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CHRISTIAAN HUYGENS' NATURAL THEOLOGY IN HIS *COSMOTHEOROS* AND OTHER LATE WRITINGS

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Abstract

Christiaan Huygens' late writings, ranging from 1686 to 1695, bear witness to his philosophical and theological reflections. In his *Cosmotheoros*, which was intended for publication, and other late writings which can be regarded as its preparatory drafts, Huygens deals with issues central to seventeenth-century philosophical debates: God's power, divine and human intelligence, probabilistic epistemology, natural theology, and the plurality of worlds. This paper explains how Huygens' reflections on animals and their souls, rational or not, play a key role in his epistemological reflections on natural theology. The issue of animal generation, as well as of animal souls, is crucial to identifying elements of continuity between the scientific topics of Huygens' works, and may be considered as the point of intersection between his understanding of mechanism and of the teleology of nature. This neglected perspective on Huygens' philosophical-natural animism reveals key elements of his model of rationality and of his attitude towards religion, demonstrating his involvement in the debate over animism, in which he seems to have been strongly influenced by English Protestant empiricism.

Keywords: Christiaan Huygens, Natural Theology, Mechanistic Philosophy, Teleology of Nature, Philosophical Animism

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1. Introduction

The late writings of Huygens considered here are collected, in large part, by the Société Hollandaise des Sciences under the thematic title of *Cosmologie*, in volume XXI of the *Œuvres Complètes* (Huygens 1888-1950)¹. They consist of both published (the *Cosmotheoros*) and unpublished materials, such as handwritten and undated folia, notes, preparatory studies and appendices, dated by the editors between 1686 and 1695. This period is particularly relevant to the evolution of Huygens' mature thought because of two notorious historical events: the Revocation of the *Edict of Nantes* and the publication of Newton's *Principia mathematica*.

In what follows, the greatest attention is paid to the *Cosmotheoros*, which was intended for publication but edited posthumously in Latin by Huygens's brother Constantijn in 1698, and to previous writings, including *Verisimilia de planetis*, *Pensees meslees*, *Quod animalium productio*, *Que penser de Dieu?*, *De probatione ex verisimili*, and *De l'œil et de la vision*, which can be regarded as its preparatory drafts. In those writings, Huygens deals with issues central to seventeenth-century philosophical debate: God's power, divine and human intelligence, probabilistic epistemology, natural theology, and the plurality of worlds.

The relevance of a thorough analysis of Huygens' mature works lies in the fact that problems related to the philosophical structures that support his scientific investigations, overlooked by prominent historians of science (e.g., Mach 1883, Cassirer 1907, Koyré 1965), remain unsolved. In fact, the "non-neutral" reconstruction performed by editors of Huygens' work has often hidden the context and process of his discoveries (Mormino 2003b). The emphasis on the published works at the expense of the ongoing drafts might be one of the main reasons why most of the critical studies have focused on aspects of Huygens' scientific activity, as various as they are specialized (Yoder 1998). These are the reasons why Joella Yoder's crucial work (Yoder 2013), consisting of the re-ordering of and the comparison between each manuscript *folio* and its version in the *Œuvres Complètes*, was and still is necessary to incorporate Huygens' unpublished materials into his overall corpus.

¹ The following texts appear in *Cosmologie*, which is Tome XXI of Huygens 1888-1950: "Pensees meslees" (1686); "Discours de la cause de la pesanteur" (1690), 451-88; "Quod animalium productio" (1690); "Verisimilia de planetis" (1690); "De probatione ex verisimili" (1690); "Cosmotheoros. Livre I e II" (1698). For works appearing in other volumes, the volume number will be provided in Arabic numerals. Huygens' writings are considered here as they were published in their original language. Even if there are some English versions of the *Cosmotheoros* (e.g., Childe 1698), for reasons of consistency I provide my English translations of all quotations.

One of the main causes of the silence surrounding these late writings, which were inspired by a greater reflective vocation, might be the fact that Huygens is a thinker who does not easily fit the predetermined and opposed categories, such as Cartesianism and English Empiricism, employed by historiography (Bos 1982, Chareix 2003). The only two studies that reconstruct the epistemology underlying his speculation, as predetermined by a supposed “Cartesianism” (Elzinga 1972) or by a lack of systematic thought (Burch 1981), fail to highlight his way of expressing epistemic problems related to his scientific theories.

Therefore, from an historical point of view, we have to recognize that Huygens’ philosophical attitude has not yet been satisfactorily defined. The same understanding of his major work of this period, namely the *Cosmotheoros* (1698), and in particular the most speculative Book I, has been widely discussed by critical literature between the 1970s and 1990s. It was either regarded as the product of a mature wisdom (Hooykaas 1979, Andriess 1993) or of a natural weakening (Romein 1977, Hall A.R. 1980) of Huygens’s intellectual capacity.

My research follows and supports those studies (Vermij 2002, Mormino 2000 and 2003, Chareix 2003 and 2003a, Radelet de Grave 2003) that emphasize Huygens’ philosophical attitude in his late writings, especially the *Cosmotheoros*, and its relevance to his scientific positions. The latter was considered by his author as “a small treatise on philosophical matters”², but cannot be regarded as disconnected from his previous scientific work.

In this respect, my analysis of Huygens’ considerations on the generation of animals (cf. Wolloch 2000) and of their souls, rational or not, may be considered as a point of intersection between his understanding of mechanism and of the teleology of nature, since they prove necessary to explain the functioning of the world machine in every part of the Universe, and thus the existence of a God who planned and created this perfect work.

This neglected perspective on Huygens’ philosophical-natural animism reveals key elements of his model of rationality and of his attitude towards religion, thus demonstrating that Huygens was not a mere a problem solver detached from the methodological, philosophical and theological debate. Instead, he was involved in these debates, especially those regarding the possibility of extra-terrestrial life (Wolloch 2002), that took place around him and culminated in Immanuel Kant’s reflections (e.g., Dick 1982).

² Huygens (1888-1950, 10, No. 2854, Letter to Leibniz, 29th May 1694, 609): “un petit traité en matière Philosophique”. See also: Huygens (1888-1950, 10, No. 2842, Letter to Marquis de l’Hôpital, 24th December 1693, 577).

2. The Miracle of Animals

In the *Cosmotheoros*' first book, Huygens refers to animals and plants as *miracles* of procreation, when he explains that all the creation is able to show with firm evidence the greatness of divine providence and intelligence working with a view to certain *purposes*:

While one of Democritus or also of Descartes' followers can undertake to explain both terrestrial and celestial phenomena so as to require only atoms and their movements, he will not succeed for plants and animals, being unable to claim anything plausible about their origin. It is absolutely clear that such kinds of things could never have been the result of the disorderly and fortuitous movement of corpuscles: since we find that everything is perfectly accommodated for certain *purposes*, with great discernment and exquisite knowledge of the laws of nature and of Geometry, as well as of the *miracles* of procreation, as one will show several times in the following pages.³

This passage is relevant for two of Huygens' statements. The first is related to his explanation that the acknowledgment of divine purposes in the created world is possible only thanks to two complementary skills, an excellent knowledge of the laws of nature and geometry and a careful observation of the "miracles" of generation, which have already been recognized as key elements of Huygens' epistemological approach in scientific methodology (Chareix 2003, 5). The second statement is his theoretical objection to Democritus, Descartes and their followers, who claimed that the atoms alone, with their disordered and fortuitous movements, are sufficient to cause the generation of plants and animals. In fact, the close juxtaposition of the terms "miracles" and "purposes" raises the serious issue of explaining Huygens' teleology within a mechanistic philosophy that still fits within the Cartesian framework, even if "heterodox" (Koyré 1965), since he never abandons the solution of vortices either in his previous scientific works or in his late speculative writings.

In the philosophical Preface to Huygens' main work on the laws of gravity, the *Discours de la cause de la pesanteur*, eventually published in 1690, Huygens premises the same considerations about the lack of explanation of the causes of bodies' attraction and heaviness through the Atoms' system by Democritus, Lucretius and especially Descartes (Huygens 1888-1950, 21, 445-46). And few years later, he renews the same criticisms against the ancient

³ Cf. Huygens (1888-1950, 21, *Cosmotheoros I*, 701; emphasis added): "Cum enim quae in Terra, imo quae in Caelo quoque aspicimus, aliquis Democriti, aut etiam Cartesii sectator, ita se explanaturum profiteri possit, ut tantum atomis et motu horum indigeat; in herbis tamen et animalibus frustra erit, nec de primo eorum exortu quidquam verisimile adferet; cum nimis manifesto appareat, nunquam vago, ac fortuito corpusculorum motu, talia quaedam prodire potuisse: quippe in quibus omnia ad certum finem egregie apta accommodataque cernantur; cum summa prudentia, et legum naturae, ipsiusque Geometriae, cognitione exquisita; quemadmodum in sequentibus saepius ostendetur: ut jam omittamus illa in progignendo *miracula*."

atomists in the *Appendix* to the letter to Pierre Bayle, dated 23 February 1693: “Democritus, Epicurus, and many other ancient philosophers, though they were persuaded that everything must be explained by the bodies’ figure and movement, and by the void, are not able to explain any phenomenon so that one can be satisfied.”⁴ Even in his later works, Huygens’ attitude remains the same: starting from a physical problem, he aims at devaluing the whole Cartesian system, including the metaphysical and methodological part. Descartes is still an eminent example from which Huygens wants to distance himself, at times even rhetorically, as he does in the *De probatione ex verisimili* (1690) by replacing the Cartesian *clear and distinct perception*, “perceptio clara ac distincta”, with his *degree of probability*, “gradus probabilitatis”⁵, in the judgment and prediction of phenomena.

The generation of plants and animals seems to Huygens a clear point of weakness of *Le Monde* (Descartes 1909), as he points out in a letter to Leibniz dated 11 July 1692: “It seems that Descartes wanted to decide on all matters of physics and metaphysics, without bothering about whether what he said was true or not. [...] However, he refrained from mentioning the production of plants and animals, no doubt because he did not see how they could have been created by the particles’ movement and figure, as well as the rest of the bodies he considers.”⁶ Huygens does not find an alternative solution to the Cartesian vortices of matter (Koyré 1965). Instead, on the issue of animal generation Huygens elaborates a solution which seems to be influenced by other major thinkers of the second half of the seventeenth century. One good example is found in a passage of his *Quod animalium production*, dated by the Huygens 1888-1950, editors to around 1689-90, where he addresses the explanation of final causes with arguments similar to Leibniz’s arguments in the *Discours de métaphysique* (Leibniz 1686, §19): “However, when it comes to the question of animals, they [the followers of Epicurus, Ed.] torment themselves for no reason and, unless they rave, they must admit that they recognize the finger of God in these things in which everything appears disposed to a *purpose*

⁴ Cf. Huygens (1888-1950, 10, No. 2791, 403-4): “Democrite, Epicure et plusieurs autres des philosophes anciens, quoiqu’ils fussent persuadez que tout se doit expliquer par la figure et le mouvement des corps et par le vuide, ils n’expliquoient aucun phenomene en sorte qu’on en restoit satisfait.”

⁵ Cf. Huygens (1888-1950, 21, *De probatione ex verisimili*, 541; emphasis added): “Certitudinem vero non bene poni in *perceptione clara ac distincta*. Patet enim ejus claritatis ac distinctionis varios quasi gradus esse. namque et in ijs quae plane nobis perspicue comprehensa putamus saepe fallimur et ipse Cartesius exemplo est, ut in legibus communicati motus ex impulsu corporum. etc. in circulo illo ex glacie in aere suspenso cujus repercussu parelia fieri vult. In bene discernendis istis *probabilitatis gradibus* ingenium judicijque rectitudinem conspici, nec usquam tantum aberrari quam in ejusmodi judicij neglectu aut perversitate.”

⁶ Cf. Huygens (1888-1950, 10, No. 2759, 303-4; emphasis added): “Il semble que des Cartes ait voulu decider sur toutes les matieres de Physique et Metaphysique, sans se soucier s’il disoit vray ou non. [...] Il s’est abstenu pourtant de toucher à la production des plantes et des animaux, sans doute parce qu’il n’a pas vu moien de les faire naitre du mouvement et de la figure des particules, ainsi que le reste des corps qu’il considere.”

assigned so wisely. Who in fact would be so arrogant to say that the birds fly because they are winged, instead of saying that the wings have been given in order to fly?”⁷ Huygens, criticizing those who attribute the ability of birds to fly to the fact of being winged instead of claiming that the wings are given with the purpose of flight, deduces *a posteriori* the existence of a divine design, thanks to the discovery of purposes perfectly planned and arranged in the physical structure of human or animal body. In fact, not only the generation of animals and plants, but also the finding of the perfection of their organic parts, causes such a wonder or “merveille” (Huygens 1888-1950, 21, 363) that it leads Huygens to conceive them as *a special work of God*, “une opération particulière de Dieu” (Huygens 1888-1950, 21, 364), in the *Pensees meslees*, a preparatory draft dated to about 1686. Already in this early study for the *Cosmotheoros*, Huygens makes use of the argument from the necessary presence of a divine design of the universe to corroborate his “probable conjectures” on the creation of other planets and their inhabitants as the main testimony of the divine purposes.

The two above-mentioned passages of the *Quod animalium production* and the *Pensees meslees* allow to shed some light on Huygens’ use of the polysemous term “mirabilia”, which I translate as *wonderful miracles*, a synonym in the *Cosmotheoros* for animals and other divine creations:

It seems no doubt to be allowed Men to feed on everything that is nourishment and grows on land or in water, such as vegetables, fruits, milk, eggs, honey, fishes, flesh of most birds and quadrupeds. It may seem strange that this reasonable animal is made so that he must live by the destruction and the killing of many other living beings. This, however, must not be considered contrary to the *precepts of nature*, since we see that lions, wolves and other beasts of prey are fed by cattle and other kinds of weaker animals. [...] But, besides all the advantages that animals and plants give us, the creator of things wanted us to enjoy being able to contemplate their various forms, ways of living and multiplying themselves, where there are a variety of almost infinite and many *wonderful miracles*, which are known by means of the *naturalists*.⁸

⁷ Cf. Huygens 1888-1950, 21, *Quod animalium productio*, § 3, 556 (my emphasis): “Sed ijdem cum ad animalia ventum est, frustra se torquent, et, nisi desipiant, digitum Dei in his se agnoscere confiteri debent in quibus omnia ad destinatum *finem* tam providè disposita apparent. Quis enim tam impudens ut aves volare dicat quia alatae sunt. non autem datas esse alas ut volent.”

⁸ Cf. Huygens 1888-1950, 21, *Cosmotheoros I*, 757 and 759 (my emphasis): “Apparet quidem hoc homini datum esse, ut omnibus iis alatur quae vel in terra vel in aquis nascuntur, si quid nutrimenti contineant; ut herbis, pomis, lacte, ovis, melle, piscibus, volucrum quadrupedumque plurimorum carnibus. In quo mirum sane videri potest, animal illud rationis composita esse comparatum, ut cum plucuisse ei videamus ut leones, lupi, aliaque rapacia, pecudes et infirmiora quaelibet pabuli loco habeant. [...] Praeter omnem vero istam ex viventibus herbisque utilitatem, hanc quoque delectationem ex iis nos capere voluit rerum conditor, ut varias eorum formas naturasque et generandi vias contempleremur; in quibus infinita quaedam varietas ac *mirabilia* multa insunt, quae apud *naturae scriptores* celebrantur.”

Huygens seems to agree with the observations of the “*naturae scriptores*”, or ‘naturalists’, according to which the survival of animals, whether rational or not, through the killing and the supremacy of the weaker is not contrary to the “*naturae praescriptum*”, or ‘precepts of nature’. Instead, in this hierarchical organization of the animal and vegetable kingdom, God wanted as Man’s prerogative not only to draw practical utility from what is inferior to him, but also to be able to study the different forms of living beings. It is likely that Huygens refers to at least three naturalistic works: the important *Micrographia* (1665) of Robert Hooke and the *Historia generalis Insectorum* (1669) of Jan Swammerdam, and that of Antoni van Leeuwenhoek, with whom Huygens corresponded between 1689-92, commenting on Hooke’s and Swammerdam’s works (cf. Huygens 1888-1950, 9, Letters No. 2532, No. 2571). Unfortunately, in a comparison among those three naturalists, precisely on the laws of the generation of animals, miracles and divine providence (Ruestow 1985, 217-241), Huygens’ considerations expressed in his late writings have not found the place in the history of philosophy that they deserve.

Instead, the term “*mirabilia*” usually sums up Huygens’ mature reflections about the objects of creation: even if they are extraordinary and not entirely comprehensible, these phenomena fall within the regularity of the laws of nature provided by an almighty God, which acts according to a design, necessary and underlying the reality, able to eliminate the role of coincidence in creation. Furthermore, as highlighted by the editors of the *Discours de la cause de la pensanteur* (Huygens 1888-1950, 21, 436), those miracles conform to the mechanical laws of nature, since for Huygens there was not a single initial creation of animals, but many creations over time.

But this *voluntarist* interpretation of divine power in the acts of creation is strongly in tension with Huygens’ claim that it is impossible to fully comprehend all the purposes of the divine design, summed up in his expression *mysteria of generation*, “*generationis mysteria*”.⁹ The phenomenon of organic generation remains one of the most controversial, and therefore interesting, issues in the evolution of Huygens’ mature thinking. In the following analysis, we will see not only how this tension arises systematically through his late writings, but also how those arguments, aimed at finding empirical evidence of the existence of God, seem very similar to those of some of the leading experimental philosophers belonging to the English empiricism (e.g., Boyle and Locke), whom Huygens knew personally, and with whom he met several times to discuss each other’s scientific theories (M. B. Hall 1980).

⁹ Huygens (1888-1950, 21, *Quod animalium productio*, 555).

On the one hand, in another preparatory draft dated 1690, the *Verisimilia de planetis*, we find the same considerations on the variety of creation that, nevertheless, can be traced back to the functioning of a machine according to laws such that nothing that has not been previously foreseen can happen: “The greater will also be offered the concept of God, creator of so many and different things, which he produced with these laws and art so that they could move spontaneously and at any time as *machines* built with such mastery that nothing that he hadn’t foreseen can happens to them.”¹⁰ Therefore, as opposed to what happens in Descartes’ world machine, God is always engaged in the many creations over time, as the world machine continues to function according to his design. In this cosmological determinism, Huygens intends to research, not only mechanical causes, but also the final cause, through the study of animals which are the miraculous effects of both. This is one of the main reasons why, in the *Cosmotheoros*, Huygens dwells many times on detailed descriptions of animals as a core issue in his reasoning by analogy. For example, he observes that the *decrees of the provident nature*, “*providae naturae jussa*”, determine the need to conserve and reproduce the species, with a component of pleasure for all the animals that is so essential to make precious life itself. The recognition of the importance of these two related purposes in animal life leads Huygens to argue that this legal principle of nature was very likely foreseen by God in every inhabited part of the Universe: “Either we think how generally in this way life is made more pleasant and happier, [...] or we especially consider the pleasures that result from the eating and the coupling, where we will understand that there are necessary, as it were, *decrees of the provident nature*, which obliges us implicitly to conserve and propagate the animal species; or perhaps, in the case of the beasts, to propagate their species only in order to enjoy those two pleasures; thereby it is consistent to imagine the same on other planets.”¹¹

On the other hand, the term “*iussum*”¹², translatable as *decree*, *command* and so on, is found also in the *Quod animalium productio* of 1690. Coherently with his statements in the

¹⁰ Cf. Huygens (1888-1950, 21, *Verisimilia de planetis*, § 21, 553; emphasis added): “Quanto vero etiam majorem Dei conceptum praebet, tot ac tam variarum rerum creatoris, quas ijs legibus eaque arte constituerit ut veluti *machinae* totidem affabre confectae sponte moveri quantocunque tempore possent, nihilque ijs accideret quod non ipse praevidisset.”

¹¹ Cf. Huygens (1888-1950, 21, *Cosmotheoros I*, 725; emphasis added): “Sive enim cogitemus, quanto in universum, propter haec, jucundior feliciorque vita reddatur, [...] Sive ad voluptates, quae in cibis capiendis, et in conjunctione utriusque sexus contingunt, attendamus; intelligemus haec esse necessaria quaedam veluti *providae naturae jussa*, tacite cogentis ad conservandum, propagandumque animantium genus: vel etiam, in bestiis quidem, fortasse genus ipsum propagari, ut utraque illa jucunditate fruatur, ut proinde, utroque nomine, in caeteris Planetis eadem reperiri consentaneum sit.”

¹² Cf. Huygens (1888-1950, 21, *Quod animalium productio*, § 5, 556-57; emphasis added): “Ad haec igitur peculiaris quaedam Dei opera requirebatur, quae quo pacto sese exercuerit dum tot varias vivorum animalium formas molitur atque in Terram per ducit id verò omnium rerum quas unquam scire optavi supremum est et

Cosmotheoros (Huygens 1888-1950, 21, 685 and 687), where he claims he is not writing in contrast to the Holy Scriptures since they do not teach us in detail about the divine creation, in this preparatory draft Huygens notes a reference to the Old Testament in which the origin of everything that has been created on Earth is traced back to the incomprehensible will and power of God acting through his law. Therefore, men will never be able to investigate something more with their reason or conjectures. Even more explicitly, in the *Pensees meslees* (1686)¹³ Huygens recognizes that the possible variety of Nature cannot be arbitrarily conceived by the human mind because of the Universe's immensity. The epistemological focus of Huygens' argumentations consists in his acknowledgement of the *immense* creation of God that is (etymologically) not measurable by the human intellect.

We can read the final shape of Huygens' considerations directly from the *Cosmotheoros*: "However, one must recognize that man cannot arbitrarily define how great the variety or dissimilarity [*of Nature, Ed.*] is. Since that it may be *immense*, and that these things are completely far from our perception and understanding, it is not mandatory that they are really such. Even if God has created on the other Planets things similar to those here, there would be no less *admiration* from the spectators, if there are, than if they are very different."¹⁴ In this passage, the term "admiratio" is especially worthy of attention: the variety of Nature has to be a source of admiration from anyone in every part of the Universe, even more if there is something unclear. In addition, the mention of possible spectators in other parts of the Universe, which is not only a well-known argument used in astronomy (*Systema Saturnium* 1659) but also a way of reasoning influenced by an anthropocentric perspective in Huygens' argumentation on extraterrestrial life (Wolloch 2002), is meant to increase the number of the limited points of view able to testify to the greatness of God. The peculiar capacity of admiration by men allows them to balance their cognitive limits, and it bears witness to the

maximum. Hic tantum voluntatem ac potentiam Dei Mosaica historia adducit, cum *jussu* ejus cuncta exorta esse narrat. Nec quicquam ulterius aut ratio aut conjectura humana pervestigare potuit aut poterit unquam."

¹³ Cf. Huygens (1888-1950, 21, *Pensees meslees*, § 59, 371): "Ce n'est pas a nous a donner des limites a la nature, et il faut scavoit que a quelque grandeur et estendue nous la bornions, toute cette grandeur ne sera que comme rien a l'egard de l'espace au dela, et y aura moindre proportion qu'un grain de sable a toute la masse de la terre. Le reste seroit il donc vuide et n'aura-t-il pour ainsi dire creé qu'un grain de sable qui pouvoit creer une infinité de choses en comparaison. L'estendue du monde estant infinie, si le nombre des estoiles est fini, il est croiable qu'au de la il y a une infinité d'autres choses creees dont l'idee ne tombe point en notre pensee." The same passage was collected also in *Que penser de Dieu?*, § 1, 341. In addition, see: HUG 28, *Portfolio Chartae astronomicae*, no. 124 (Yoder 2013): "[...] Que pouvaient-ils faire autre chose? Avouer qu'il surpasse de bien loin l'homme d'avoir une idée de Dieu."

¹⁴ Cf. Huygens (1888-1950, 21, *Cosmotheoros I*, 703; emphasis added): "Sed cogitare debent, non esse hominum arbitrio definiendum quàm magna ista sit varietas ac dissimilitudo. Neque, quia possit esse *immensa*, resque illae ab intellectu, et comprehensione nostra penitus remotae, idcirco necesse esse, ut reipsa tales existant. Quamvis enim similia omnia iis quae apud nos sunt, finxisset Deus in caeteris Planetis; nihilo minor esset spectatoribus eorum, si qui sunt, *admiration*, quam si plurimum distarent."

greatest expression of Huygens' religiosity (Mormino 2000). Huygens' inner Protestant religiosity is further supported by relating the thesis of the limitation of reason to an adherence to the Reformation (Chareix 2006) rather than to skepticism (Gori 1976; Vilaine 1996). In particular, it is worth highlighting the close resemblance between Huygens' views and the arguments of natural theology by the Protestant Robert Boyle, whom Huygens met in London in the '70s (Hall 1980) and whom Huygens continued to read, discussing Boyle's work in his correspondence with Henry Oldenburg (Chareix 2009). In this context, it is worth highlighting Boyle's "epistemology of the limit" (Pacchi 1973, 240), expressed in particular in the *Things above Reason* (1681) and *The Christian Virtuoso I* (1690-1).

This philosophic attitude is particularly evident in the *Pensees meslees*, where Huygens demonstrates the evidence and the necessity of the existence of God in two steps. Firstly, Huygens argues that if one considers only the *inorganic* creations, such as suns, lands, planets, etc., it is not really necessary to suppose a Divinity that impressed a certain quantity of movement on matter in the beginning. However, when one contemplates the *organic* creation, such as men, animals, and plants, it seems that their 'beginning' needs an eternal Intelligent Agent. Secondly, the further proof of His existence and providence is given by the perfection recognized in His creation of the smallest parts composing them, for instance, the animal's eye and the bird's wing. Therefore, not only the generation of animals but especially the perfection of their parts are particularly worthy of admiration.

If there were nothing in nature but suns and globes around them, composed by land, water and surrounded with air, it may be conceived, as some did, that God simply has given some movement to matter to produce our system and all the others. And they will not need to suppose a divinity if you grant them that space, matter and movement are from all eternity. But when we consider animals and plants, the admirable construction of their parts for each use, the astonishing manner of their generation, it seems to me impossible that the only movement given to matter can be the cause of all this without the cooperation of an infinitely intelligent and powerful Entity. So much so that the magnitude of the heavens and these inconceivable distances of the stars of which I spoke above prove much less in my opinion the existence of a *providence* than the *eye of a man or of another animal* as well as the wing of a bird.¹⁵

¹⁵ Cf. Huygens (1888-1950, 21, *Pensees meslees*, § 42, 363; emphasis added): "Que s'il n'y avoit rien dans la nature que des soleils et des globes autour d'eux, composez de terre d'eau et entourez d'air, l'on pourroit concevoir comme quelques uns ont fait que Dieu n'avoit qu'a donner simplement du mouvement a la matiere pour produire nostre systeme et tous les autres. Et ceux la n'auroient point besoin de supposer une divinite si on leur accordoit que l'espace la matiere le mouvement sont de toute eternite. Mais quand on considere les animaux et les plantes, l'admirable construction de leur parties pour chaque usage, la maniere estonnante de leur generation, il me paroît impossible que le seul mouvement donne a la matiere puisse estre cause de tout cela sans la cooperation d'un Estre infiniment intelligent et puissant. De sorte que la grandeur des cieux et ces inconcevables distances des

Under this dual perspective, we can interpret the statements in the *Cosmotheoros* where Huygens explains, by means of a probabilistic analogy, that it is very likely that the inhabitants of the other planets need some counterpart of our sense organs allowing for the *usage of reason*, “rationis usus”. Huygens highlights that especially the *ability to see*, “videndi potestas”, consisting in the perception of light and the understanding of the shapes of objects and their different distances, helps us to avoid danger in order to preserve our life and society (Huygens 1888-1950, 21, 719). This animal “potestas” is possible only because of the divine “potentia” in making our eyes according to the admirable *art of Geometry*, “Geometriae ars” (Huygens 1888-1950, 21, 721).

Therefore, based on the perfection of geometric proportions, the divine work of the eye, made for the inhabitants both of the Earth and of the other planets, embodies the instrument given by God to men to contemplate and partially understand His works. Once again, the similarity with Boyle’s interpretation seems evident: in the *Usefulness of Natural Philosophy I*, Boyle refers to the anatomical structure of the body, and especially the small part of the eye, as evidence of the mastery of an omniscient Creator (Boyle 1675, 264-5).

Furthermore, the scientific core of these theological reflections can be found in drafts dated in a period ranging from the ‘70s and ‘90s, where Huygens deals with the topic of the anatomy of eye and the mechanism of vision. In the last study, named by the editors of the *Œuvres complètes* as *De l’œil et de la vision* and dated to 1690, we find:

Who could say that all these things were produced otherwise than for what they should serve? And what kind of an excellent knowledge it must have been that, without having seen anything similar before, has conceived and built such a *beautiful machine*, to say nothing now of the power which has kept it going and occurs so wonderfully in the generation of animals. [...] Certainly, both the instruments and the manner of making them act, as well as the perfect ratio to their purpose of both of these senses, clearly demonstrate that they are not produced by chance or by matter accidentally stirred, but by a supreme and incomprehensible intelligence and power.¹⁶

astres dont j’ay parlè cy dessus prouvent bien moins a mon avis l’existence d’une *providence* que l’œil d’un homme ou d’un autre animal ou l’aile d’un oiseau.”

¹⁶ Cf. Huygens (1888-1950, 13, *De l’œil et de la vision*, 799; emphasis added): “Qui est ce qui pourrait dire que toutes ces choses ayent esté produites autrement qu’en vüe de ce a quoy elles devoient servir? Et quelle excellente connoissance ce doit avoir esté, qui sans avoir rien de semblable devant elle a conceu et basti une si *belle machine* pour ne rien dire maintenant de la puissance qui l’a fait continuer et se produire si merueilleusement dans la generation des animaux. [...] Certainement et les instruments et la maniere de les faire agir et le parfait raport à leur fin dans l’un et l’autre de ces sens marquent tres evidemment que ce ne sont pas des productions du hazard ou de la matiere fortuitement remuée, mais d’une intelligence et puissance supreme et incomprehensible.”

Therefore, the eye of the animals is a “beautiful machine” that demonstrates the excellent knowledge of God, while his will is shown not only in the creation of the world machine but also in the decision to keep it functioning. The act of creation following mechanical laws is not produced by chance or by matter accidentally mixed, but by the divine intelligence and power operating according to a specific purpose. It is worth noticing that in the context of the detailed scientific description of this study on the laws of optics, Huygens remarks consistently that the intelligence and power of God are both supreme and incomprehensible, attesting to his belief that God’s will is so absolute that it cannot, and should not even, be predicted by men.

Furthermore, in a previous passage of the same study, where Huygens criticizes the Euclidean conception according to which the vision occurs through rays emitted by the eye, he makes an interesting correction: initially he writes that it is not clear how these rays interact with *our senses*, “notre sens”, but then he replaces “sens” with “ame” (Huygens 1888-1950, 13, 791). This correction is clarified later in the same draft when Huygens assimilates the *soul*, “ame”, to an *internal sense*, “sens interieur”, which rooted in the body structure is an essential part in the mechanism of vision: “F is the optic nerve which terminates in the brain and whose very subtle fibers extend through the entire inner surface of the hollow B, receiving in their extremity the action of light and thus bringing back the order and colors of the painting of the objects to our *soul* or *internal sense*. The walls of this hollow are firstly covered with an opaque black coating called choroïde, and on top of it there is another transparent, which is the retina.”¹⁷

About in the same year, in his *Verisimilia de planetis* (1690), Huygens reuses the terminology of this scientific study in his probabilistic arguments about the physical appearance of the inhabitants on the other planets: the divine creation of the eye is so perfect and worthy of admiration that other ways of making the eye cannot be hypothesized in any possible part of the Universe. This time, the point of arrival of the process of visual perception is explicitly called the “internal soul”, which is able to judge the external images produced by the optic nerves:

Certainly, the creation of the eyes is compared to the use of a marvelous activity, so that with difficulty it seems that it could have been undertaken for another reason than to return distinct images of external realities through the senses. In fact, the light rays,

¹⁷ Cf. Huygens (1888-1950, 13, *De l’œil et de la vision*, 794; emphasis added): “F est le nerf optique qui se termine au cerveau et dont les fibres tres subtiles s’estendent par toute la surface interieure du creux B, recevant dans leur extremitez l’action de la lumiere et raportant ainsi l’ordre et les couleurs de la peinture des objets a nostre *ame* ou *sens interieur*. Les parois de ce creux sont revestues premierement d’une tunique opaque noirastre qu’on appelle choroïde, et par dessus d’une autre transparente qui est la retine.”

which extend from single points to the pupil's orbit, are connected back to the individual points by means of the refraction of the convex surface, and they spread in the direction of the nerves, which are subtly scattered in the bottom of the eye and whose texture is composed by the film that they call choroid, so as to stimulate the *internal soul* to judge things' position, distance and color.¹⁸

Those considerations seem very close – also terminologically – to those of John Locke in his *An Essay Concerning Human Understanding*, which dates back to the same period as the preparatory drafts for the *Cosmotheoros*. In particular, Huygens' definition of *internal soul*, “interior animus”, resembles that “internal sense”, the faculty of perceiving mental states, that the English philosopher calls “reflection” (Locke 1689, II, I, §4). And Locke borrows the image from optics. From the correspondence of Huygens with Nicolas Fatio de Duiller and his brother Constantijn between February and March 1690 (Huygens 1888-1950, 9, No. 2558; No. 2567; No. 2572), we know how much Huygens enjoyed Locke's *Essay*. And Huygens met with Locke to discuss Newton's theory in the Netherlands (Snelders 1980, 210), at the time he was preparing to publish the *Cosmotheoros*. It is very likely that these two great thinkers discussed, in addition to physics, Locke's considerations on natural philosophy and epistemology, which found their place in Huygens' late writings as the philosophical substratum supporting his arguments by analogy about rational and non-rational animals living on Earth or other planets (cf. Locke 1689, IV, XVI, §12).

Furthermore, similarly to Locke (1689, II, XI, §11), in the *Cosmotheoros* Huygens decries as cruel and absurd the opinion of some philosophers who deny *every sense*, “sensus omnem” (Huygens 1888-1950, 21, 731), to animals by reducing them to mere automata or marionettes; and previously, in a letter to Pierre Bayle, he commented that Descartes' theory of the absence of the soul in beasts was a *ridiculous paradox*, “paradoxe ridicule” (Huygens 1888-1950, 10, No. 2791, 400). On the contrary, Huygens explains that, by means of their senses, animals are even able to enjoy *bodily pleasures*, “voluptates corporis”, as much as rational animals do. Therefore, for Huygens there is a strong continuity of essence between rational and non-rational animals, which are similar in their primitive need to live in social communities. The only real difference between man and animal consists precisely in the contemplative capacity of the former. What elevates man is not the possession of reason in

¹⁸ Cf. Huygens (1888-1950, 21, *Verisimilia de planetis*, 546; emphasis added): “Certe oculorum fabrica uti mirabili industria comparata est, ita vix alia ratione iniri potuisse videtur, ut distinctas rerum exterarum imagines sensibus referret. A singulis enim punctis radij ad pupillae orbem manantes, ad singula rursus puncta refractione convexae superficiae colliguntur, ac nervulorum sensu qui in fundo oculi subtilissime sparguntur, quorumque contextu pellicula quam choroidem vocant, componitur, ita afficiunt, ut inde rerum situm, distantiam, colorem, *interior animus* judicet.”

itself but its proper use, “rationis usus” (Huygens 1888-1950, 21, 731), that is, being directed to the advancement of science and the explanation of the cosmic order to recognize the greatness of God in making Nature.

3. Conclusions and Future Works

Huygens’ reflections on the generation of animals and their souls, rational or not, as testimony of the divine will operating in view of certain purposes, hold together the two opposing conceptions of mechanistic philosophy and the teleology of nature. These reflections also demonstrate that Huygens’ mature production should be framed by the seventeenth-century debates wherein divine design, providence, and teleology are elements of a wider metaphysical debate on the new mechanical conceptions of nature (cf. Funkenstein 1986; Harrison 1998).

In his arguments, which take their final shape in the *Cosmotheoros*, Huygens seems to elaborate once again some anti-Cartesian objections by the “English empiricists” who, in explaining miracles, do not try to fill a gap in scientific interpretation, but use them as empirical evidence of the truth of Christianity (cf. Burns 1981). As for his almost contemporary thinkers Robert Boyle and John Locke (cf. McIntosh 1994), Huygens’ Protestantism emerges both in his epistemological conception of miracles as wonderful events reflecting divine providence, and in his reintroduction of the final causes in his interpretation of the mechanical laws of Nature.

Those miracles conform to the mechanical laws of nature, since for Huygens there was not a single initial creation of the animals but many creations over time, thus demonstrating evidence for, and the necessity of, the existence of God. As opposed to what happens in Descartes’ world machine, for Huygens God is always engaged in His many creations over time, as the world machine continues to function according to His design. Further proof of His existence and providence is given by the perfection of the smallest parts composing the animals, especially our eyes. The divine creation of the eye, as well as of the “internal soul” rooted in the body’s structure as essential part of the mechanism of vision, is so perfect and worthy of admiration that other ways of making the eye cannot be hypothesized in any possible part of the Universe. However, given Huygens’ recognition of the absolute freedom and will of God in exercising His power for reasons that are mostly, and rightly, incomprehensible to us, Huygens should be counted among the “voluntarist” scientists, such as Gassendi, Barrow, Boyle, Clarke and Newton (cf. Harrison 2002).

The insights given in my paper should be considered as a first step for further analysis of Huygens' late writings, where he tried to address one of the most difficult questions: the beginning and end of life, taking place in a continuous cycle everywhere in the Universe. In particular, the remarkable similarity with Locke's arguments on human and animal perception and cognition, as well as with Locke's method of reasoning by means of probabilistic analogy, calls out for a more detailed comparison between the passages of the *Cosmotheoros* and the *Essays*, as well as their preparatory drafts. Such a comparative study would be, not only a major proof of Huygens' mélange of influences as elaborated in his natural philosophy, but also a useful tool to validate the presumed dating of the preparatory drafts here examined (roughly between 1686-90), as currently attributed by the editors of the *Œuvres complètes*.

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