////// studie / articles //////////////////////////////////////

INSTITUTIONS AND DISSENT: HISTORICAL GEOLOGY IN THE EARLY ROYAL SOCIETY

Abstract: *The paper aims to question the traditional view of the early Royal Society of London, the oldest scientific institution in continuous existence. According to that view, the institutional life of the Society in the early decades of activity (1660s and 1670s) was characterized by a strictly Baconian methodology. But the reconstruction of the discussions about fossils and natural history within the Society shows that this monolithic image is far from being correct. Despite the persistent reference to the Baconian Solomon House, the Society did not impose or support a common programme of research in the field of the natural history of the Earth.*

Keywords: *Royal Society*; *historical geology*; *experimental philosophy*; *Robert Hooke*

Instituce a disent: historická geologie v počátcích Royal Society

Abstrakt: *Text si klade za cíl zpochybnit tradiční pohled na ranné období londýnské Royal Society, nejstarší kontinuálně fungující vědecké instituce. Podle tradičního pohledu byl institucionální život v počátečních desetiletích vývoje Royal Society (šedesátá a sedmdesátá léta 17. století) charakterizován přijetím striktně baconovské metodologie. Rekonstrukce debat o fosiliích a přírodní historii v rámci Royal Society však ukazuje, nakolik je tento monolitický obraz vzdálený skutečnosti. Navzdory trvalým odkazům k baconovské Šalamounově koleji Royal Society nerozvinula ani nepodporovala společný výzkumný program v oblasti přírodní historie Země.*

Klíčová slova: *Royal Society*; *historická geologie*; *experimentální filosofie*; *Robert Hooke*

FRANCESCO G. SACCO
Humanities Department, University of Calabria
via P. Bucci, Cubo 18c,
87036 Rende (CS), Italy
email / francescogsacco@gmail.com

1. A New Science and a New Academy

Unlike mathematics and astronomy, the study of the Earth was not an independent discipline till the seventeenth-century scientific revolution. The emergence of a new science requires the formation of a community of researchers sharing a clearly defined object and some fundamental theoretical principles guiding their work. Historical geology achieved this through a complex process, which started in the second half of the seventeenth century. Like other experimental sciences at the same stage, its field was full of facts resisting generalization of theories.[1] Nicolas Steno compared the doubts which facts engendered to the "Lernean Hydra's heads": dispatched one, innumerable others grew up.[2] Till then, the natural history of the Earth essentially consisted in the classification of *fossilia*. As Walter Charleton explained in 1668, this word denoted all the objects under the superficies of the Earth.[3] To distinguish the remains of living beings from minerals one needed a clear discrimination of the organic from the inorganic within a continuous spectrum of fossil objects.[4] But Aristotelian and Neoplatonic philosophies supported an integral identification of what we now consider fossils with inorganic minerals. An example of this view and its wide diffusion in England can be found in Edward Jorden's *An Account of Natural Bathes and Mineral Waters*. From 1631 to 1673 the book had four editions. Influenced by the Paracelsian chemist Petrus Severinus, Jorden affirms that *fossilia* are continuously produced in the bowels of the earth, where mineral seeds are placed from the creation of the world.[5] This doctrine, as Thomas Sherley observes in 1672, is not new but originates from Plato, Pythagoras and Moses, and has been revived by "the noble Van Helmont and other great wits". Operating as ferment, the "architectonick stonifying spirit or petrifick

The research for this article was made possible through a grant from European Commission (FSE 2007–13).

[1] *Cf.* Thomas KUHN, *The Structure of Scientific Revolutions*. Chicago – London: University of Chicago Press 1970, p. 15; Cecil Schneer, "The Rise of Historical Geology in the Seventeenth Century." *Isis*, vol. 45, 1954, pp. 257, 263 (256–268).
[2] Nicolas STENO, *Prodromus to a Dissertation concerning Solids naturally contained within Solids, english'd by H.O.* London: *s.n.* 1671.
[3] Walter CHARLETON, *Onomasticon zoicon*. London: *s.n.* 1668, p. 217. The word *fossilia* derives from the Latin *fodio*, to dig.
[4] Martin RUDWICK, *The Meaning of Fossils: Episodes in the History of Palaeontology*. Chicago – London: University of Chicago Press 1972, p. 44.
[5] Edward JORDEN, *An Account of Natural Bathes and Mineral Waters*. London: *s.n.* 1669, pp. 82–5.

seed" produces all inorganic substances.[6] Despite the fortune of Paracelsian seeds in England, the continuity of the fossil spectrum was mainly supported by the Neoplatonic principle of a plastic virtue operating throughout Nature. Mimicking living animals and plants, this virtue produces similar but inanimate bodies within the mineral kingdom.[7] Considered as bodies of inorganic nature and origin, fossils were classified according to their external shape (*lapides figurati*).

The advent of the mechanical philosophy offered an alternative view of minerals and fossils. Assuming a corpuscular definition of matter and body, Steno defined the question of fossils as a mechanical problem: "a body of certain figure, and naturally produced, being given, to find in the body itself arguments, discovering the place and manner of its production".[8] The mechanical analysis carried out by Steno provided decisive arguments favouring the organic origin of fossils. Looking for the place and time of their production, he found the solution in the biblical universal deluge.[9] Behind Steno's assumption of a biblical frame for the organic theory of fossils, there were traditional principles such as the stability of Earth's morphology after the Creation, and biblical chronology. Notwithstanding the re-emergence of pagan chronologies in the Renaissance, the reformed and counter-reformed biblical literalism ended up reaffirming the six thousand years of Christian chronology. In England, for instance, the date of the creation calculated by Bishop Ussher (4004 BC) was printed in the King James Bible, and virtually become part of the scripture. In future, only under the pressure of compelling arguments would these principles be questioned.[10] Steno maintained

[6] Thomas SHERLEY, *A Philosophical Essay declaring the probable Causes whence Stones are produced in the Greater World*. London: *s.n*. 1672, pp. VI, 21; *cf*. Norma EMERTON, *The Scientific Reinterpretation of Form*. Ithaca – London: Cornell University Press 1984, p. 142.

[7] Paolo ROSSI, *The Dark Abyss of Time: The History of the Earth and the History of Nations from Hooke to Vico*. Chicago – London: University of Chicago Press 1984, pp. 6–8.

[8] STENO, *Prodromus*, p. 8.

[9] Despite Rejer Hooykaas's criticism of "Stenolatry" (see Rejer HOOYKAAS, "Pitfalls in the Historiography of Geological Science." *Histoire et Nature*, vol. 19–20, 1981–82, p. 23 (21–34)), there are still apologetic historians attributing to the Danish bishop the invention of almost everything within earth sciences, e.g. Gabriel GOHAU, "Naissance de la géologie historique." In: BLOCH, O. – BALAN, B. – CARRIVE, P. (eds.), *Entre forme et histoire: la formation de la notion de development à l'âge classique*. Paris: Meridiens Klincksieck 1988, pp. 37–38 (127–43); Gabriel GOHAU, *Les sciences de la terre aux XVII^e^ et XVIII^e^ siècle: naissance de la géologie*. Paris: Albin Michel 1990, p. 107.

[10] Denis DEAN, "The Age of the Earth's Controversy: Beginnings to Hutton." *Annals of Science*, vol. 38, 1981, p. 442 (435–456); Anthony GRAFTON, "Tradition and Technique in Historical Chronology." In: CRAWFORD, M. H. – LIGOTA, C. R. (eds.), *Ancient History and*

the deluge as the only moment of alteration of the Earth's structure and morphology, and did not challenge the non-historical approach of sixteenth-century natural history. As Nicoletta Morello argued, the long prevalence of classification aims and the belief in the stability of divine creation represented an "epistemic preconception which did not induce a search for proof of an 'order' among the fossils".[11]

In different ways scholars faced the difficulties of a science such as seventeenth-century historical geology in the early stage of its formation. English experimental philosophers of the Royal Society assumed Francis Bacon's project of a new natural and experimental history. In one of his baroque metaphors, Bacon argued for a philosophy that, like bees, combined the ability to acquire the essential experimental material and to elaborate theories from it. The fundament of Bacon's instauration was a new experimental history "which may serve for the building up of philosophy, and embrace material tested, abundant and properly arranged for the work of interpretation which will follow it." It is "a labour of many working together", whose "work and labour (especially for the gathering in of experience) can best be shared out and then brought together."[12] Only a community of researchers could realise Bacon's project. In the eyes of many fellows, the Royal Society was, or rather had to be, that community. In 1661, Abraham Cowley called for a new "philosophical college", where naturalists, like miners, cooperate for the extraction of natural treasures. Living in their private studies, he noted, most ingenious person are driven to the "inactive contemplation of nature", while in a new academy they would be engaged in a collective work.[13] "Solomon's house in the New Atlantis – Joseph Glanvill wrote in 1665 – was the profetick scheam of the Royal Society."[14]

Within the Baconian project of a new instauration undertaken by the Society, Robert Hooke, first curator of experiment, pursued the natural history of the earth. "The subject is large, as extending as far as the whole

Antiquarians: Essays in Memory of Arnaldo Momigliano. London: The Warburg Institute, 1995, pp. 21–25 (15–32); Stephen TOULMIN – June GOODFIELD, *The Discovery of Time*. London: Penguin 1967, pp. 21–22, 91.

[11] Nicoletta MORELLO, "Steno, the Fossils, the Rock, and the Calendar of the Earth." In: VAI, G. B. – CALDWELL, G. (eds.), *The Origins of Geology in Italy*. Boulder, CO: Geological Society of America 2006, p. 82 (81–93).

[12] Francis BACON, *The "Instauratio magna" Part II: Novum Organum and Associated Texts*. Edited by G. Rees and M. Wakely. Oxford: Clarendon Press 2004, pp. 450–451, 170–171.

[13] Abraham COWLEY, *A Proposition for the Advancement of Experimental Philosophy*. London: *s.n.* 1661, pp. 8, 13, 10.

[14] Joseph GLANVILL, *Scepsis scientifica*. London: *s.n.* 1665, p. XXII.

bulk included within the utmost limits of the atmosphere, and 'tis not less copious and repleat with variety, as containing all several parts and substances included within those limits". Only a community of scholars could have achieved it, not single men working separately.[15] For Hooke, scholars engaged in the study of new fields of nature like historical geology should have shared not only their ideas, but also a common programme along the lines traced by Bacon:

> Such persons also ought to agree upon a method & should indeavour to share the difficulty of the work amongst them. And unless there be such a method agreed on, & that joint & united indeavours be added, the work of a philosophical history cannot be thought feasible in less than many ages.[16]

In spite of the numerous difficulties of such a plan, fellows aimed to represent the Society as the historical realization of the "college of Solomon" that Bacon "with all his authority in the state" could never raise if not in romance.[17] Thomas Sprat's *History of the Royal Society* carried out this task. Sprat's emphasis on the Baconian features of the Society did not reflect its real state during the early years of activity. After the royal patronage in 1662, fellows aimed to show the congruence of their activities with the new political order of the Restoration.[18] Sprat, himself an Anglican bishop, portrayed the Society as a natural ally of the Crown and the Church of England, both engaged in a desperate search for stability and conformity after the Commonwealth years.[19] He described the fellows as devoted to their Baconian project, attending assemblies without "confusion, unsteadiness, and the little animosities of divided parties" and avoiding the "dangers for the time past". The non-confessional nature of the new philosophy, however, should not mislead, the Baconian plan of the Society supported the Church of Eng-

[15] Robert HOOKE, *The Posthumous Works*. Edited by R. Waller. London: *s.n*. 1705, p. 279.
[16] Robert HOOKE, "Lectures of Things Requisite to a Natural History." In: OLDROYD, D., "Some Writings of Robert Hooke on Procedures for the Prosecution of Scientific Inquiry." *Notes and Records of the Royal Society of London*, vol. 41, 1987, no. 2, p. 152 (145–167).
[17] Thomas SPRAT, *History of the Royal Society*. London: *s.n*. 1667, pp. 151–156, 243–244, 246–251.
[18] Thomas BIRCH, *The History of the Royal Society of London for Improving Natural Knowledge*. London: *s.n*. 1756–1757, vol. I, pp. 88–96; Alvin SNIDER, "Bacon, Legitimation and the Origin of Restoration Science." *Eighteenth Century*, vol. 32, 1991, no. 2, pp. 126–128 (119–138).
[19] Paul B. WOOD, "Methodology and Apologetics: Thomas Sprat's History of the Royal Society." *British Journal for the History of Science*, vol. 13, 1980, no. 1, pp. 1–3, 5–6, 14–15 (1–26).

land.[20] Even if theology was excluded from the Society's field, the study of Nature shows "the power, and wisdom, and goodness of the creation". "It cannot be deny'd – he notes – but it lies in the natural philosophers hand, best to advance that part of Divinity", natural theology. Sprat, therefore, did not maintain Bacon's firm separation of science and theology.[21]

2. Fossils and the *Micrographia*

These aspects of the early Royal Society influenced its institutional life and had significant consequences on the study of fossils by its fellows. The first specimen of fossils, "a curious piece of petrified wood", was presented to the Society by Jonathan Goddard. The same day, 20 May 1663, "Hooke produced three microscopical observations." He was carrying out a plan of microscopic observations, and the counsel assigned to him the fossil specimen so as to observe it with the microscope. At the following meeting, Hooke showed a thin section of Goddard's petrified wood, but "he was desired to cause the same stony wood to be cut sideways, and also to bring in his observations upon it." On 10 June Hooke's observations were read and registered. The report consisted of a comparison of fossil wood with ordinary wood. It showed that the specimen maintained the internal structure and external shape of wood. Fossil wood had the physical and chemical features of minerals, which Hooke explained by a process of substitution of the wood's particles with stony ones. From the beginning of Hooke's microscopic observations, the Society decided to publish them.[22] For most of the fellows, the book was expected to be part of the general history of Nature undertaken by the Society. As "it was ordered" on 23 March 1664, at every weekly meeting Hooke had to read "one of his microscopic discourses, in order to their being printed by order of the Society." At the meeting of the council of 22 June, fellows ordered the printing of "Mr. Hooke's microscopical observations", demanding that "they might be perused and examined by some members of the Society."[23] As appears from a letter written by Hooke to Boyle on 24

[20] SPRAT, *History*, pp. 63, 91; *cf.* Christoph LÜTHY, "The Confessionalization of Physics: Heresies, Facts, and Travails of the Republic of Letters." In: BROOKE, J. – MACLEAN, I. (eds.), *Heterodoxy in Early Modern Science and Religion*. Oxford – New York: Oxford University Press 2005, p. 82 (81–114).
[21] SPRAT, *History*, p. 82; *cf.* Michael HUNTER, *Science and the Shape of Orthodoxy: Intellectual Change in Late Seventeenth–Century Britain*. Woodbridge: Boydell Press 1995, pp. 178–179.
[22] BIRCH, *The History*, vol. I, pp. 213, 244, 248, 260–262.
[23] *Ibid*., pp. 397, 442.

November 1664, the book was already printed in October but was still in the hands of several fellows examining it. "I hope– Hooke confides – I shall prevail with the printer to dispatch it some time this or the next week".[24] Indeed, the day before the council had released the book. However, the license for printing was subordinated to the presence of a dedication explaining that the Society was not involved in the theories he advanced:

> That Mr Hooke give notice in the dedication of that work to the society that though they have licensed it, yet they own no theory, nor will be thought to do so; and that the several hypothesis and theories laid down by him therein, are not delivered as certainties, but as conjectures; and that he intends not at all to obtrude or expose them to world as the opinion of the Society.[25]

The council's note shows that Hooke's *Micrographia* was not the book they were expecting. It was not just a book of microscopic observations, neither the initial part of the general history of Nature. In contrast with the historical limit of the Baconian method as represented by the Society, Hooke's book contained numerous hypotheses and theories.

Methodology had been at the centre of historians' analysis of *Micrographia*'s case within the Royal Society.[26] There are documents that contain elements making clear the extent of disagreement among its fellows, far beyond the apologetic image depicted by Sprat. Between late June and late November in the journal book there is only one reference to Hooke's microscopic observations. It is among the entries of 24 August 1664:

> It was read a paper of Mr. Hooke concerning petrifications, designed by him as part of his microscopical book, then in the press. The Society approved of the modesty used in his assertions, but advised him to omit what he had delivered concerning the ends of such petrifications.[27]

This brief note supplies relevant data about the origins of *Micrographia*. The reference to the stage of the publication reveals that the "paper concerning petrifications" read by Hooke can be identified with a draft version of the observation 16 or 17 of *Micrographia*. The Society's approval of Hooke's "mod-

[24] Robert BOYLE, *The Correspondence*. Vol. II. Edited by M. Hunter, A. Clericuzio and L. Principe. London: Pickering and Chatto 2001, p. 412.
[25] BIRCH, *The History*, vol. I, p. 491.
[26] See Steven SHAPIN – Simon SCHAFFER, *Leviathan and the Air Pump: Hobbes, Boyle and the Experimental Life*. Princeton: Princeton University Press 2011, pp. 321–322.
[27] BIRCH, *The History*, vol. I, p. 463.

esty" in his "assertions" and the demand to omit a part of the paper from the publication, suggests that the fellows' dismissal of Hooke's hypotheses is not only methodological. As a community of researchers engaged in an historical and experimental work, the fellows avoided appearing to adhere to any of Hooke's theories. The book was associated with the Society: it was written by its curator, published by its printers, composed of observations read in its meetings and registered in its journal book. But the methodology it adopted and the view of nature it supported could not be attributed to the Society itself. It is significant that this comes into focus with reference to fossils. In fact, Hooke's observations contained a general view of the Earth's history incompatible with the biblical scheme and the traditional assumptions maintained by Steno and the other defenders of the organic origins of fossils.

3. Hooke, History and the Natural History of the Earth

The seventeenth observation of *Micrographia* reproduces part of the paper read at the Society's meetings. The published text maintains the comparison between the organic and the inorganic features of the specimens, and extends the conclusions on the organic origins of fossils into a criticism of inorganic hypothesis. Hooke's emphasis on the structural composition of bodies, proper to the general project of microscopic investigations, influenced fossils observations. The microscope was expected to make visible what was supposed invisible, the "schematismes" and "textures" of bodies. Corporeal forms and structure were explained by the composition of microscopic "globular bullets". Hooke intended the Society's microscopic project as an experimental history of matter's forms. In his view, the microscope showed that the "geometrical mechanism of nature" operates in the same way in the generation of minerals, vegetables and animals.

The old idea of continuity in the scale of Nature is assumed here in mechanical terms. From "fluidity, or bodies without any form, we descend gradually till we arrive at the highest form of a brute animal's soul".[28] Even where Nature "seems to act yet more secretly and farther remov'd from the detection of our senses", such as in the processes of formation and generation of bodies, by means of the microscope "her working also can be

[28] HOOKE, *Micrographia*. London: *s.n.* 1665, pp. 85–86, 91, 114, 127; *cf.* Arthur LOVEJOY, *The Great Chain of Being: A Study of the History of an Idea*. Cambridge, MA: Harvard University Press 1936.

detected to be mechanical". In this matter, Hooke observed, men appealed to spiritual and immaterial principle because bare senses do not enter into the microscopic realm of bodies. But now these principles "stand up as an opprobrium to philosophical enquiry". The microscope and a belief in the gradual continuity of Nature supported Hooke's exclusion of immaterial principles from Nature: "if we consider the progress of nature from the most simple and plain operations to the more complicated and abstruse, we may deduce from them a great argument of incouragement".[29] Neither in living nor in mineral bodies is there a "vegetative faculty", an "anima or *forma informans*", a "plastic virtue" or a "*seminal formatrix*", which gives them structure and shape. Only mechanical and geometrical principles are the causes of the generation of bodies.[30] Thus, the origin of fossils cannot be but organic; their inorganic composition is due to the admission of mineral substance into the structure of bodies overwhelmed by earth:

> From all which and several other particulars which I observ'd, I cannot but think, that all these, and most other kinds of stony bodies which are found thus strangely figured, do owe their formation and figuration, not to any kind of plastic virtue inherent in the earth, but to the shells of certain shell-fishes, which either by some deluge, inundation, earthquake, or some other means, came to be thrown to that place, and there to be fill'd with some kind of mudd or clay, or petrifying water, or some other substance, which in tract of time has been settled together and hardned in those shelly moulds into those shaped substances we now find them.[31]

As it appears in this passage, the alterations of the Earth's morphology are the main cause of fossils. The vague reference in *Micrographia* to "some deluge, inundation, earthquake, or some other means" is sufficient to show Hooke's refusal of a diluvial origin of fossils even at this stage. In a long series of lectures delivered to the Royal Society from 1668, Hooke exposed the definitive moving out of the biblical scheme and the challenge of the traditional views of the Earth's history.[32] In these papers, which largely

[29] HOOKE, *The Posthumous*, p. 47; on Hooke's and Boyle's criticism of plastic virtues see Roberto BONDÍ, *L'onnipresenza di Dio: saggio su Henry More*. Soveria Mannelli: Rubbettino 2001, chapter 3.
[30] HOOKE, *Micrographia*, pp. 95, 130, 133–134.
[31] *Ibid*., p. 111.
[32] *cf.* Robert T. GUNTHER, *Early Science in Oxford*. London: Dowson of Pall Mall 1968, vol. VI, p. 343.

circulated among fellows but were published only in 1705, Hooke added a clear indication of the causes of fossils to the criticism of the appeal to plastic virtues and the confirmation of the organic hypothesis. For Hooke, the microscopic observations were what "Lord Verulam call'd *experimenta crucis*, which serve to direct the inquirer to proceed the right way in making his judgement".[33] In Hooke's work the experimental activity was not separated from the theoretical one. Observing fossils and comparing hypotheses on their origin were parts of the same process. Once the microscope gave the decisive proof in favour of fossils organic origin, the research was directed to inquire its consequences, both theoretical and experimental. Thus, in the geological lectures Hooke undertook the research of the causes of fossils. He distinguished the proximate causes, the agents promoting the petrifactions of the organic substances from the remote ones.[34] Only when bodies are carried under the surface of the earth, petrifactions could take place. Indeed, in Hooke's eyes the organic origin of fossils involved geological alterations of the Earth's morphology by means of which vegetable and animal bodies were placed underground. Fossils become "sea marks and evidences", because they indicate the existence of past alterations of the land-sea order in the place where they are found. These "monuments and hieroglifick characters of preceding transactions" are document that natural historians can read to reconstruct the Earth's past.[35]

4. Metamorphoses

The irregular disposition of minerals and the length of the biblical deluge did not support the diluvial hypothesis largely associated with the organic origin of fossils. Refusing to take recourse to Noah's flood, Hooke challenged the idea of an immutable stability of Nature after the Creation. He clearly outlined an alternate view to the prevailing image of a static Nature. That image was shared both by those who refused the organic origin of fossils and also by those who defended it, employing biblical support for the deluge. Both maintained the essential stability of the Earth after Noah's flood. The question of fossils in itself did not represent an alternative between two opposite views of the Earth's history. Not all the advocates of the organic hypothesis were ready to accept entirely its consequences. For a long time,

[33] HOOKE, *The Posthumous*, p. 339.
[34] *Ibid*., pp. 290–296.
[35] *Ibid*., pp. 341, 411, 432.

the prevailing recourse to the biblical deluge was a way to reduce the impact of the organic hypothesis, reconciling it with the traditional view.[36]

Hooke extended the historical approach from Earth history to natural history as a whole. Among fossils known there were the remains of animals that did not have correspondence with any living species. For Hooke these were remains of extinct species or represented a previous form of those still living. According to his mechanical interpretation of the chain of being, Hooke assumed the principle that place, time and medium produce variations in bodies.[37] "Climate, soil, and nourishment doth often produce a very great alteration in those bodies that suffer it." [38] This mechanical transformism led to the acceptance of the transformation or generation of new species under the influence of environmental variations. A single deluge, such as the biblical one, could not have explained such effects. The alteration of the Earth's internal structure and superficial shape had been continuous since the Creation. Hooke recognized the cause of this changing system in a phenomenon still operating in Nature, but in a different degree of intensity: earthquakes. "Nor are these changes now only – he notes – but they have in all probability been of as long standing as the world." In contrast with the biblical deluge, there is no doubt as to the "universality of this active principle", because "there is no country almost in the world but has been sometimes or other shaken by earthquakes, that has not suffered some, if not most parts of these effects".[39] Like the Earth's one, "in the younger dayes of the world" moon's morphology has been altered by earthquakes, or rather moonquakes.[40] The intensity of past earthquakes was such as to alter the centre of gravity and magnetic direction of the Earth. The great mountain chains, such as the Alps, were created at the same time by the same causes.[41]

Since the 1668 lecture, Hooke acknowledged the absence in ancient natural history of accurate descriptions of the great catastrophes of the past. These events were supposed "very hard positively to prove".[42] Fossils are "monuments and hieroglyphick characters of preceding transactions of the

[36] *cf.* ROSSI, *The Dark*, p. 4; RUDWICK, *The Meaning*, p. 36.
[37] HOOKE, *The Posthumous*, p. 56.
[38] *Ibid*., p. 327.
[39] *Ibid*., pp. 311, 326–327, 417.
[40] HOOKE, *Micrographia*, p. 243.
[41] HOOKE, *The Posthumous*, pp. 320–322, 328, 347, 372.
[42] *Ibid*., pp. 324, 327. For a different view see Rhoda RAPPAPORT, "Hooke on Earthquakes: Lectures, Strategy, and Audience." *The British Journal for the History of Science*, vol. 19, 1986, p. 137 (129–146).

body of the earth" but, Hooke notes, "it is very difficult to read them and to raise a chronology out of them, and to state the intervals of the times wherein such or such catastrophes and mutations have happened". However, the task was not impossible. In Hooke's view, there were "other means and assistance of information".[43] Since natural histories do not give any proof of the Earth's early alterations, Hooke directed his views to other ancient forms of knowledge, to those events which had happened in the early stage of the Earth, before the invention of writing. Till the time of that invention, men preserved their memory by means of obscure histories and fables.[44] "Mythologick history – Hooke states – was a history of the production, ages, states, and changes that have formerly happened to the earth."[45]

For Hooke, preceding civilizations and systems of knowledge could have been destroyed in the early time of the Earth's morphological alterations. Hooke clearly drew these arguments from the hermetic tradition of the *prisca theologia*, but he does not seem to have been interested in Neoplatonic mysticism and theosophy. On the contrary, his interest seems only historical.[46] The argument of a lost "preceding learned age wherein as many things may have been known as are now", supported the idea that despite the evidence of natural histories, there was a knowledge of early natural catastrophes. In spite of its apparent specious character, Hooke's approach was influenced by Bacon's *De sapientia veterum*. Like Bacon, he believed that mythologies should be interpreted because their literal meaning is absurd.[47] But Hooke's interpretation was based on the assumption that myths do not contain any philosophical theory, but only historical notices of natural events. In mythology he distinguished three coexisting meanings: "a physical, comprehending the causes, effects and reasons; an historical, comprehending the times ages, persons and places; and a moral, to make them instructive and useful for the regiment and moralizing the more vulgar part of mankind."[48] Poets employed myths "to conceale their knowledge from the vulgar, and yet communicate it to such as had a key to unfold the mystery contained therein."[49] But not all the fables contains a natural truth:

[43] HOOKE, *The Posthumous*, p. 411.
[44] *Ibid.*, pp. 334, 372, 374.
[45] *Ibid.*, p. 384.
[46] *Ibid.*, p. 328; *cf.* William POOLE, *The World Makers: Scientists of the Restoration and the Search for the Origins of the Earth*. Oxford: Peter Lang 2010, p. 113.
[47] HOOKE, *The Posthumous*, p. 392; *cf.* ROSSI, *The Dark*, p. 16.
[48] HOOKE, *The Posthumous*, p. 402.
[49] *Ibid.*, p. 392.

> Nor that I do here undertake for the truth of history in every fable, for I conceive that there are as various kinds of fables as there are of histories. Some are reputed and believed fables which are true histories, other are believed true, but are really fables; some are believed fables and are really so, and others are believed true and are really so. But of this fourth head I fear is the smallest number.[50]

Among ancient mythologies, Hooke considered Ovid the depositary of all the natural knowledge of early times.[51] The Roman poet composed the *Metamorphosis* in order to transmit the oral knowledge of the early ages. Indeed, he did not conceal "marks and characteristics by which it may be found what the history is which he doth there mythologize".[52] Ovid assembled the history of past catastrophes and the theories of those who, like "Orpheus, Pythagoras, &c", lived "in ages so much nearer to those more active ages of the earth". Ovid's work, then, contained an account of the formation of the world similar to Genesis and opposite to Aristotle's notion of eternity.[53] But the analogies between ancient mythologies and the Bible do not end here. Hooke employed the same hermeneutic approach both to pagan fables and to sacred history. Ancient mythologies not only contain a description of the formation of the world very similar to the biblical one, but even references to a "total" deluge. This and the other particular floods described by pagans were effects of early earthquakes.[54] According to Hooke, a "plain and intelligible way" to explain the floods and the formation of the world was possible. A physical interpretation of Genesis, avoiding miracles and supernatural events, seemed to Hooke consonant with the meaning of the mythological works of pagans and the rules of Nature.[55]

Hooke's lectures do not contain a physical description of the Earth's creation alternative to the Bible and based on the Cartesian model. Even if these events have been explained only by means of physical causes, it does not entail the exclusion of providence from history and nature.[56] Following Gassendi, Hooke distinguished the proximate natural causes of phenom-

[50] *Ibid*., pp. 396–397.
[51] *Ibid*., pp. 377, 394.
[52] *Ibid*., p. 406.
[53] *Ibid*., p. 380.
[54] *Ibid*., pp. 328. 408, 410.
[55] *Ibid*., pp. 313–314, 324–327, 377–378, 380–381, 413–416.
[56] *Ibid*., p. 391.

ena from the remote ones.[57] "I do not conceive – he notes – it doth any way detract from the omnipotency and power of God to explain the causes that he was pleased to make praevious to those effects".[58] Natural laws depends on God, and "the universal providence that ordereth all the effects, doth also determine and appoint all the causes and means conducing thereunto". Indeed the contemplation of the order of Nature "does most magnify the beauty and excellency of the divine providence which has so disposed, ordered, adapted, and impowered each part to operate as to produce the wonderful effects which we see."[59] Only an "extremely depraved" ratiocination can believe that Nature is an effect of chance.[60] In Hooke's eyes, a rigorous physical explication of phenomena does not entail the refusal of the Christian doctrine. Natural philosophy is limited to natural causes, and miracles or suspensions of natural laws should not be part of it. It is significant that Hooke's lectures closed with a claim of the *libertas philosophandi* and the refusal of authority contained in Royal Society's Horazian motto *Nullius iurare in verba magistri*.[61]

Hooke's conciliation of biblical history and pagan mythology by means of a physical hermeneutic produced a sort of 'physico-mythology'. Hooke did not use science to defend sacred history, rather the contrary.[62] The strict comparison between sacred history and pagan mythology and their subordinate role to natural history generated scepticism towards the historical value of the bible.[63] Hooke's ambiguity evidently appears in the case of

[57] *Cf.* Pierre GASSENDI, *Opera omnia*. Lyon: *s.n.* 1658–75, vol. I, pp. 334–335; Margaret OSLER, *Divine Will and the Mechanical Philosophy: Gassendi and Descartes on Contingency and Necessity in the Created World*. Cambridge: Cambridge University Press 1994, pp. 49, 51.
[58] HOOKE, *The Posthumous*, p. 392.
[59] *Ibid.*, p. 442.
[60] HOOKE, *Micrographia*, p. 172.
[61] HOOKE, *The Posthumous*, p. 450; *cf.* Peter DEAR, "*Totius in verba*: Rhetoric and Authority in the Early Royal Society." *Isis*, vol. 76, 1985, pp. 145–161; Clive SUTTON, "*Nullius in verba* and *nihil in verbis*: Public Understanding of the Role of the Language in Science." *The British Journal for the History of Science*, vol. 27, 1994, pp. 55–64;
[62] Kirsten BIRKETT and David OLDROYD, "Robert Hooke, Physico–Mythology, Knowledge of the World and Knowledge of Ancient World." In: Stephen GAUKROGER (ed.), *The Uses of Antiquity*. Dordrecht: Kluwer 1991, pp. 153–156 (147–170).
[63] POOLE, *The World Makers*, pp. 110–111; John REDWOOD, *Reason, Ridicule and Religion: The Age of Enlightenment in England 1660–1750*. London: Thames and Hudson 1976, pp. 128, 131.

chronology. The refusal of long pagan chronologies coexists with a sceptical tendency towards the "chronophobia" diffused among his contemporaries.[64]

5. Hooke's circle

Hooke's ideas on sacred history were not limited to the lectures delivered at the Royal Society. His diaries attest the existence of a group of scholars interested in these topics. The place of their exchange of ideas was not the Society, but the coffeehouses where Hooke met Francis Lodwick, Edmond Halley, John Aubrey, Richard Waller and others scholars interested in discussing the Genesis account of the formation of the world.[65] Diary entries from November 1675 to December 1676 attest that their private discussions were not limited to these topics. All the members of the so-called Hooke circle were fellows of the Royal Society. The choice of an alternative place to the public meetings of the Society suggests the need of a private place where fellows freely exchanged their ideas not only on natural history and the Bible, but even on the Society itself. Lodwick's desire to escape the censure of orthodoxy coexisted with Hooke's dissatisfaction with the Society's organization and his criticism of the first secretary Henry Oldenburg. On 11 December 1675 the informal circle took the shape of a "new clubb". Secrecy was its main feature. "We now began our new philosophical clubb – writes Hooke on 1 January 1676 – and resolvd upon ingaging ourselves not to speak of any thing that was then reveald *sub sigillo* to any one not to declare that we had such meeting at all". On 14 October 1676 Hooke noted: "resolved to leave the Royal Society".

But the destiny of the new philosophical club depended on the success of Hooke's project of reform of the Society's offices. Involved in the election of the new president, Hooke himself was elected secretary after Oldenburg's death in 1677.[66] The polycentric nature of the early Royal Society continued during Hooke's office as much as the private meetings of Hooke circle.

[64] Claude ALBRITTON, *The Abyss of Time: Changing Conceptions of the Earth's Antiquity after the Sixteenth Century*. Los Angeles: Freeman and Company 1980, pp. 10, 18; POOLE, *The World Makers*, p. 175; DEAN, *The Age*, p. 448.

[65] POOLE, "The Genesis Narrative in the Circle of Robert Hooke and Francis Lodwick." In: HESSAYON, A. – KEENE, N. (eds.), *Scripture and Scholarship in Early Modern England*. Aldershot: Ashgate 2006, pp. 41–42 (41–57).

[66] HOOKE, *The Diary 1672–1680*. Edited by Henry Robinson and Walter Adams. London: Taylor and Francis 1935, pp. 82, 199–200, 202, 205–206, 214–215, 232, 239, 240, 242, 253, 260, 264, 292, 294, 299, 312, 318–319, 328.

Even if references to the philosophical club almost disappear from Hooke's diaries, the Genesis narrative and the formation of the world were still discussed only in private by a limited number of fellows.[67] Hooke's hope to improve the Society's activities did not entail that heterodox ideas on sacred history could be freely debated at such an institution as the Royal Society. The need for secrecy and privacy that moved Hooke and his fellows towards a new philosophical club remained. Francis Lodwick was one of the leading members of the Hooke circle. He was involved in the formation of the new club and with Hooke shared interest in heterodox works, such as those of Richard Simon, Isaac La Peyrère and Baruch Spinoza.[68]

Lodwick developed the most heterodox ideas within the Hooke circle, but neither expressed them at the Royal Society nor published them.[69] According to Lodwick, the Bible described things "according to humane understanding and not always according to their truth". Consequently, Lodwick undertook a physical interpretation of Genesis. Despite a recourse to Cartesian physics, Lodwick maintained belief in the direct intervention of God in the formation of the world.[70] Like Hooke, Lodwick did not question the existence of God or providence, but his arguments generated scepticism on the historical validity of biblical narration. Lodwick's most heterodox ideas were about the origin of mankind. "I suppose," he writes, "that the men primitiue were in number more then two a male and a female and that they were primitiuvely produced by the earth in places and climats different as it produceth other animals."[71] His version of the Genesis narrative was very distant from Hooke's strictly physical account of world formation in Ovid and Moses. Members of the Hooke circle did not share the same ideas, but only a common heterodox approach to the sacred history.

[67] Felicity HENDERSON, "Unpublished Material from the Memorandum Book of Robert Hooke, Guildhall Library Ms 1758." *Notes and Records of the Royal Society of London*, vol. 61, 2007, pp. 148, 151 (129–75); *cf.* Lotte MULLIGAN – Glen MULLIGAN, "Reconstructing Restoration Science: Styles of Leadership and the Social Composition of the Early Royal Society." *Social Studies of Science*, vol. 11, 1981, pp. 329–30, 334 (327–364); Michael HUNTER, "Reconstructing Restoration Science: Problems and Pitfalls in Institutional History." *Social Studies of Science*, vol. 12, 1982, pp. 452–454, 457, 460 (451–466).
[68] HOOKE, *Diary*, pp. 202, 242, 336, 340; POOLE, *The Genesis*, p. 43.
[69] POOLE, "Francis Lodwick's Creation: Theology and Natural Philosophy." *Journal for the History of Ideas*, vol. 66, 2005, no. 2, p. 250 (245–263).
[70] Francis LODWICK, *On Language, Theology, and Utopia*. Edited by Felicity Henderson and William Poole. Oxford: Clarendon 2011, pp. 252–253.
[71] *Ibid*., p. 255.

Hooke's ideas on the Earth's alterations were not present in Lodwick's papers; they were shared by John Aubrey and criticised by Edmund Halley. In the first chapter of an unpublished manuscript, *The Natural History of Weltshire*, Aubrey defended the organic origin of fossils and the existence of great alterations of the Earth's structure and morphology after the Creation.[72] On the contrary, Halley refused Hooke's ideas and advanced a different physical explication of the biblical deluge. Earth history, Halley notes, is "knowable but by revelation, or else a posterior by induction from a convenient number of experiments and observations."[73] But Holy Scriptures as historic documents are somewhere imperfect in the description of the natural events of the past. The secret working of Nature cannot be searched within the Bible, but should be inquired by means of experiments and observations, employing only natural causes.[74] Halley refused Hooke's hypothesis of an axial displacement in the early time of the world. Adopting Newtonian physics, he thought that the deluge and morphology alterations were the effects of the impact of a comet on the Earth. The Caspian depression is what remains of that catastrophe.[75] The biblical history of Creation contains an accurate description of the creation of man, not of the Earth or the universe.[76] Thus, biblical chronology was about the age of man, not of the world. For Halley, the saltines of oceans represented the "medium" to calculate the age of the world, which is much beyond the six of seven thousand years of the Bible.[77] Like Hooke's and Lodwick's, Halley's research on the Earth's history was clearly independent of the authority of the Bible.

[72] POOLE, *John Aubrey and the Advancement of Learning*. Oxford: Bodleian Library 2010, pp. 76–84.
[73] Edmund HALLEY, "Some Farther Thoughts upon the Same Subject." *Philosophical Transactions*, vol. 33, 1724–25, p. 124 (123–125)
[74] Simon SCHAFFER, "Halley's Atheism and the End of the World." *Notes and Records of the Royal Society of London*, vol. 32, 1977, no. 1, pp. 17, 27–28 (17–40); Alan CHAPMAN, "Edmund Halley's Use of Historical Evidence in the Advancement of Science." *Notes and Records of the Royal Society of London*, vol. 48, 1994, no. 2, pp. 175–180 (167–191).
[75] EDMUND HALLEY, "Some Considerations about the Cause of the Universal Deluge." *Philosophical Transactions*, vol. 33, 1745–45, pp. 121–123 (118–123).
[76] DEAN, *The Age*, p. 445.
[77] EDMUND HALLEY, "A Short Account of the Cause of the Saltness of the Ocean." *Philosophical Transactions*, vol. 29, 1715, pp. 296 (296–300).

6. Within Solomon's House.

Hooke was aware that there were no direct natural proofs of the great geological alterations of the past. There was a great difference in magnitude between the observable earthquakes and those supposed by his hypothesis. "We do not now find – he notes – instances or effects of the same grandure produced in our present age, or in the ages of which we have some perfect account."[78] How can a theory be founded on such grounds? A seventeenth-century scientist had microscopes and telescopes for inaccessible objects because of their dimensions, but for those lost in the past no material instrument was available to him. "By telescopes or microscopes – Hooke affirms – he may not see some hundred of years backwards and forwards, and distinguish by such microscopes and telescopes events so far distant both before and behind himself in time, as if close by, and now present."[79] The only data available were fossils, but in Hooke's view the simple historical collection of them did not advance human knowledge of the Earth's history. Observations and experiments related to fossils were collected "in order to deduce some doctrine from them." But how to obtain any "certainty of knowledge" concerning the nature and origins of fossils or "the cause and reason of the present figure, shape and constitution of the surface of this body of the earth?" To answer this question, in the lectures on the Earth's history Hooke recalled his ideas on the development of Bacon's methodology.[80] From 1665 to 1667 he probably composed a manuscript on scientific method developing the plan of *Micrographia*'s preface. Hooke's methodological and scientific project aimed to adapt Bacon's ideas to the new mechanical natural philosophy. According to Hooke, the new Baconian natural and experimental history is "a philosophical history". Experimental philosophy is not limited to the collection of data, but should provide the causes of phenomena. Experiments and observations were not collected at random, but followed attempts of explication. Hooke compared experiments to the letters of the alphabet, because most of them "seldom signify but when they are joyn'd and compounded in syllables or words." The experimental research should be guided by theory. Because of this, "hints of accidental remarks" and "queries" are part of the philosophi-

[78] HOOKE, *The Posthumous*, p. 427.
[79] *Ibid*., p. 343.
[80] *Ibid*., p. 332, 334; *cf.* David OLDROYD, "Robert Hooke's Methodology of Science as Exemplified in his Discourse of Earthquakes." *British Journal for the History of Science*, vol. 6, 1972, pp. 110–111 (109–130).

cal history.[81] Hooke's mechanical and experimental philosophy proceeded by analogies and comparisons among data in order to overcome the limits of experience. The distance separating researchers from the past of Nature, can be filled only by means of these methodological instruments. Guided by the organic hypothesis, Hooke employed the analogy between actual and past earthquakes. He compared the effects now observable with fossils, then deduced the possible existence of greater earthquakes in the past causing the alterations of the Earth's surface and structure.

After the Society's criticism of *Micrographia*, in the lectures of 1668 Hooke seems determined to defend from the beginning the methodological bases of his work. As we have seen, in 1664 Hooke was asked to add a dedicatory epistle to *Micrographia* to explain that the "rules" of the Society avoid "dogmatizing and the espousal of any hypothesis not sufficiently grounded and confirm'd by experiments". The hypothesis presented in the book belonged to Hooke and could not be considered part of the Society's activities. But Hooke clearly declared that Society's rules did not condemn all hypotheses. "I desire – he states – to have them understood only as conjectures and quæries (which your method does not altogether disallow)."[82] They were not intended as undisputable axioms, but only as "doubtful problems and uncertain ghesses" guiding the course of the inquiry.[83] This note shows the existence of different interpretation of the Society's methodological program. Notwithstanding the council's influence, Hooke did not renounce to consider his methodological principle as part of the common Baconian inheritance assumed by the Society.

In 1668 he started his lectures declaring his point of view. Again, the defence of the use of hypotheses coexisted with their compatibility with the Society's methodology. Even if Society "have hitherto seem'd to avoid and prohibit pre-conceived theories and deductions", their use in science is fundamental. It distinguished the vulgar empiricism from the real experimental philosophy. Only "some pre-design'd module and theory and some purpose in our experiments" can guarantee a "method in the collecting of material". Without this method, experimental philosophy might have easily turned into a blind collections of meaningless data and random experiments.[84] The Society's aim was to collect and make experiments tending to the "advancement

[81] HOOKE, *The Posthumous*, pp. 18, 42.
[82] HOOKE, *Micrographia*, n.p.
[83] *Ibid.*, p. V.
[84] HOOKE, *The Posthumous*, p. 280.

of natural knowledge", to build "a firm and lasting structure of philosophy". In Hooke's eyes both *Micrographia* and the lectures on fossils are "specimen of such a structure raised from observations and collections of their own,"[85] and his work was not in contrast with the Society's methodological rules.

But was there an official methodology or a set of principles adopted by all the fellows of the early Royal Society? It seems unlikely. As with Hooke, other fellows too interpreted the Society's role in very different ways, according to their interests and leanings. Sprat's work contains only one of the different interpretations of the Society's Baconian program.[86] Apart from the differences among fellows' works, the lack of such an official doctrine is suggested by the frequency and diversity of reform plans in the early decades after the foundation. Every plan, in fact, is based on a different style of Baconianism and a consequent methodological orientation.[87]

A more complex image of the Society emerges in the discussions of the fossils question. Not only did the fellows not share a unique methodological program, they even maintained contrasting views o Nature.[88] Despite the prevailing assumption of a corpuscular or atomic views of matter, mechanical philosophy was not the only conception of Nature diffused among the fellows. Furthermore, mechanistically oriented fellows did not share a monolithic view of matter and motion.[89] In 1665 the divine Joseph Glanvill claimed that the Royal Society's "experimental way of enquiry" was associated with "the mechanical attempts for solving the phenomena" undertaken by some fellows embracing "the Cartesian and atomical hypothesis".[90] But the mechanical philosophy was not the only view of nature associated with

[85] *Ibid*., p. 329.
[86] Michael LYNCH, *Solomon's Child: Method and the Early Royal Society of London*. Stanford: Stanford University Press 2001, pp. 20–21, 23, 30; Robert KARGON, "The Testimony of Nature: Boyle, Hooke and the Experimental Philosophy." *Albion*, vol. 3, 1971, no. 2, p. 72 (72–81).
[87] Michael HUNTER – Paul WOOD, "Towards Solomon's House: Rival Strategies for Reforming the Early Royal Society of London." *History of Science*, vol. 24, 1986, pp. 53–55, 63–67 (49–108); *cf.* OLDROYD, "Some Writings," pp. 158, 159–161.
[88] Theodore HOPPEN, "The Nature of the Early Royal Society. Part II." *British Journal for the History of Science*, vol. 9, 1976, no. 3, p. 257 (243–273).
[89] John HENRY, "Occult Qualities and the Experimental Philosophy: Active Principles in pre–Newtonian Matter Theory." *History of Science*, vol. 24, 1986, pp. 336–7, 342 (335–381); SCHAFFER, "Godly Men and Mechanical Philosophers: Souls and Spirits in Restoration Natural Philosophy." *Science in Context*, vol. 1, 1987, no. 1, p. 56 (55–85); Franco GIUDICE, "Newton e la tradizione dei principi attivi nella filosofia naturale inglese del XVII secolo." In: GIUNTINI, C. – LOTTI, B. (eds.), *Scienza e teologia fra Seicento e Ottocento*. Firenze: Olschki 2006, p. 46 (39–55).
[90] GLANVILL, *Scepsis*, n.p.

the Society's Baconian program. As Seth Ward and John Wilkins observed in 1654, "the magneticall philosophy" was well received by the founders of the Society.[91] Influenced by Gilbert vitalistic view of the earth, Martin Lister refused the organic origin of fossils and Hooke's mechanical philosophy.[92] At the meeting of the 2 November 1671 the Secretary of the Society, Henry Oldenburg, read Lister's letter containing the refusal of the organic hypothesis. It is significant that Lister's observations on fossils were originated by the English translation of Steno's *Prodromus*, published early in 1671. Indeed, Lister's main argument consisted in the lack of correspondence between fossils and living being. This was a problem Italians scientists did not know, because the fossils analysed by Steno belong to the Holocene and the Quaternary period, being similar in form to living species. As Martin Rudwick observed, the organic origin of the Mediterranean fossils "was therefore fairly simple to assert."[93] Nevertheless, there were members of the Society, such as Hooke and John Ray, who defended the organic origins of fossils even though this entailed a new problem about the lack of correspondence with living beings. Hooke, in fact, was the only one to criticise Lister's arguments at the meeting of the Society on 2 November 1671.[94] Lister acknowledged the difference between Mediterranean and English fossils, and emphasized the importance of an analytical approach to fossils, which overcomes the analogies and resemblances sustaining the organic hypothesis:

> This argument perhaps will not so readily take place with those persons that think it nor worth the while exactly and minutely to distinguish the several species of the things of nature, but are content to acquiesce in figure, resemblances, kind and such general notions.

Lister's confidence in the relevance of this taxonomic argument clearly comes across at the end of the letter. Offering some specimens to the Society, he seemed to have challenged Hooke to solve the taxonomic problems involved in the organic hypothesis: "if there shall not be enough specifically

[91] John WILKINS – Seth WARD, *Vindiciae academiarum*. Oxford: *s.n.* 1654, p. 2.
[92] Stephen PUMFREY, "Mechanizing Magnetism in Restoration England: the Decline of Magnetic Philosophy." *Annals of Science*, vol. 44, 1987, pp. 2, 9–10, 12–13 (1–22); Anna Marie ROSS, *The Salt of the Earth: Natural Philosophy, Medicine, and Chemistry in England 1650–1750*. Leiden: Brill 2007, pp. 68–76; Anna Marie ROSS, "Loadstone and Gallstone: the Magnetic Iatrochemistry of Martin Lister (1639–1712)." *History of Science*, vol. 46, 2008, no. 3, pp. 346–351 (343–364).
[93] RUDWICK, *The Meaning*, p. 58.
[94] BIRCH, *The History*, vol. II, p. 487.

to distinguish them, and hinder them from being sampled by any thing of the spoils of the sea or fresh water or the land-snails, my argument will fall, and I shall be happily convinced of an error." As Lister himself noted in the previous lines, it was not only a difference of approach, taxonomical or historical, but "a different view of nature" separating his ideas from those of Hooke and Steno.[95] According to Lister, what we now consider fossils were only mineral substances produced, like all other minerals, by seminal active principles. His refusal of the mechanic world-view appears even in the 1680s polemics with Hooke on fossils and magnetism. In both cases, Lister defended a vitalistic image of Nature, incompatible with the mechanical one maintained by Hooke. In Lister's view, the fossils question was not a mechanical problem, because those particular stones were produced by an active non-mechanical principle conferring them shapes resembling those of living beings.[96]

John Ray and Robert Plot also took part to the Society's discussions on fossils originated by Lister's letter of 1671. Ray published his papers only in 1693, while Plot discussed the question in his *Natural History of Oxfordshire* of 1676. Ray defended the organic origins of fossils, but he did not share Hooke's ideas on sacred history and the chain of being. On the contrary, the organic hypothesis in his eyes was the only way to save the image of a cosmos well governed by providence. The argument of a plastic virtue mimicking living being can support the idea that things are produced by chance and without any reason in nature. If we refuse the organic hypothesis, Ray affirmed, "we put a weapon into the Atheist's hands, affording him a strong argument to prove that even animals themselves are casual productions, and not the effects of counsel or design."[97] Ray's aim was to achieve conciliation between the organic hypothesis and the defence of sacred history and providence. Fossils were the remains of the universal biblical deluge, whose origins and nature were different from the local inundations described by pagan writers. It was the divine intervention that caused the Deluge, and it was the Deluge that changed the morphology of the earth, altering the order of land and sea.[98] For Ray, a strictly physical description of the Earth's history was not possible, because "God doth not stand by as an idle and un-

[95] Martin LISTER, "A Letter of Mr. Lister, written at York August 25, 1671." *Philosophical Transactions*, vol. 6, 1671, pp. 2282–2284 (2281–2284).
[96] BIRCH, *The History*, vol. III, pp. 196–216, 338, 389–390; *Ibid.*, vol. IV, pp. 63–64, 138, 141, 237–238, 261–266, 512–530: cf. EMERTON, *The Scientific*, pp. 110–111, 116, 142, 203.;
[97] John RAY, *Three Physico–Theological Discourses*. London: *s.n.* 1693, p. III.
[98] *Ibid.*, pp. 4–5, 10, 12–13, 69–73, 125–127, 175–177.

concerned spectator, and suffer thing to run at random, but his providence many times interposes and stops the usual course and current of natural causes."[99] And if the species corresponding to some non-Mediterranean fossils were not observable at that point, it did not mean they were not existent. As a taxonomist, he knew that the enlargement of the European world originated in the continuous discovery of new species. The limits of human knowledge of nature should not be imposed on God's providence: species are not destroyed or lost, but continue to live as they were originally created "somewhere or other in the seas".[100]

Ray maintained a taxonomic approach to the question of fossils, depriving it of all the perilous consequences which Hooke's historical ideas involved, such as biological transformism. Even Robert Plot, the first keeper of the Ashmolean museum and secretary of the Oxford Philosophical Society, refused Hooke's transformist ideas on species. For Plot, fossils were *lapides sui generis*, produced by the action of a saline active principle upon the matter of earth.[101] The universal deluge was not sufficient reason for the irregular disposition of fossils, and earthquakes were not able to transform all earth's morphology. Plot's main argument against the organic hypothesis consisted in the refusal of species extinction:

> If it be said that possibly these species may be now lost, I shall leave it to reader to judge, whether it be likely that providence which took so much care to secure the works of creation in Noah's flood, should either then, or since, have been so unmindful of some shell-fish (and no other animals) as to suffer any one to be lost.[102]

Other members of the Oxford Society expressed similar ideas against Hooke's hypothesis. In 1687 a letter of Edmund Halley to John Wallis described Hooke's lectures on the Earth's history. Hooke's ideas were discussed and criticised by the members of the Oxford Society in a series of letters sent to London in the following months.[103] As Wallis wrote on 4 March, Oxford fellows "seemed not forward to turn the world upside down (for so 'twas phrased) to save an hypothesis, without cogent reason for it; not only, that possibly it might be so, but that had to been so." For them, the great altera-

[99] *Ibid*., p. 208.
[100] *Ibid*., p. VIII.
[101] Robert PLOT, *The Natural History of Oxfordshire*. Oxford: 1676, pp. 32–35, 105, 122.
[102] *Ibid*., pp. 113–114.
[103] GUNTHER, *Early Science*, vol. XII, pp. 123–126; BIRCH, *The History*, vol. IV, p. 128; *Journal Book of the Royal Society*, vol. VIII, pp. 113–117, 124–129, 133, 146–148.

tions of the Earth's morphology were not consonant with the sacred history and the literal interpretation of the Bible.[104]

7. Conclusion

According to the traditional image of the Royal Society, its aim was the institutionalization of a clear program of research founded on Baconian history of Nature. This view, whose origins are in Sprat's *History*, is still maintained by historians with different or opposite interests. Positivists historians saw in the Society the realization of Baconian reform of natural science and a model of the modern scientific institutions of the nineteenth and the twentieth century. The unity and uniformity characterizing this image are maintained on different grounds by non-positivist historians. According to Henry Van Leeuwen, for instance, the Royal Society had not only an institutional and methodological programme, but also a particular theory of knowledge commonly accepted by all fellows and identifiable with John Tillotson's religious scepticism. Through Glanvill and Wilkins, this theory was assumed by Robert Boyle and conditioned Isaac Newton's position on gravity.[105] Steven Shapin and Simon Schaffer, mainly interested to evidence the social nature of the knowledge question in restoration science, identified Society's institutional aim with the affirmation of a new 'form of life', that of the experimental scientist able to distinguish legitimate matters of facts from illegitimate causal explanation.[106] Thus, different historical analyses seemingly share the assumption that the Baconian experimental philosophy consisted of anti-hypothetical empiricism, which was embraced by the Royal Society.[107] The debates on fossils and Earth history suggest an alternative image of the Society and its fellows. The large-scale programme

[104] David R. OLDROYD, "Geological Controversy in the Seventeenth Century: Hooke *vs* Wallis and its Aftermath." In: HUNTER, M. – SCHAFFER, S. (eds.), *Robert Hooke: New Studies*. Woodbridge: Boydell Press 1989, pp. 210, 220 (207–233); A. J. TURNER, "Hooke's Theory of Earth's Axial Displacement: Some Contemporary Opinions." *British Journal for the History of Science*, vol. 7, 1974, no. 2, p. 167 (166–170).

[105] Henry VAN LEEUWEN, *The Problem of Certainty in English Thought 1630–1690*. The Hague: Martinus Nijhoff 1963, pp. 14, 34, 89, 111.

[106] SHAPIN – SCHAFFER, *Leviathan*, pp. 14, 22, 55; this model is maintained by Barbara Shapiro, but on the base of a different genesis of the principle of this discrimination, see Barbara SHAPIRO, *A Culture of Fact: England, 1550–1720*. Ithaca: Cornell University Press 2000, pp. 4–5.

[107] *Cf.* Peter ANSTEY – Alberto VANZO, "The Origins of Experimental Philosophy." *Intellectual History Review*, vol. 22, 2012, no. 4, pp. 500, 513–515 (499–518).

of a general history of Nature, ideally realizing Bacon's dream, never took place because of a constant scarcity of funds. In addition, what we may call the philosophical independence of the fellows, hindered the existence of a common programme of research in the Earth sciences.

The variety of positions on methodology suggests that Bacon and Baconianism worked as a sort of label used for very different objects.[108] Regarding ontology, the apparent unity guaranteed by the unifying slogan of Baconianism, was not available. Among fellows, along with different or rather opposite versions of mechanical philosophy, a series of anti-mechanical philosophies of Nature were diffused.[109] Lister and Hooke, Halle and Plot, Ray and Lodwick, did not follow any institutional program of research, nor did they embrace a cooperative compilation of the general history of nature. As Marie Boas Hall affirmed, "the Society acquired its reputation not because it was a research institute directed by a brilliant autocrat, but because it was an association of independent equals", who willingly shared the discoveries and ideas which they achieved independently in the solitude of their own studies.[110]

[108] Marie BOAS HALL, "Science in the Early Royal Society." In: CROSSLAND, M. (ed.), *The Emergence of Science in Western Europe*. London: Macmillan, pp. 61–63 (57–77); Michael HUNTER, "First Steps in Institutionalization: the Role of the Royal Society of London." In: FRÄNGSMYR, T. (ed.), *Solomon's House Revisited: The Organization and Institutionalization of Science*. Canton, MA: Science History Publication 1990, p. 22 (13–29); HUNTER, *Science and the Shape*, pp. 102–103.

[109] HOPPEN, "The Nature of the Early Royal Society: Part I." *British Journal for the History of Science*, vol. 9, 1976, no. 1, pp. 1–3 (1–24).

[110] Marie BOAS HALL, "Solomon's House Emergent: The Early Royal Society and Cooperative Research." In: WOOLF, H. (ed.), *The Analytic Spirit: Essays in the History of Science in honor of Henry Guerlac*. Ithaca – London: Cornell University Press 1981, p. 194 (177–194).