–15). Chapter 1 starts with a detailed description on folate mediated one-carbon metabolism in different cellular compartments and organelles, namely the cytosol, the mitochondria, and the nucleus. Chapter 1 also provides a nice overview of the biochemical pathways and the corresponding enzymes, which is further complemented by the following three chapters. Chapter 2 touches on an interesting aspect of how to use mathematical modeling of one-carbon metabolism mediated by folates as an investigative tool. Here, the authors suggest that by using already generated detailed knowledge about the individual reactions, mathematical modeling can help to better resolve the poorly understood regulatory network of the whole system of folate-mediated one-carbon metabolism. Chapter 3 deals with folate deprivation and its consequences on the accumulation of homocysteine and in Alzheimer disease. Here it becomes clear how critical normal homeostasis of folic acid metabolism is for the cell; it also provides a good preview of the compound's role for general cellular well-being and disease development, which is further discussed in, for example, Chapter 7 (Exploitation of the Folate Receptor in the Management of Cancer and Inflammatory Disease). How cells respond on the molecular level to folate deficiency is described in Chapter 4. This is of special interest for mammalian organisms including humans, because they do not have the enzymatic machinery to de novo synthesize the vitamin and consequently rely on its external uptake.

Different aspects of folate receptors are addressed in Chapters 5 to 8. The structure and function of reduced folate carriers in mammalian organisms are described in detail in Chapter 5 and Chapter 6 focuses on the meaning of folate transporter in renal conservation, an important field in folate research because these transporters play a critical role in preventing high rates of loss of folate and folate derivatives via the urine. Chapters 7 and 8 provide meticulous descriptions of the folate receptor, which is considered a tumor biomarker and a potential tool for therapeutic purposes to introduce cytotoxic folate drug-conjugates and antifolates into tumor cells. Finally, chapters 9–15 focus on enzymes involved in folate and folic acid related metabolism. For example, Chapter 9 reviews structure, function, and regulation of human dihydrofolate reductase, which catalyzes the regeneration of tetrahydrofolate. This enzyme is also discussed, like the folate transporters, as a target for chemotherapy because its inhibition affects vital biosynthetic pathways and may cause cell death. Similarly, controlling the pool of folylpoly-γ-glutamate homeostasis (Chapter 12) or enzymes, such as methylene tetrahydrofolate reductase (Chapter 13) are discussed as well as possible targets for chemotherapeutic approaches. Chapter 14 reviews in detail the mitochondrial folate pathway from serine to formate, and compares participating enzymes with the cytosolic ones. Chapter 15 concludes the book with structure and mechanistic studies on HPPK, a folate biosynthetic enzyme that catalyzes the step to the ATP-dependent formation of 6-hydroxymethyl-7.8-dihydropterin pyrophosphate, an intermediate in the folic acid biosynthetic pathway.

Overall the book nicely summarizes multiple aspects related to folic acids and folates thus providing the reader with current state-of-the art knowledge and a broad and thorough description of the vitamin and its related compounds. In addition, the book provides at the very end an attractive collection of colored figures from the different articles, which is greatly informative. Some chapters are difficult to read (e.g., Chapter 1) because the authors rapidly accumulate abbreviations for enzymes and compounds. This cannot be avoided due to the complex nature of the field, but it would have been helpful to have provided an appendix with a summarizing figure and table on folate metabolism and abbreviations used, respectively. In addition, it would have been helpful if the three thematic fields were clearly grouped into three independent sections. However, the book touches and describes such a broad variety of interesting aspects of folic acids and folates that it is a very helpful and recommended reading for the experienced reader as well as an important, informative resource for interested scientists new to the field.

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The Atlas of Food: Who Eats What, Where, and Why. Edited by Erik Millstone and Tim Lang. 128 pp. Berkeley, CA: University of California Press. 2008. $19.95 (paper).

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Often a picture, or a figure, is worth a thousand words. That tenet holds true for *The Atlas of Food,* an updated and revised volume in a series that includes endangered species, climate change, health, and religion. Unlike many a weighty atlas, this one has an accessible and visually appealing format for presenting graphically an array of sobering data and trends. Forty themes are provided grouped within sections designated as contemporary challenges, farming, trade and processing, retailing and consumption. Human health indices like obesity rates, number of meals eaten out, levels of alcohol use, and liver disease are included along with environmental and structural criteria like inequities in distribution, future river flows, and depletion of fish stocks. Taken together, they yield considerable insights into the scope and complexities of critical matters, the interconnectness of human health with the world's food systems, and other global political and economic developments.

The atlas includes a number of creative avenues for visualizing information. Comparative emissions are provided for transport by ship compared to air. Nutrition shifts reveal a steep climb in consumption of animal products, sugars, and sweeteners and are effectively set against figures revealing an explosion in the sheer number of invented flavoring agents and an alarming growth in pesticides, fumigants, and chemical fertilizers entering our soils, waters, and bodies. Other useful ways to present data include trends in "burgerization" and in disproportionate advertising for fatty and sugary foods compared to balanced diets.

Not all domains are easy to depict or map; however, the impact of climate change is so vast that having to select from so many potential indices is inevitably unsatisfactory, while visualization of the critical dimensions of fair trade or citizen activism is scanty at best. Topics are modestly sourced, including mainly electronic and internet resources. Tables are also included for national data on agriculture (such as extension of arable land, levels of agrochemical use, meat production) and consumption (including access to water and indices of undernourishment and overnourishment).

For younger generations steeped in visual inputs, this atlas is an ideal entry point for stimulating interest and further investigation. For all its depressing topics—from numbers of species at risk, to the lunacy with which bloated trade volumes are subsidized with little regard for the health of natural systems—this small volume also conveys a good deal of hope. Varied urban farming practices and growing emphasis on organic production provide just two positive trends, revealing that the irrevocable link between food and power can also shift from inequities and dependencies to systems that are vastly more sustainable and just.

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The Anthropology of Childhood: Cherubs, Chattel, Changelings. Edited by David F. Lancy . xii + 466 pp. New York, NY: Cambridge University Press. 2008. $99.00 (cloth).

Lancy's book demonstrates that the anthropological study of childhood is a rich field of inquiry, contrary to recent suggestions (Hirschfeld, 2002). This book draws on an impressive expanse of literature and sketches a picture of the diversity of childhood around the world. Anthropological descriptions of non-Western childhood and child development are often overlooked outside of anthropology. Lancy demonstrates remarkably well that the lives of children and children's culture are far from uniform. What is frequently considered normal childhood and child development in fields outside of anthropology is culture-bound and often, as Lancy frequently points out, on the fringe of any normal distribution. Lancy effectively argues that a cross-cultural and holistic view of childhood is necessary and provokes the reader to question and reevaluate assumptions about childhood.

The book is generally organized along the early human life course, from reproduction through adolescence. Although, repeated many times throughout the book, what represents or characterizes these stages can vary across cultures. The initial chapters focus on reproduction and infancy into early childhood. The chapters then move through early, middle, and late childhood exploring learning, play, and work. The latter part of the book explores adolescence, with added chapters on schooling and the value of an anthropological perspective for research on childhood.

Lancy successfully integrates evolutionary and cultural perspectives on childhood. This theoretical coalescence is particularly evident in the early chapters, where Lancy weaves together recent work in evolutionary anthropology and human biology with more traditional ethnographic studies of childhood. In Chapter 2 entitled "To make a child", he argues that fertility is universally valued, but the outcome of reproduction rarely leads to an American style neontocracy, the elevation of children to cherubs and a god-like state. He presents the history of Western families covering topics such as marriage, pregnancy and childbirth, differential investment in sexes, and the demographic transition, and contrasts it with the diversity of children's experiences around the world. Following the lead of the previous chapter, Chapter 3, "A child's worth", describes, through historical and current descriptions of childhood, how such disparate views on children—cherubs, chattel, and changelings—have developed. Chapter 4, "It Takes a Village", explores the social world of infants and children. Most child development literature remains focused on the mother/infant dyad or the nuclear family, but Lancy illustrates that cross-culturally, caregiving responsibilities are spread widely among individuals, each of whom possess varied capacities and skills. In fact, biological parents often take a backseat to childminding,

particularly as children move out of infancy into their toddler years.

"Making sense" (Chapter 5) explores how cultures approach child development, their ability to learn, and become competent members of society. He cites a range of folk wisdom on child development from the new trend of American mothers offering learning experiences to their fetuses (i.e., playing classical music to their offspring in the womb), to the belief that children are less than complete humans or members of society, and are thus incapable of learning social and cultural rules until they are five to seven years of age. The patterns and developmental implications of play, both in humans and nonhuman primates, are examined in Chapter 6, "Of marbles and morals". In addition, Lancy illustrates the varied responses and participation of adults in child play. Chapter 7, "His first goat", reviews young children's participation in labor, at an age when many American families do not consider their children capable of walking to the end of the block unsupervised. There is increasing international opinion that critiques child labor, but Lancy argues that most children's work and contributions to the family economy are vital and culturally acceptable. However, he is careful to differentiate children's longstanding participation in traditional labor from the emerging situation that children face in the global market. As populations increase, causing stress on families, and the global market reaches further into traditional communities, children are moved from participating in family economic activities to being sold or sent to work in unsafe conditions, thus, leaving the protection of their communities.

The transition to adolescence is explored in "Living in limbo" (Chapter 8), a time when the diversity of experience for children around the world seems the greatest. Sexual maturity is reached during adolescence, but community acceptance of adolescents into adult status may be years away. Lancy emphasizes this state of limbo varies widely by culture and the sex of the adolescent. He presents contrasting cases ranging from young women being married shortly after puberty, to a middle-class American style of adolescence, characterized as hyperextended (at times lasting into the third decade) and describes also the variety of cultural institutions and practices created to manage this "difficult" human life stage. Lancy then details in Chapter 9, entitled "How schools can raise property values", the rise of formal schooling around the world, how societies have adopted this institution, and its effects on children and communities.

In the concluding chapter, "Suffer the children", he presents headline grabbing topics, such as high-fertility in the face of poverty, child labor, orphans, street children, and child soldiers. He explores child agency and the unease with which policy and aid organizations approach these children, because they rarely resemble the cherub-like state that dominates our thinking. In addition, he lays a foundation for how anthropological perspectives may be utilized as we contend with the myriad of issues facing children in a global age. In Lancy's concluding remarks, he points to the moral obligation of the developed world to play a role in the lives of children around the globe. Children are shown to be remarkably resilient and adapted to their local communities, but the pressures of the world market are taking their toll. The implementation of policy that emphasizes a neontocracy will fail to address the needs and conditions that children face.

In a recent conversation with a Human Development graduate student, she explained to me that her graduate class on child development only spent one week exploring childhood from a cross-cultural perspective, and the cross-cultural discussion was restricted to examples from developed, industrialized nations. Unfortunately, it is this limited and culture-bound view of childhood which often informs policy around the world. This conversation only reinforced my opinion that there is an urgent need for a holistic view of childhood, an opinion likely shared by all anthropologists studying childhood. Lancy's book does an excellent job moving us toward this goal. *The Anthropology of Childhood: Cherubs, Chattel, Changelings* will be a valuable addition to the classroom, exposing students to the variety of childhoods around the world. It will also serve as an excellent reference for scholars of childhood, both within and, more importantly, outside of anthropology.

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The Ethics of Protocells: Moral and Social Implications of Creating Life in the Laboratory. Edited by Mark A.Bedau and Emily C.Parke . xii + 368 pp. Cambridge, MA: MIT Press. 2009. $55.00 (Cloth), $28.00 (Paper).

"In what way is the synthesis of a cell less admissible than the synthesis of a molecule?" asked the French biophysicist Stéphane Leduc one hundred years ago (Leduc, 1912, p. 14). This laconic question summarizes the issues addressed in *The Ethics of Protocells*, a collective work offering a wide panorama of the social and ethical aspects of current attempts to synthesize life. Leduc pursued the synthesis of life forms by using mineral ingredients within an explicit materialistic (or rather antivitalistic) tradition, as did the Mexican scientist Alfonso L. Herrera. Their empirical ingenuity, which contrasted even with their contemporary colleagues, and the mocking and forced oblivion of their work by the official history of biology should not hide their intimate ambition, i.e., the synthetic approach rather than the analytical one would be the best way to answer the question of "what is life." At that time, the German-American physiologist Jacques Loeb was one of many to whom it seemed obvious that the understanding of the nature of life will be the outcome of its fabrication: "there is no reason to predict that abiogenesis [the synthesis of living matter from inert matter] is impossible, and I believe that it can only help science if the younger

investigators realize that experimental abiogenesis is the goal of biology" (Loeb, 1906, p. 223).

The current (re)emergence of synthetic biology has an uninterrupted tradition with the origin-of-life (e.g., prebiotic chemistry) researches, since the times when Oparin and Haldane founded the field convinced that "the artificial building or synthesis of living things is a very remote, but not an unattainable goal" (Oparin, 1938, p. 252). Nowadays, this bottom-up approach (or production of suprachemical/infrabiological systems, like the splendid work by Jack Szostak) converges with a top-down approach, a postgenomic/genetic engineering driven by powerful computational tools and theoretical modeling. One example of this second approach is Craig Venter and Hamilton Smith's efforts to introduce a synthetic genome in a cellular chassis. Another one is the Cartesian naivety of some engineers that still believe that a cell is a computer and try to manipulate cells standardizing its parts, ignoring the complexity of interactions and the emergent properties that are intrinsic even to the simplest living cells. At any rate, one thing is sure: we are closer than ever to produce a synthetic life form in a laboratory (but when we will achieve it is still an open question). Thus, the time is ripe to start to discuss the potential risks and benefits of both the scientific and technological advances, together with their social and ethical implications: *scientific aspects*—because, as Loeb believed, the synthesis of a protocell from complex chemical systems could lead to a better understanding of the nature of life, impossible to achieve only by deconstruction or analysis, and *improved technologies*—because many research groups and funding agencies avidly seek short-term biomedical, energy production or environmental applications of protocells.

In this context, Bedau and Parke's book is a timely attempt and a good companion to *Protocells: Bridging Nonliving and Living Matter* edited by Rasmussen et al. (MIT Press, 2009). The 16 contributions are classified in three different sections, although it is clear that some chapters extend the discussion beyond these borders: (1) Risk, uncertainty, and precaution with protocells; (2) Lessons from recent history and related technologies; and (3) Ethics in a future with protocells. The work includes a wide range of topics, from the intellectual property and patentability and the public perception of risks to the difficulties to warrant the priority of the general interest in front of any hidden agenda of some political, ideological, or economic minorities. I found especially interesting the discussion by several authors on the limits and concerns regarding the precautionary principle (including a remarkable contribution by Bill Durodié on the UK experiences). This principle can be stated as "in the absence of definitive scientific evidence to the contrary, measures to protect the environment or human health should be taken whenever any threat of serious or irreversible damage to either may be present" (p. 111). In the European context, we have witnessed how the abuse on this principle is the basis of some neglected options in biotechnology (e.g., with genetically modified plants) and a bad decision making, for "the uncertainties and unknowns of not deploying new technologies are rarely examined, let alone the missed opportunities and benefits of not experimenting" (p. 109). Thus, recent history on scientific and social conflicts on biotechnology, genetic engineering, stem cell research, and nanotechnology offers many lessons on how to deal (or not) with the future protocells. In any case, the major difficulty, due to the true novelty of a technology literally "alive," is how to quantify the "harms of inaction." In summary, we are confronting an unprecedented opportunity for discussion among science, philosophy, and the general public. However, at the same time, we have to be lucid enough to avoid some dialectical traps. In this sense, I found misleading the comparison of "epistemic values" between protocell research and creationism (Chapter 16 by Christine Hauskeller), which appears to me as incommensurable worldviews as astronomy and astrology represent. Also, we must discern between ethical and moral (i.e. religious based) implications, so I would have suggested to the editors a change in the subtitle of the book. Judeo-Christian prejudices may constrain too much of the debate.

Bedau and Parke describe in the preface the context that justifies a book like this one. On one hand, the complexity of the social and ethical issues raised by the realistic prospect of protocells being synthesized in a lab urges a debate between many different actors, including among others, scientists, philosophers, and policymakers. On the other hand, the interest of some funding agencies has substantiated several research programs that explicitly include the ethical debate on the synthesis of life. This was the case with the EU-funded FP6 projects "Programmable Artificial Cell Evolution" (PACE) and "Safety and Ethical Aspects of Synthetic Biology" (SYNBIOSAFE) or the current FP7 project on "Targeting environmental pollution with engineered microbial systems à la carte" (TARPOL). This book owes part of its content to the PACE project, and it is foreseeable that additional discussions will result from future programs. As the editors recognize, this work raises more questions than answers, but it is a step in the long way of the philosophical debate on synthetic life.

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