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Essay review

What needs to be explained about modern science?

H. Floris Cohen, *How Modern Science Came into the World: Four Civilizations, One 17th-Century Breakthrough*. Amsterdam: Amsterdam University Press, 2010. Pp. xl + 784. ISBN 978-90-8964-239-4. €65.00/£59.00 (hardback).

The claim made in this important and ambitious book is to have resolved three riddles: why modern science emerged in Europe only, why this happened in the period between Copernicus and Newton, and why this seventeenth-century breakthrough instigated an as yet unbroken chain of scientific growth. 'Resolved' is Cohen's word. Of course he is aware that there is unlikely ever to be a final answer to big and fundamental questions like these. A fair reading of the claim is that Cohen is able to answer in a new and comprehensive way the ultimate comparative question in the history of science: 'why modern science developed only in Europe'. This he certainly does.

In this review I shall focus on the explanatory framework brought to bear on what the explanandum is deemed to be and query whether Cohen's explanatory framework is fit for the task at hand.

Key features of Cohen's explanatory framework are the notion of modes of nature-knowledge (the consistent ranges of distinct approaches to natural phenomena) as well as a social-transformation mechanism, for which he introduces the twin concepts of cultural transplantation (transfer of a body of knowledge to a civilization not previously touched by it) and cultural transformation (transformation of the body of knowledge endured in the process of transplantation). Transformations are forced upon a foreign body of knowledge practices because of what the sinologist Zürcher calls cultural imperative, a notion strangely absent from Cohen's vocabulary.[1]

The initial modes of nature-knowledge Cohen starts with are Athena, named after the main city of ancient Greece, and Alexandria, named after the capital city of Hellenist Egypt. Athena is the elegant shorthand for the highly speculative activity of the *physiologoi* and the tradition that stemmed from it, in which explanations are provided through the positing of first principles. Alexandria is the shorthand for a different and separate tradition of natural philosophers who speculated about the cosmos in primarily mathematical terms. In setting up the historical record in this

1 Erik Zürcher, 'Jesuit accommodations and the Chinese cultural imperative', in David E. Mungello (ed.), *The Chinese Rites Controversy: Its History and Meaning*, Nettetal: Steyler Verlag, 1994, pp. 31–64.

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way, the problem becomes one of explaining how and why these two traditions came together. Crucial in this process is that Athena and Alexandria were three times subject to a process of cultural transplantation, from Greece to Islam (via Baghdad, *c.*760), from Islam to Latin Europe (Toledo, in the twelfth century), and again from Byzantium to Renaissance Italy (Constantinople, in 1453). Because this transplantation process was usually brutal and violent, cultural transformation of the original tradition was the assured outcome. A full-blown scientific revolution required three more revolutionary transformations: the mathematization of nature experimentally sustained; fact-finding experimentation; and the breakdown of the barriers between the Galilean, the Cartesian and the Baconian modes of nature-knowledge. Whereas in the old narratives the scientific revolution is the outcome of a single breakthrough such as mathematization of nature (Dijksterhuis) or amalgamation of brain- and handwork (Zilsel), Cohen presents it as a multilayered, long-drawn-out process, the upshot of six distinct revolutionary transformations.[2]

Six transformations were needed before modern science 'found itself'. This formulation is due to Needham.[3] I am appropriating it to elucidate how Cohen explains the unbroken chain of scientific growth. With any cultural transplantation there is a relatively short period of creative extension of the original ideas. After a golden age characterized by high creativity and explorations of new insights, the impetus due to this crossing of cultural barriers slowly peters out; adhering to the old masters and rehearsing their arguments takes precedence over extending them into new domains. Only with the scientific revolution did there emerge a comprehensive and sophisticated strategy 'of inquisition of causes, and the production of effects' that is able to propel itself on an ever-continuing streak of new discoveries because for the first time the quest for nature-knowledge possessed a 'procedurally and institutionally established self-correction' mechanism (p. 720).[4] This is a challenging argument. I will articulate my discomfort with it in terms of a disagreement about what it is that needs to be explained when it comes to modern science.

Cohen is robust in his claim that what needs to be explained when the issue is the emergence of modern science is the seventeenth-century transformation in natural philosophy known as the scientific revolution. I do not believe that the seventeenth-century events are that significant. This, of course, is in line with the 'Cunningham thesis', which argues against an early modern scientific revolution because post-Newtonian and pre-Napoleonic inquiry into nature was not much different from that of the 'friars' natural philosophy': theirs was essentially about God and God's Creation, and so was post-Newtonian natural philosophy up to, say, the year 1800.[5] The changes in the first half of the nineteenth century, when institutions and

2 E.J. Dijksterhuis, *The Mechanization of the World Picture*, Oxford: Clarendon Press, 1961; Edgar Zilsel, *The Social Origins of Modern Science*, 2nd revd edn, Dordrecht: Kluwer Academic Publishers, 2003.

3 Joseph Needham *et al.*, *Science and Civilisation in China*, vol. 5, Cambridge: Cambridge University Press, 1976, Part 3, p. 220.

4 Francis Bacon, *The Advancement of Learning*, New York: Modern Library, 2001, p. 97.

5 Andrew Cunningham, 'How the *Principia* got its name: or taking natural philosophy seriously', *History of Science* (1991) 29, pp. 377–393; Andrew Cunningham and Perry Williams, 'De-centring the

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disciplines became recognizably modern, much better deserves to be labelled a scientific revolution than the changes, radical or not, that occurred in the seventeenth century. I want to support this line of reasoning by accepting the Huff thesis on the scientific revolution: seen 'from a comparative and civilizational point of view, the rise of modern science appears quite different than it does when seen exclusively as an intra-European movement'.[6] The Huff thesis supports the Cunningham thesis in the following way.

The three main civilizations involved in the quest to understand comparatively the emergence of modern science – China, Islam and Europe – differ in the way they have organized their knowledge-scapes. In China the *regina scientiarum* is history; in Islam it is jurisprudence; and in Latin Europe it is theology. But seen from a comparative angle the odd thing is that with the advent of modernity, in the nineteenth century, Europe opted to make physics king.[7] The social space allotted to the *philosophia nova naturalis* of the seventeenth century was not that much different from before. The significant difference came much later when modern science started its imperialist conquest of all knowledge domains. From a comparative perspective, it makes much more sense to refer to this as a scientific revolution and to define it as the process by which Europe changed its *regina scientiarum* to mathematical physics. This scientific revolution is about science becoming reason's exemplar, about science becoming the measure of Men as well as the quintessential element in Europe's self-definition.[8]

Do not mistake this disagreement for just a minor tiff. Cohen suggests that the upheavals in seventeenth-century natural philosophy mark the crucial difference between the civilizations his comparative analysis encompasses. At issue is whether one can argue that it is the principal difference without having to assume the very premises one claims to be proving.[9] I am not sure that Cohen is in the clear here. Before exploring my doubts let me first indicate why, despite reservations about Cohen's explanatory framework, I still unreservedly maintain that this book is important.

The greatest achievement of this book is the detailed story of the trials and tribulations of Athena and Alexandria and how after a total of six transformations they merge, by 1670, in the natural-philosophical practice of people like Boyle, Hooke and Huygens, into 'modern' science. This is the most comprehensive treatment ever of this immensely complex process. Cohen's breadth of learning and

"big picture": *The Origins of Modern Science* and the modern origins of science', *BJHS* (1993) 26, pp. 407–432.

6 Toby E. Huff, *The Rise of Early Modern Science: Islam, China and the West*, Cambridge: Cambridge University Press, 1993, p. 321.

7 Iwan Rhys Morus, *When Physics Became King*, Chicago and London: Chicago University Press, 2005.

8 The notion of 'reason's exemplar' is found in Lewis Pyenson, 'The ideology of Western rationality: history of science and the European civilizing mission', *Science & Education* (1993) 2, pp. 329–434, 329; Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance*, Ithaca and London: Cornell University Press, 1989.

9 This is a well-known problem with comparative causal explanations. Jack Goody's claim that literacy is a causal agent has been found wanting on exactly this point; see Diederik Raven, 'How not to explain the Great Divide', *Social Science Information* (2001) 40, pp. 373–409, 380.

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command of technical historiographical detail, as well as the vigour and skill with which he produces a truly fascinating and smooth-running narrative, is impressive. The most beguiling aspect of this narrative is the enhanced understanding it provides of the role medieval Europe had in this process. Unlike most books on the scientific revolution, which take as their starting point some arbitrary period in medieval society, Cohen's narrative is able to incorporate the whole of the medieval period and a refreshing and more balanced understanding is the upshot.

I described this achievement as a narrative because I want to distance it from the causal explanatory claims he makes. (I am aware that ultimately this disentanglement is impossible.) The causal claims are tied up with Cohen's consistent application of his comparative methodology. The comparative approach is presented as the motor of historical thinking. This is a proposition open to debate, one would think, but it is easy to see why it is made and why there is sense to it. I am less sure that this is the case with Cohen's claim that the comparative method is an effective antidote to the venial sin of presentism. One wonders how this can be true. Are comparisons not what you bring to your material? Cohen's narrative from the Greeks to Huygens is compelling because, up to a point, the notion of nature-knowledge can indeed be utilized as an analytical construct. This is because medieval Europe invented the idea of *scientia naturae*; indeed, the medieval university system made sure that all liberal-arts students had a roughly similar view of nature. But there is something about 'nature' that requires further explanation.

The problem is that the ethos and the very idea of *scientia naturae* has no clear and obvious counterpoint in Confucian China – as the Jesuits found out the hard way, in that the late Ming/early Qing did not really have any appetite for it – or in Islamic civilization. Furthermore, Lloyd has argued that the Greek *physiologoi* were never near any consensus on what kind of entity nature was – hence the excess of conflicting ideas about it.[10] Sivin has pointed out that in Mandarin there was no term corresponding to the Western concept 'nature' before the late nineteenth century.[11] In Islamic thinking there is no room for an independent entity called nature to be investigated rationally; the notion of *Twahid*, expressing the unity and uniqueness of Allah as creator and sustainer of the universe, takes care of that. As an example of the problem this creates, consider the following question: were the Chinese who noted, a millennium and a half before the Europeans, the existence of blemishes upon the solar orb recording sunspots or were they interpreting deviations of the solar regularity as indications of irregularities and abnormalities, *yi-xiang*, in the functioning of the state? Sunspots or astrological omens, natural or moral phenomena? Interpreting their concern as being with a natural phenomenon, as an example of nature-knowledge, has an ethnocentric ring to it.

More specifically, I want to suggest that Cohen's explanatory framework is biased towards a Western understanding of nature-knowledge. It too readily assumes the

10 G.E.R. Lloyd, *Methods and Problems in Greek Science*, Cambridge: Cambridge University Press, 1991, pp. 417–434.

11 Nathan Sivin, 'State, cosmos, and body in the last three centuries B.C.', *Harvard Journal of Asiatic Studies* (1995) 50, pp. 5–37, 5 n. 1.

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quest for nature-knowledge to be undertaken as a matter of course. But it isn't. In my reading of Cohen's explanatory structure he assumes something that requires explanation: the 'natural drift' (Cohen's words) of Western thinking.

According to Westfall, a distinguishing feature of Western civilization is its obsession with the study of nature.[12] Cohen, in an admirable way, is able to tell the story of this Western craze to comprehend nature. China and the Islamic civilization never were subject to this craze and never that deeply interested in nature-knowledge. According to Cohen, the scientific revolution happened only in Europe because only Europe, as a kind of historical accident, was at the receiving end of a number of cultural transplantations and three localized transformations of two modes of nature-knowledge. As indicated above, I have no quarrel with this aspect of the argument. It all makes perfect historical sense and Cohen is able to present it in a magnificent and historiographically rich story. But two things are left in the dark: the origin (cultural or otherwise) of this European fascination and why it is lacking in both the sinitic and Islamic civilizations. (Here is a suggestion why it is so all-persuasive in the West: nature-knowledge in Latin Europe was always intrinsically vested with legitimacy because of the congruity of grace and nature. This idea of God's two books, of God's word and of God's work, can be traced back to St Augustine.) The weakness of Cohen's framework comes to the fore in his treatment of why this quest for nature-knowledge is absent in Confucian China or the Islamic tradition. Because it is weak with respect to cultural and sociological assumptions, mechanisms and principles, he is not able to provide a thick description that encompasses religious and/or cultural considerations. There is more to this argument than, in the Islamic case, a faith-saturated atmosphere hostile to 'foreign' learning. On the whole I am dissatisfied with Cohen's explanatory framework because it is too much tailored to the internal development of the European quest to understand nature. I am at a loss as to how this framework can explain the marked differences in *regina scientiarum* of the civilizations involved.

To show that Cohen's narrative needs to be enriched in a cultural and sociological direction, let me briefly take issue with a notion that has to shoulder the burden of his explanatory strategy. I am referring to the notion of latent development possibilities unfolding under the impact of cultural transplantations. Clearly this is not a popular notion – what-if history never has been a respectable implement in the historians' toolkit. But if it is used then methodological control over it is needed, and this requires a comprehensive understanding of the legitimacy bestowed upon the quest for nature-knowledge. Did Copernicus, in developing his heliocentred cosmology, have access to Nasir al-Din al-Tusi's work? Denying it seems close to absurd. Could Tusi have come up with the Copernican system himself? Yes he could! Would it have found a favourable reception? The answer remains shrouded in history. Would it have propelled mathematics and astronomy on the path of independence from *iman*, faith? Highly unlikely. Could al-Battānī, or any other participant in the

12 Richard S. Westfall, 'The Scientific Revolution of the seventeenth century: the construction of a new world view', in John Torrance (ed.), *The Concept of Nature: The Herbert Spencer Lectures*, Oxford: Clarendon Press, 1992, pp. 63–93, 63.

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'ulum al-awa'il (the ancient, i.e. pre-Islamic, sciences), have come up with the kind of mathematical explanation Galileo in the end produced? Cohen suggests that he could. I am agnostic on this question. Besides, I am not sure it is a very interesting one unless one addresses the issue of the legitimacy allotted to this kind of endeavour. As the Qur'an (31:34) puts it, 'Verily with God is full knowledge and He is acquainted (with all things)', indicating that learning and religious veneration overlap. In Islam the eternal 'war between Revelation and Reason' is fuelled by lack of legitimacy of any kind of ratiocinations outside *iman*.[13] (Tusi could find legitimacy as a mathematical practitioner because of the role of mathematics in determining the *qibla*, the prayer direction to Mecca.) This line of reasoning indicates that the niche assigned to the quest for nature-knowledge is not only what requires explanation but also what necessitates a deeper understanding of the cultural dynamics than Cohen provides. His realist reading (yes, dear reader, we *know*) of the science involved is of no help on this issue.[14]

Let me draw this review to a close. Cohen has written a genuine comparative study on one of the great riddles in history: why is modern science an offspring of European civilization? In this powerful book he diligently argues his case for a radical new perspective on the scientific revolution and on what the uniqueness of the European contribution consisted of. Notwithstanding my qualifications of aspects of Cohen's explanatory framework, I strongly recommend this inspiring book and sincerely hope it will get a wide reading. I am confident readers will not be disappointed; they are bound to come away from this book enriched and stimulated. I certainly did.

Diederick Raven
Utrecht University

13 A.J. Arberry, *Aspects of Islamic Civilization, as Depicted in the Original Texts* (Ann Arbor, University of Michigan Press, 1967) pp. 119–120.

14 This realist understanding of science is not a slip in the argument. Cohen's fascination with the scientific revolution is due to the influence of Jacques de Kadt (1897–1988), an unconventional Dutch political thinker. It was he who instilled in him the idea of the uniqueness of the West as marked by 'affirmative scepticism'. See H. Floris Cohen, *The Scientific Revolution: A Historiographical Inquiry*, Chicago and London: Chicago University Press, 1994, pp. 3–7.

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