DICIONÁRIO
DE HISTORIADORES PORTUGUESES
DA ACADEMIA REAL DAS CIÊNCIAS AO FINAL DO ESTADO NOVO
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HOOYKAAS, Reijer (Schoonhoven, Netherlands, 1906 - Zeist, Netherlands, 1994)

Hooykaas was born into a Calvinist family of goldsmiths. From 1923 to 1930 he studied chemistry at Utrecht University. In 1945 he was appointed to the first history of natural sciences chair in the Netherlands at the Free University of Amsterdam, where he remained until 1967. He then moved to the University of Utrecht, where he stayed until his retirement in 1976. In 1947 he took part in the 5th Congress on the History of Science in Lausanne, where he met Armando Cortesão, a specialist in cartography of the Discoveries and then counsellor for the History of Science and Culture at UNESCO. Hooykaas was vice president for Europe (1967-1976) and then president of the International Committee for the History of Geological Sciences (1976-1984); this was largely due to the importance of his 1959 work, a historical-critical study of the principle of uniformity in geology, biology, and theology. In 1970 he was in charge of the Erasmus Lectures at Harvard University, and in 1975-1977 he took over the Gifford Lectures at the University of St Andrews. He was elected a full member of the Académie Internationale d'Histoire des Sciences in 1957 and of the Royal Netherlands Academy of Arts and Sciences in 1959. For many years, he was an active member of the Christian Society of Scientists and Doctors in the Netherlands. The relationship between religion and science and the origins of modern science were omnipresent themes in his work, an interest based on his conviction that the history of science should be taken seriously as part of cultural history. This led him to study the technical, scientific, and cultural significance of the Portuguese discoveries. Since 1962, he has taught the History of Sciences at the University of Coimbra and collaborated with two professors from this university: his friend Armando Cortesão and Luís de Albuquerque, a mathematician who became a notable historian of Portuguese nautical knowledge. In 1969 he was awarded an honorary doctorate by this university. However, his attempt to develop the history of science in Portugal, especially by sending scholarship holders to the Netherlands, ended up failing (A. Flipse, "Reijer Hooykaas...", 2013; J. D. North, "Eulogy of Reijer Hooykaas", 1994; R. Hooykaas, Selected Studies..., 1983, pp. VII-XXII, 7 and 23; Pereira et al., "Os primórdios do ensino..." [The beginnings of education], 2019, p. 42).

The matter of the emergence of modern science is present in his 1958 study of Pierre de la Ramée (1515-1572), in which he showed that this scholar developed a utilitarian and empiricist philosophy—linked to his Calvinist religious convictions—based on the idea of a "natural reason" adapted to nature and the defence of "philosophical freedom". By associating with tradesmen and visiting workshops, Ramus united the tradition of scholars with that of the craftsmen. Ramism, which soon spread to the reformed countries, favoured the transformation of the mediaeval sciences into modern experimental science (Humanisme, science et

Réforme…, 1958, pp. 1-2, 91-96). In "Religion and the Rise of Modern Science" (1972), a compilation of his Gunning Lectures at the University of Edinburgh (1969), Hooykaas dealt with the evolution of the relationship between reason and experience, showing how the emergence of modern science in the 16th and 17th centuries implied an overcoming of the Greek heritage, which included a rationalist philosophy and the development of mathematics, but also a worldview characterised by the deification of nature, the underestimation of human capacity, and the depreciation of manual labour. He believed manual labour should be valued, with a humbler conception of human reason, while at the same time affirming human capacity to intervene in nature and put it at our service. The new mentality associated with the beginning of modern science, that of cooperation "between head and hand," was favoured by the emancipation of the bourgeoisie during the Renaissance. This was exemplified by reformed cities such as Nuremberg, Antwerp, London, or Amsterdam—where many of the bourgeois were craftsmen and collaboration between scholars and practical men was promoted, and this favoured the experimental method ("Religion and the rise"…, 1972, p. 92; "Science in Manueline Style"…, 1981, pp. 395-398; "Selected Studies"…, 1983, pp. 19-31; "The Rise of Modern Science…", 1987/2003, pp. 27-28). This new attitude received positive sanction from reformed religious thought, which valued manual and experimental labour. Dialoguing with the so-called Merton thesis (1938), which linked English puritanism to the tendency towards scientific and experimental knowledge—a thesis inspired by Max Weber—Hooykaas corrected it by stating that scientific research was favoured in the following ways: by the belief in the principle that all actions of human life are done "for the glory of God" (which includes a labour ethic), Calvin's "theory of accommodation" (which favours a non-literal interpretation of the Bible as far as physis is concerned), the Protestant doctrine of the "universal priesthood of believers" (which eliminated the mediation of ecclesial authority), as well as the belief that God reveals himself to men in two books—the Bible and Nature (Idem, 1972, pp. 98-134). As he would later say, man's intervention in nature was favoured by the mechanistic perspective, which developed in opposition to the organicism dominant among the scholastics, for which natural beings are irreproducible by artificial means—in other words, the attitude of coercive empiricism is favoured by mechanicism, which progresses clearly between the end of the Middle Ages and Newton (Idem, 1987/2003, pp. 29, 30).

Always uniting philosophy to the history of science, Hooykaas went on to develop a sophisticated empiricism. This was evident in his Gifford Lectures, in which he affirmed the historical continuity of the scientific way of thinking. In these lectures he identified three fundamental components: "fact", "faith" and "fiction", the "proportions" of which are not set *a priori*. Scientific facts are not raw facts—there is a dialectic of mutual adaptation between the data obtained through experimentation and the expected laws, and the role of the creative imagination that creates hypotheses is remarkable, assuming the suspension of judgement plays an important role (fictions). "Faith" refers to the set of basic beliefs in 'things that are not seen", many of which have a metaphysical or *a priori*/methodological character. These beliefs, which are also a practical necessity for scientists, lead them, for example, to persist in the idea that a group of phenomena obeys a law—João de Castro, with his experiments on magnetic declination, invalidated any possible relationship of proportionality between that and the difference in longitude in relation to a reference meridian but maintained the conviction that a law existed and should be discovered (Fact, Faith and Fiction…, 1999, pp. 7-13, 188-190). The relationship between this sophisticated empiricism and historical studies is clear in the chapter of this book entitled "Thinking with the hands". This part of the book shows that it was above all from the 17th century

onwards in the countries of northwestern Europe that experimental research developed, linked to a cooperation between craftsmen, engineers, and scholars.

Four years after his first visit to Portugal, Hooykaas learnt Portuguese and wrote his seminal text, "The Portuguese Discoveries and the Rise of Modern Science' (1966). It presents the core of his vision of the evolution and innovative nature of the knowledge associated with Portuguese Discoveries, the conflicts of mentality associated with its reception in Portugal, and its international diffusion. This text was part of the whole of his work, which was very focused on the general conditions of the emergence of modern science. Using Portuguese studies on the period (Joaquim Bensaúde, Joaquim de Carvalho, the Cortesão brothers, Pereira da Silva, Fontoura da Costa, Hernâni Cidade, etc.), he launched a general interpretation of the cosmopolitan significance of this knowledge—which these authors were unable to provide because they ignored the detail of the international literature that allowed Portugal to be placed in the general European movement that led to modern science. The author himself summarised it: "Portuguese sailors and scientists of the 15th and 16th centuries made an important contribution to the emergence of modern science, unwittingly undermining belief in scientific authorities and reinforcing confidence in an empirical and natural-historical method" ("The Portuguese Discoveries…", 1966/1983, pp. XV, 580).

If the humanists were decisive for the outbreak of the Renaissance, the arts and literature, and the recovery of the classics of the Greco-Latin world, their effect on science was not so positive, given the excessive veneration of the ancient—which is still felt in the work of Copernicus—and the contempt for experience. Hooykaas found ample signs of this conservatism—that showed contempt for manual labour—in the humanists active in Portugal, such as Sá de Miranda, Francisco de Holanda and António Ferreira, or professors at the College of Arts in Coimbra, such as Arnaldus Fabricius, George Buchanan or Élie Vinet; the only significant exception—because his adventurous life made him travel a lot and he became friends with Garcia da Orta—was Luís de Camões, the humanist poet who makes the case for the "knowledge of experience" in "*Lusíadas"* [Lusiads], defending an empiricism that is not against reason but against rationalism (especially Scholasticism), since reality goes beyond the expectations of reason (Idem, 1966/1983, pp. 581, 587-588, 591-594; Idem, 1981, pp. 236-238, 327-328, 342, 424; Idem, 1999, pp. 185, 201). Hooykaas developed the theme of the humanists' reaction in the 16th century in his long study on Castro (Idem, 1981, pp. 233-245) and in the book "Humanism and the voyages of discovery..." (1979).

Citing authors linked to the navigations (Diogo Gomes, Pacheco Pereira, João de Barros, Pedro Nunes, João de Castro), Hooykaas shows how they denounced the errors and incompleteness of ancient science, emphasising their methodological shift by considering the authority of experience as superior to the *a priori* reasoning of the ancients, scholastics, and humanists. More specifically, João de Castro insisted on how Reason must adapt to new facts (like in the case of the habitability of the antipodes) and not the other way round, which is why Hooykaas saw this author as a "precursor" of Francis Bacon (Idem, 1966/1983, pp. 582-586, 588-589). Hooykaas analysed the lively conflict between the conservative tendencies of the scholastics and humanists and the abundant evidence of the errors and insufficiency of the ancients and showed that the solution found was "to follow nature wherever it led and, secondly, to respect tradition wherever possible without violating the first directive" (Idem, 1966/1983, p. 587). Exemplifying this attitude of commitment, Pedro Nunes and João de Castro praised and accepted Archimedes' mechanics, Ptolemy's cosmography, and Euclid's maths, noting how the novelties of observation had radically renewed natural history in particular—

this was an area where knowledge was more contingent and the bypassing of Ptolemy's geography was evident; Hooykaas praises João de Castro and Garcia de Orta for having an obvious experimentalist attitude (Idem, 1966/1983, pp. 590-591, 594-595). In the Gifford Lectures of 1976, Hooykaas takes up the early cases of João de Castro (in his "Roteiros" written between 1538 and 1541) and Garcia de Orta, stating: "Castro and Orta were exceptionally realistic, free from fables, and unafraid to use their own hands to find the truth about nature"—unlike the Jesuits of Coimbra, whose Aristotelian conservatism went hand in hand with the invocation of experiments they never carried out. However, Hooykaas states that João de Castro remained a deep conservative (Aristotelian) when it came to natural philosophy—an aspect that is evident from reading his "Tratado da esfera" [Treatise on the Sphere]. For this reason, he concludes that "Castro's work shows what science could have been around 1500 if it hadn't interacted with "'philosophical' circles"—in other words, modern experimental spirit was accompanied by a scholastic "philosophical" worldview, in line with the dominant intellectual vision (Idem, 1999, pp. 201, 200). Hooykaas would later call this attitude of compromise—non-revolutionary, as is the case with many scientists, and like Kuhn would insist—between the acquisitions of experience and the portions of ancient knowledge retained (Ptolemaic geocentrism and Aristotelian organicist cosmology without openness to the mechanics of the nominalists) a "Manueline-style science." In architecture, a (conservative) Gothic structure was creatively decorated with non-fantastical decorations, which created a hybrid style. However, this science never reached a system stage and was restricted to fragments of physics, botany, and maths (Idem, 1981, pp. 351, 421-426). One of the aspects of Hooykaas' analyses that favoured the relevance of the geographical revolution—which generated in Europe a conflict between 'hard facts' and systems of ideas—was his analysis of Copernicus' work and its reception throughout the 16th century, showing the anachronism of those who see it as essentially revolutionary ("The Rise of Modern Science…", 1987/2003, pp. 31-36, 40-43).

In the liberal tradition of criticism, Hooykaas wondered why the Portuguese—after having pioneered geography and natural history—didn't make any significant contribution to the creation of the worldview established by Copernicus, Kepler, Galileo, Huyghens, and Newton: this was a combined effect of the curtailment of intellectual freedom (by the Inquisition and the spiritual monopoly of the Jesuits) and a sparse collaboration between practical men (craftsmen) and the scholars, which certainly had to do with the social structure of the Portuguese bourgeoisie of the time (Idem, 1966/1983, p. 596). In 1981 he added that, despite an initial period of royal protection for scientific activity (by princes Henrique and then Luís, brother of King João III), this ended up waning with the last kings of the house of Avis and the Filipes (Idem, 1981, p. 395-397).

In short, Reijer Hooykaas deepened the pragmatist interpretation, which was open to social explanations, of the significance of the knowledge linked to the Discoveries, which had its exponent during the First Republic in António Sérgio (in his essay "O Reino cadaveroso" [The corpse kingdom]). This interpretation is compatible and even has affinities with the work of Olschki, Merton, and Zilsel. Hooykaas was a cosmopolitan Dutchman whose research was not motivated by Portuguese/Iberian nationalist or pro-Catholic arguments. After carefully studying the relationship between science and the Reformation—which did not favour an optimistic perspective on the perpetuation of the Portuguese "revolution of experience"—he saw a particular configuration in our "case": a "Manueline-style science" in which he identified elements of modernity imposed by practical needs, i.e. the interaction between the hand and the head, the sense of the concrete, the abandonment of

philosophical prejudices when solving concrete problems, as well as the development of the rigour of observation, which in Castro was extended to a care for the causes of error and an experimental sense, which was combined with a disinterested curiosity, a feeling for the beauty of the natural world and the glory of understanding it, as well as an (Erasmian) ethical humanism, ruled by care for others and a tolerance and interest in other peoples (Idem, 1981, p. 408).

Hooykaas emphasised the contingent aspect of this process. The consequences of this interaction between practice and theory, which favoured the emergence of experimental science, were unpredictable. It was not anchored in a metaphysical or philosophical perspective that could guarantee that we were on the right path to knowledge of the book of nature, nor could the pragmatic attitude that had been developed lead us to assume that this new approach contained an essential component of modern science—the attitude of coercive empiricism, as Floris Cohen would say, which, together with Greek philosophical rationalism and its mathematics, with the addition of a more humble attitude of reason towards the unexpected in the world of facts, would allow modern science to emerge. In his 1987 article, which was presented to the public in 1983, Hooykaas insisted that our geographical revolution "marks the beginning of a new, empiricist and non-rationalist trend in science" (Idem, 1987/2003, pp. 22, 25-28, cit. 28).

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This work is financed by national funds through FCT - Foundation for Science and Technology, I.P, in the scope of the projects UIDB/04311/2020 and UIDP/04311/2020.