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Book Review
"A Natural History of Time"

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Pascal Richet: A Natural History of Time, translated from French (L'âge du monde: à la découverte de l'immensité du temps, Paris, Éditions du Seuil, 1999) by John Venerella, Chicago and London, The University of Chicago Press, xiv+471 pp., ISBN-13: 978-0-226-71287-1, US$ 29.00, 2007 (paperbound: ISBN-13: 978-0226712888, US$ 22.50, 2010).

This excellent book must now be regarded as the preferred starting point for anyone wishing to understand the history of efforts to know the earth's age. In graphic prose it traces the pathways by which scientists arrived, in the second half of the twentieth century, at a confident determination that our planet is close to 4.55 billion years old.

As this characterization suggests, the story told by Pascal Richet has a directional quality: this is a discursive record of remarkable advances in knowledge. It is a richly amplified and well-documented excursion through a long and complex series of reflections and researches by which the question of the earth's age was pursued, from ancient times to the later part of the last century. Needless to say, a remarkable variety of answers to this question came forth with changing times. But the principal end toward which Richet's narrative flows is a picture of how we came to the present understanding of the matter. One of the great merits of this account, therefore, is that it is much more than a triumphal affirmation of scientific progress. The tale is related here with a subtle awareness of cyclic repetitions underlying some of the ideas and events of which it consists. The scientific enterprise is shown, more than once, to stumble. Moreover, Richet's discussion is refreshingly devoid of condescension toward those in the *dramatis personae* whose ideas some readers might be tempted to ridicule or dismiss as unworthy of serious attention. It is pervaded instead with respect for and sympathetic comprehension of the actors, many of whom – especially in the story's early stages – lived and worked in cultural circumstances far from familiar to most of us.

While any attempt to distill Richet's argument must necessarily oversimplify and distort, nonetheless it may be helpful to observe that much of the exposition is built around four main themes in four broad and overlapping periods. The first of these concerns mythical, religious, and philosophical approaches to the fundamental nature of time, change, and history, along with the establishment of astronomy as a foundation for basic timekeeping. Here we have our first encounter with a sustained interplay between, on one hand, the notion of time as cyclic or endlessly repeating (as enunciated especially clearly by Aristotle, and broadly supported by what the ancients knew of astronomy), and on the other the contrasting conception of time as irreversibly directional (authoritatively sanctioned in the sacred documents of Judaism and Christianity). The most conspicuous theme in this portion of the book is the protracted undertaking to harmonize reasoned understanding of the natural world with the tenets of religious belief – a project of conciliation especially familiar in the Scholasticism of late medieval Christianity. An important kind of corollary within this project, one that continued its cultural exertions well into the modern period, was erudite chronology. This rested on the nearly universal acceptance of Scriptural authority in the sphere of historical knowledge, thus ratifying the congruence of nature's history with that of human beings. This in turn warranted determination of the date of the world's beginnings through calculations drawn out of Biblical chronology. Richet shows how much Newton occupied himself with refinement of this sort of knowledge.

A second theme involves a series of efforts to come to grips analytically with varied objects and processes of nature – fossils, sedimentation, ocean salinization, and cometary recurrences, to name a few examples – where investigators tended to view the need of reconciling their results with Scripture as a secondary concern. This is not to say that very many of the protagonists in these sorts of scientific endeavors were indifferent regarding the agreement of their conclusions with religious tenets. Certainly any such unconcern ill fits Steno or Leibniz, for example, nor would it really apply to Descartes.

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But on the whole they were inclined to assume such consistency as uncontested, or felt that their own duty to demonstrate it receded in comparison with the task of developing rational procedures to understand nature's operations and its past. If there is a single culminating figure for this phase of the argument, it must be Buffon, whose manner of setting himself apart from most contemporaries included an uncommonly clear nonchalance regarding accommodationism. His notorious public declaration of a terrestrial time scale incompatible with Mosaic chronology, supported by his engagement at his own foundry with quantified experiments on rates of cooling in hot iron balls, emerges here as a significant turning point.

The third leading thread of Richet's narrative has to do with the extension during the ensuing century of the hypothesis (advocated by Buffon among others) of an irreversibly cooling earth. Heat and its dissipation became a central problem in physics for much of the nineteenth century. Richet provides a fine discussion of the origins and development of thermodynamics and its application to the question of the earth's age, from Sadi Carnot and Joseph Fourier through William Thomson's (Lord Kelvin's) contentious campaign, politely civil though it may have been, to rein in profligate estimates of the earth's age on the part of geologists and evolutionists. Indeed, in a book involving a large number of characters – many of whom are deftly brought to life through finely condensed portrayals, frequently with bracing touches of humor – probably no single figure rivals Kelvin's recurring presence.

Finally, a fourth stage begins with the startling *fin de siècle* innovations in physics inaugurated by Röntgen, Becquerel, the Curies, and others, leading in short order to the founding of nuclear physics and the advent of radiometric methods for age determination. By no means the least interesting development here is the ironic spectacle of physicists now set on a reversed path, preaching an enormous enlargement of the geological time scale to often suspicious earth scientists, many of whom were understandably reluctant to concede to the dictates of physics a second time so soon after disclosure of its error the previous time around. For this last phase of the story it is not easy to identify a single commanding scientific character, but certainly among the best candidates are Rutherford and Holmes, even if the story is capped off with the "unspeakable delight" of Clair Patterson upon his resolution of the controversy the book addresses.

One of this book's strengths is how skillfully it depicts interactions within and between multiple spheres of science, the ease with which it allows readers to follow work passing over boundaries between scientific disciplines. We are shown, for example, how approaches to the central problem through studies of sedimentation and erosion rates eventually converged with others through chemical periodicity or spectral analysis. This book illustrates with great clarity how a big scientific question was pursued over a long period through an ever-changing series of cross-disciplinary efforts, sometimes generating unexpected new methods. It takes into account sweeping historical shifts of perspective on what the sciences are for and how they should go about their business. It even acknowledges occasional effects of ephemeral intellectual fashions within the sciences: for instance, two pages are devoted to the "Mars craze" fostered through the work of Schiaparelli, Flammarion, and Lowell, among others, as a significant part of the disorienting landscape within which to consider the scientific reception of spectacular new discoveries like X-rays and radioactive elements.

A Natural History of Time is accessible to – and has much to offer to – a broad range of readers. Only modest levels of scientific and historical knowledge are assumed. At certain junctures there are lengthy interludes or summaries of developments in or between the sciences of physics, chemistry, biology, and geology, as background and introduction to major episodes in the quest for reliable knowledge of the earth's age. No doubt such interludes will be more useful to some than to others, but at no point is the reader patronized. Himself a geophysicist of impressive cultural breadth, Richet evidently intends his book to be read by "a knowledgeable public" – an expression he uses when speaking of Leibniz's purpose in writing *Protogaea*. In short, this is a valuable study that will stimulate further historical research, and that deserves to be widely read.

John Venerella's translation is very well done. It succeeds in capturing the vitality of the original French version. Among the modest number of mistakes or dubious choices I encountered in the translation, very few are likely to throw the reader off. The volume's back matter has been expanded and reorganized for this English edition. For example, it now includes a series of references, and a general bibliography, rather than bunching most of the sources within an index of characters. Short synopses have been added at the head of each chapter. In several places, the author has taken the opportunity to insert textual material that had been cut from the original French edition because of the publisher's limitations on length.