

The Roots of the Silver Tree: Boyle, Alchemy, and Teleology

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Abstract: Though Robert Boyle called final causes one of the most important subjects for a natural philosopher to study, his own treatise on the subject, the *Disquisition about Final Causes*, has received comparatively little scholarly attention. In this paper, I explicate Boyle's complex argument against the use of teleological explanations for inanimate bodies, such as metals. The central object of this argument is a mysterious allusion to a silver plant. I claim that the silver plant is best understood as a reference to an alchemical product: the *Arbor Dianae*, an offshoot of George Starkey's recipe for the Philosophers' Stone. Then, I show how the context of alchemy not only clarifies Boyle's argument but also places it within a wider dialectic about matter and teleology. I then contrast the parallel arguments of Boyle and John Ray on the question of whether metals have divine purposes and show that the difference is explained by Boyle's belief in the transmutation of metals.

Keywords: Robert Boyle; John Ray; Teleology; Alchemy; George Starkey; Philosophers' Stone

1. Introduction

Spurred by the publication of Robert Boyle's complete works and correspondence (Hunter and Davis, 1999, 2000; Hunter, Clericuzio, and Principe, 2001), a new wave of scholarship has begun to build a more complete picture of Boyle in his own context. Boyle's alchemical pursuits, a long-ignored facet of this context, have been the subject of several recent studies (Clericuzio 1994, Principe 1994, Principe 1998, Newman and Principe 2002). Boyle privately pursued alchemical works all through his life, and even his non-alchemical writing is littered with covert references to the aurific art. However, though recent scholarship has thrown new light on the previously ignored alchemical content of Boyle's corpus, it remains unclear how integrated his interest in the alchemical tradition was with the natural philosophy he espoused more openly. In this paper, I show how the interpretation of Boyle's 1688 natural theological tract "A Disquisition About the Final Causes of Natural Things: Wherein it is Inquir'd, Whether, and (if at All) with what Cautions, a Naturalist Should Admit Them?" depends on an understanding of Boyle's alchemical beliefs and projects.

I claim that Boyle's argument against the knowability of the final causes of inanimate bodies given in Section II of the Disquisition can best be understood as reliant on Boyle's alchemical ambitions and his youthful collaboration with the alchemist George Starkey (and with the published works of his pseudonym, Eirenaeus Philalethes). Moreover, the invocation of alchemy and transmutation in the context of inanimate teleology places Boyle in the center of a

contemporaneous debate about the properties and origins of the most fundamental corpuscles of nature. As such, Boyle's argument against the knowability of inanimate final causes should be taken as evidence for the integration of different parts of Boyle's intellectual life with each other in general, and of the influence of his alchemy on his philosophy more specifically.

Boyle took the subject of final causes extremely seriously: he prefaces the *Disquisition about Final Causes* (hereafter DFC) by claiming that, "There are not many Subjects in the whole compass of Natural Philosophy, that better deserve to be Inquired into by Christian Philosophizers, than That which is Discours'd of in the following Essay¹" (2000e, 84). Though the *Disquisition about Final Causes* is a little-studied work in the Boyle corpus² its importance to Boyle demands that we understand how it fits alongside Boyle's other work. Previous works on the DFC have provided useful insight into Boyle's general beliefs about final causes and his methods for investigating and using them. However, all of these investigations have focused on Boyle's admission of final causes in living beings and their parts, with only brief mention of his denial of final causes for inanimate bodies. Hence, by showing the connection between Boyle's teleological reasoning and his private alchemical investigations, I hope to bridge a gap in the literature.

¹ Boyle's spelling and emphasis is preserved throughout.

² Several of the few authors to investigate the DFC in detail, Lennox (1983), Shanahan (1994), Wojcik (1997), and Carlin (2011, 2012), begin their paper with a lament that so few others have discussed the work.

First, I will give a brief overview of Boyle's account of final causes and the rhetorical aims of the DFC. Then, I will present the argument against inanimate teleology from Section II and argue that the mysterious plant mentioned in it is best understood as a reference to a stage of Starkey's recipe for the Philosophers' Stone. Understanding the reference to the plant in this way will then help to explicate and strengthen the argument against teleological explanations of metals by clarifying Boyle's notion of chance. After this, I will present the implications of Boyle's belief in transmutation and denial of teleology for metals in the context of the contemporaneous debate over whether corpuscles are mutable or immutable. Boyle was cited and used in the context of this debate by John Ray, whose views provide a close parallel to Boyle's but with the possibility of transmutation as a key difference. I will conclude by arguing that this way of interpreting Boyle's argument against inanimate teleology allows greater insight into the metaphysical issues at play in Boyle's alchemical pursuits.

2. Teleology and Theology

The DFC begins with a clear statement of the targets of Boyle's argumentation: the Epicurean position that, since the world is "the Production of Atoms and Chance, without any intervention of a Deity... 'tis improper and in vain to seek for Final Causes in the effects of Chance"; and the Cartesian position that, since "God being an Omniscient Agent, 'tis rash and presumptuous for men to think, that they know, or can investigate, what Ends he propos'd to himself in his Actings about his Creatures" (2001d, 86). Boyle refrains from attacking by name the 'baptized Epicureans' who deny any evidence of divine design in nature in Boyle's own time. However, he devotes a lengthy portion of the work to a targeted refutation of Descartes, despite

his stated appreciation for Descartes and Cartesians (Davis 1994, 163). Boyle was at pains throughout much of his writing to defend the mechanical philosophy he espoused from charges of atheism, and he feared that by stripping mechanism of the recourse to purpose in nature, Descartes was opening the door to such arguments.³ Observing divine purpose in the design of natural things, then, was an essential part of the proper appreciation of their Creator. Boyle's lifelong devotion to the rhetorical project of inspiring faith in God made finding another avenue from which the skeptical naturalist may observe the glory of the Creator a task of no small importance.

Boyle's two named opponents, the Baptized Epicurean and Descartes, define the two broad questions Boyle attempts to resolve in the DFC. The first is the question of whether there are final causes in nature at all – whether nonrational creatures can be said to truly act towards purposes. I will call this the *metaphysical* problem of final causes. The second is the question of whether, if there are such causes, humans as created beings are adequate to the task of knowing any of them. I will call this the *epistemic* problem of final causes. The Epicurean answers the first question in the negative, Descartes the second. Boyle's position throughout the DFC is a qualified affirmative to both. There genuinely are final causes present in *some* natural things, and humans have rational grounds to infer at least *some* of them.

³ For more on the theological context of Boyle's teleological stance, see McDonough (2011), Shanahan (1994), Wojcik (1997), and Carlin (2011).

In particular, Boyle argues that the parts of living beings both have functions and have functions that we can ascertain. These parts are, "...so curiously contrived, and so exquisitely fitted for certain Operations and Uses, that it seems little less than Blindness in Him, that acknowledges with the *Cartesians* a most wise Author of things, not to conclude, that, tho' they *may* have been design'd for *other*, and perhaps higher Uses; yet they *were* design'd for *this* Use" (2001d, 89). Some functions of the parts of animals are so manifest to our observations and experiments that only by denying either the evidence of our senses or the wisdom of God can we deny that we have some knowledge of them. The eye of an animal, an example to which Boyle often returns throughout the text, is so perfectly designed an instrument that no part of it could be altered without a deleterious effect on the animal's ability to see.⁴ James Lennox terms this the 'argument from adaptation'. Moreover, in order for brute chance to produce such a complex structure, an improbably long sequence of specific causes would have to have been instantiated by simple chance, which Boyle considers explanatorily suspect. This is what Lennox terms the 'argument from complexity'. I will address this argument in more detail below.

Boyle considered the primary function of the study of natural philosophy to be the glorification of the Creator by the reading of his 'Book of Nature'.⁵ If this 'reading', experiment

⁴ "...Tho' the parts that concur to make up that admirable Organ of vision, are very numerous, yet how little any of them could have been spar'd or alter'd, unless for the worse" (Boyle 2000e, 98).

⁵ Boyle made frequent use of the Book of Nature metaphor throughout his corpus, though his use of it evolved over time. The metaphor is also common amongst contemporaneous alchemical

and observation of the natural world, gives us reason to infer particular final causes, the pious naturalist will do so. A natural philosophy like Descartes', whose adherents dare not presume the intentions of the Creator even when they seem to be clear, then, does a disservice to the wisdom of the Creator and removes an avenue of His proper veneration. The Epicureans do an even greater disservice to the Creator by denying categorically that such inferences are possible.

Boyle claims that in those instances where the purposes of natural things are clear and obvious, we are justified in inferring that the purpose we observe is at least *amongst* the purposes that the Creator has intended for them, though not that these purposes exhaust the Creator's intent⁶. This evidence can be used to further our investigation of nature along two lines, which Boyle names Physical and Physico-Theological arguments (2001d, 119). Physical arguments infer from the apparent purposes of natural things to the mechanism that fulfils those purposes. Physico-Theological arguments infer from the apparent use of a thing to the purpose for which it

authors and in the Neoplatonic and Hermetic traditions. For further discussion of Boyle's evolving use of the Book of Nature metaphor, see Matthiessen (2019).

⁶ The reason that Boyle denied that human reason could discover *all* the final causes of a particular creature was that Boyle believed that human reason was categorically incapable of understanding the whole of any divinely-ordained thing. Boyle maintained a strict and unbridgeable division between finite human reason and infinite divine reason throughout his work. Though Boyle's skepticism about the power of the human intellect is most prominent in his discussion of theological mysteries, he also applied this skepticism to natural philosophical claims such as this one. See Wojcik (1997).

was made by the Creator. Physical arguments are teleological arguments in the service of natural philosophy, while Physico-Theological arguments are arguments in the service of theology, including in the persuasion of atheists towards belief. Boyle's archetypal Christian Virtuoso, the ideal naturalist and gentleman, should neglect neither.⁷

There are further conclusions we can draw from Boyle's argument here. Though the reasons we should believe that created things were created for ends are theological in nature (and provided in part by revelation), knowledge of the ends themselves comes primarily⁸ from empirical observation. The theological ends of Boyle's search for final causes in nature do not conflict with its experimental means. Boyle quotes liberally from empirical research throughout the *Disquisition*. His references are contemporary and cutting-edge: they include the observations of the structure and function of parts of the eye in Christoph Scheiner's *Oculus* of 1620 and Descartes' *Dioptrics* of 1637 (2001d, 127), William Harvey's observations of the valves of the heart in 1628's *De Motu Cordis*, (ibid, 129) and Robert Hooke's micrographic observation of the eyes of flies.⁹ In these cases, the detailed structures visible under experimental

⁷ See Shanahan 1994, Wojcik 1997, and Carlin 2011 for discussion of Boyle's pursuit of final causes as a theological project.

⁸ A notable exception is Boyle's admission that scriptural revelation designates one of the purposes of plants and animals of the earth to be the service of Man (2000e, 123).

⁹ The reference to the eye of the fly is (2000e, 97). Hooke is not mentioned by name alongside the discussion of the fly, but he did edit an early manuscript of DFC for Boyle and was working closely with him at the time of the DFC's likely writing. (Davis 1994).

manipulation present clear functions which direct and support the investigations of the naturalist. The ability of the naturalist to make inferences relies on this evidence of the functions observed in the natural world. Were those functions not clear, Physical arguments would be unable to give reliable knowledge of nature and Physico-Theological arguments would be unable to persuade recalcitrant nonbelievers. In short, the force of Boyle's teleological program rests on the fact that design is evident in nature.

Where that design is less evident, Boyle advises more caution. He is keen throughout the DFC to avoid hasty conclusions about the purposes of things (2000e, 145), though he attributes this haste to neither of his stated opponents. He expresses skepticism about those who claim to know all the ends of any particular creature, or to know the ends of all creatures. There may be some creatures for which even an intrepid naturalist cannot easily infer final causes. Some creatures may not have any final causes to be inferred at all. Since Boyle's approach to teleology is empirical, as Lennox and Carlin stress, he is forced to investigate each creature in turn to answer the metaphysical and epistemic problems of final causes. The second part of the DFC, under the heading 'Whether we may consider Final Causes in all sorts of bodies or only in some particularly Qualified ones', seeks to differentiate the created bodies whose ends we can clearly see from the ones whose ends are either obscure or nonexistent. Boyle's answer is that we cannot consider final causes in many inanimate bodies, including the objects of his lifelong alchemical study, the metals. Let us turn to an investigation of why.

3. Boyle and the Metals

Though Boyle wrote on a vast variety of topics, much of his published work and correspondence is chemical (or, in contemporaneous language, *chymical*) in nature. The term ‘Chymistry’ applies both to operations similar to contemporary chemical procedures and theories and to operations that would later be considered to be alchemical and mystical¹⁰. Boyle used the same term interchangeably for both, which implies that he did not consider ‘mystical’ alchemy to be different in kind from the new chemistry.¹¹ After his introduction to the chymical arts in the 1650s under the tutelage of the American alchemist George Starkey, Boyle retained a fascination with them until his death in 1691. Boyle was interested in the material results of alchemy, such as the Philosophers’ Stone and the ‘excellent medicines’ that could be derived from it. However, he was also intrigued by alchemy as a fascinating chapter of the Book of Nature – a realm of natural philosophy characterized by its mystery.

¹⁰ For a discussion of ‘chymistry’ as a historiographical term, see (Principe 1998, 8-9). I follow this usage throughout.

¹¹ A clear example is Boyle’s *Skeptical Chymist* of 1661, which puts alchemy and more benign chemistry in literal conversation with each other through Boyle’s interlocutors. That is not to say that Boyle made no distinction between the various alchemical schools, and between the alchemical schools and Scholastic chemistry – he did. See Clericuzio (1994) for discussion of Boyle’s rhetorical stance in the *Skeptical Chymist* towards Aristotelians and the Chymists.

If Boyle thought the uses of the parts of animals were manifestly obvious to experience, the same cannot be said of the uses of metals and minerals, since:

... 'tis yet more unsafe, to ground arguments of the Nature of particular Bodies that are present in the sublunary world, upon the Uses we think they were design'd for. This will not appear an unreasonable Caution if we consider, How little we know of the Particular Purposes of Nature in those Bodies here below, which not being Organical, like those of Animals and Plants, cannot by the Curiousness of their Structure disclose to us the Particular Ends to which they were ordained. (2001d, 123)

There are two claims here: one is that our interactions with minerals do not give us sufficient understanding of their uses to ground inferences about them, and the other is that the structures of these bodies are sufficiently simple that no evidence of purpose is visible in their makeup. Structural simplicity is the key – mineral substances are composed of aggregates of basic material corpuscles, Boyle's 'catholick matter', like all other bodies (1979b 141-2). The only differences between material bodies are differences arising from the texture and motion of these corpuscular bodies. The *parts of matter* that make up a nugget of gold are not any more complex than the parts of matter that make up of a human eye. The difference lies in the complexity of the mechanical construction of the bodies. Boyle insists that even the lowest orders of animal anatomy are more complex in structure than the highest orders of human ingenuity. There is, according to Boyle, "incomparably more Art express'd in the structure of a Doggs foot, then in that of the famous Clock at *Strasburg*" (2001d, 98). Divine design is different from human

design by orders of magnitude, not by kind. Boyle uses the metaphor of God as Divine Artificer¹² often throughout the DFC, which reinforces the analogy. By placing the Clock at Strasburg in the same comparison class as the part of an animal, Boyle is implicitly praising human arts even as he denigrates them. And, in particular, he is inviting us to pay close attention to those places in which human and divine creative power seem to have the same result – the production of metals.

As Principe (1998) has demonstrated with his unearthing of Boyle's unfinished (and unpublished) *Dialogue on Transmutation*, Boyle was doubly committed to the possibility of transmuting one metal into another through chymical processes, and thus to the production of metals as a human art. Boyle believed in two kinds of transmutation. In a famous passage from the Origin of Forms and Qualities, Boyle supports *particular* transmutations, transmutations from a particular kind of metal to another particular kind, which allow that "...by the Intervention of some very small *Addition* or *Subtraction* of Matter, (which yet in most cases will scarce be needed,) and of an orderly *Series of Alterations*, disposing by degrees the Matter to be transmuted, almost of any thing, may at length be made Any thing:," (2000b, 332). In the fragments of the Dialogue on Transmutation, Boyle also expresses support for the possibility of instantaneous, *universal* transmutation effected by projection of a large quantity of any metal

¹² John Hedley Brooke (2000) suggests that there may be a sympathy between Boyle's notion of comparative complexity between divine and human achievement and an anthropocentric aggrandizing of human art. The theme of the human alchemist or magus as being made in the image of a *creative* God is a common one in Renaissance and Early Modern magical literature.

onto the Philosophers' Stone. This transmutation is 'universal' in that it transforms any metallic substance into gold in the same way (Principe 1998, 76-82).

Regardless of the means, the fact (according to Boyle) that metals are producible by human art as well as by divine art puts them in a special class of natural object. It is not generally the case that the productions of mankind do not equal those of God – only that they do not equal sufficiently complex productions of God. This point is highlighted as well by Boyle's insistence in a famous passage from the *Origin of Forms and Qualities* that alchemical gold should be considered the same substance as natural gold (2000b, 323). This claim occurs against a background of debate over the genuineness of alchemical products.¹³ Genuine metals are within the domain of human influence for Boyle. His analysis of the final causes of metals depends on this consideration.

4. The Tree of Silver

¹³ See *Promethean Ambitions* Chapter 2, "Alchemy and the Art-Nature Debate", for a detailed discussion of this debate. The key texts are Avicenna's denunciation of alchemical products in the *Book of Healing*, and Albert's rebuttal in *On Minerals*. Boyle was certainly familiar with both arguments. He cites *On Minerals* as a potentially spurious work of Albert in his *Origine and Virtues of Gems*, and it can scarcely be believed that he did not read on to the famous discussion of transmutation contained within (2000c, 7).

When Boyle considers the question “*Whether we may consider Final Causes in all sorts of Bodies, or only in some peculiarly Qualify'd Ones*”, the answer is the latter. Animate bodies give us ample reasons to posit final causes as explanatory and inferential aides, but inanimate bodies in general do not. This means that, methodologically, Boyle must go through the various orders of creatures individually and empirically, instead of issuing a blanket statement that they either have or lack divine purposes.¹⁴ The heavenly bodies, for instance, are too large to serve only the interests of earthly beings, and Boyle cautions that we do not well-enough understand the true system of the world to know the full extent of their purposes. They have the effect of inspiring worship of the divine, but not more so than any earthly animal, properly investigated.¹⁵ As for terrestrial inanimate bodies, such as minerals, we may say even less. The minerals are “...of such easy and unelaborate contextures, that it seems not absurd to think, that various occurrences and justlings of the parts of the Universal matter, may at one time or other have *produc'd* them; since

¹⁴ As Carlin (2011) argues, the only kind of teleology that Boyle admits in the case of inanimate objects is external teleology – teleology determined relative to the intentions of an agent, in this case, God. No inanimate object has immanent teleology as in Scholastic theories. See Osler (2001) for a different perspective on this point.

¹⁵ “I foresee, it may be said, that These and other the like Celestial Bodys may be at least Thus far Useful to Man, as to Discover to him, and give him a Rise to Admire and Praise, the Greatness and Power of the Divine Maker: And if this be said, I shall not quarrel with the Allegation, but readily grant, that, tho’ perhaps his Wisdom shines as bright to Us Men, in the Structure of a Gloworm, as in the Disposition of the unseen Stars that make up the *Galaxy*” (2000e, 121)

we see in some Chymical Sublimations, and Christallizations of Mineral and Metalline Solutions... where the motions appear not to be Particularly guided and directed by an Intelligent Cause” (2000e, 97). Creation by a Designer God is thus contrasted with creation by *chance* – by the “justlings” of the Universal matter. The notion of ‘chance’ at play here is the same notion raised by the Epicurean opponent against whom the metaphysical puzzle of teleology is framed. It does not denote randomness, since the justlings of the Universal matter are still governed by divinely ordained laws of motion,¹⁶ but it does denote a process unguided by design. Moreover, Boyle’s mention of chymical sublimations and the crystallizations of metalline solutions introduce a context of human alchemical action to the notion of Chance. Thus, we can conclude that, for Boyle, humans can produce metals only in a way that is equivalent to the chance production of metals.

This equivalence allows Boyle to respond to an important objection. He writes:

If it be objected, that if we allow Chance, or any thing else, without the particular Guidance of a wise and All-disposing Cause, to make a finely shap'd Stone, or a metalline substance, growing, as I have some times seen silver to do, in the form of a Plant; it ought not to be denied, that Chance may also make Vegetables and Animals: I can by no means allow the consequence. There are some effects, that are so easy, and so ready, to be produc'd, that they

¹⁶ For the theological and metaphysical background on Boyle’s notion of natural law, see McGuire (1972)

do not infer any knowledge or intention in their Causes; but there are others, that require such a number and concourse of conspiring Causes, and such a continued series of motions or operations, that 'tis utterly improbable, they should be produced without the superintendency of a Rational Agent, Wise and Powerfull enough to range and dispose the several intervening Agent's and Instruments, after the manner requisite to the production of such a remote effect. And therefore it will not follow, that if Chance could produce a slight contexture in a few parts of matter; we may safely conclude it able to produce so exquisit and admirable a Contrivance, as that of the Body of an Animal. (2000e, 97)

If it were the case that human-guided chance could produce creatures as complex as plants and animals, then Boyle would not be justified in asserting that plants and animals show obvious evidence of divine design. Boyle must use this argument from complexity to cut off the slippery slope – the fact that chance can produce metals does not imply that chance could produce animals. There must be a threshold of complexity beyond the plant-shaped silver crystals but before the simplest animals that justifies our inference of design in the latter case but not the former.¹⁷ The creative potential of human arts is a threat to teleological inference, which is in

¹⁷ The explanatory strategy of positing a threshold of complexity between phenomena easily explained by the mechanical hypothesis and phenomena that requires an explanation of a different sort is familiar from other places in Boyle's corpus. As Peter Anstey notes in his treatment of seminal principles across Boyle's work, Boyle uses an argument very similar to this threshold of complexity to explain the presence of seminal principles in plants and animals but not dead matter. See Anstey (2002) for more discussion.

turn a threat to the proper veneration owed to God. However, human arts too come in degrees of complexity. In order for this argument to show what Boyle claims it does show, it must be the case that the tree of silver represents a particularly high degree of complexity in human arts. Otherwise, the fact that nature surpasses the silver plant would not suffice as a reason to deny that art or chance could make something as complex as an animal. Thus, an interpretation of the silver plant argument will rely crucially on what kind of process would actually generate the plant. I will argue in what follows that what generates the silver plant is an alchemical product: the *Arbor Dianae*, or Tree of Silver, grown from Starkey's *Philosophical Mercury*. Furthermore, I argue that this identification allows for a charitable interpretation of Boyle's argument that would otherwise not be possible.

Boyle does not elaborate on his reference to the Plant-shaped silver crystal that is so central to this argument. However, the context of Boyle's own alchemical pursuits offers up a ready candidate. Boyle made his first serious study of chymistry under the tutelage of George Starkey (Newman 2004). Boyle and Starkey continued to correspond on chymical subjects until Starkey's 1665 death. Boyle was also familiar with the published works of Starkey's 'teacher' and pseudonym Eirenaeus Philalethes.¹⁸ One of the most significant procedures described by Philalethes is the preparation of the *Philosophical Mercury* – a mercury-silver (or mercury-gold) amalgam that marked the first step along the road to the *Philosophers' Stone*. Starkey sent Boyle

¹⁸ To the extent that Boyle penned a list of the 'Excuses of Philaletha for Concealing the Great Arcanum', which imply that Boyle believed Philalethes to have the *Great Arcanum*, the *Philosophers' Stone*. See Boyle 1994.

a recipe for the Philosophical Mercury in a letter from after 1651 (Boyle 2001, 95). Another, more clandestine version of the recipe would appear in Starkey's *Secrets Revealed: Or, An Open Entrance to the Shut-Palace of the King; Containing the Greatest Treasure in Chymistry, Never Yet so Plainly Discovered* (1645, 5-6) which he published in the persona of Philalethes. In the recipe, Starkey describes the substance as "bright as burning silver ☉". When mixed with a small quantity of gold, it will "grow in the forme of a tree" with "sprigs and branches" and colours that vary before the eyes (Boyle 2001, 95-6). Boyle engaged in the study of this substance throughout his life. Lawrence Principe argues that the Philosophical Mercury is likely also the Incalescent Mercury about which Boyle published in his semi-anonymous paper "On the Incalescence of Mercury with Gold" in the *Philosophical Transactions of the Royal Society* of 1675.¹⁹ The similarity of the description of the 'vegetation' of the Philosophical Mercury to the description Boyle gives of silver growing in the form of a plant is striking. The plant produced by this procedure closely resembles a full-grown tree made of silver crystals.

Of course, the connection between Boyle's oblique reference and the Philosophical Mercury procedure is not certain. However, if we accept that it is plausible, it lends an additional

¹⁹ As Principe has argued, the Incalescent Mercury paper also contains concealed references to the process of making gold from base metals (1998, 155-58). These concealed references would alert other alchemical adepts to the progress Boyle was making in the preparation of the Philosophers' Stone. It would therefore not be out of character for Boyle to make another concealed alchemical reference within the body of a non-alchemical text.

layer to the interpretation of Boyle's argument and, I claim, makes the reasoning more persuasive. The tree of silver is presented in Boyle's argument as an example of the degree of complexity reachable by human art. The whole force of the argument derives from the implicit observation that the silver tree is less complex than a living plant. In order for it to be the case that this argument implies that the products of human art are less complex than the products of nature in general, it must be that the tree of silver represents a particularly complex example of human art. If the tree of silver is a reference to the Philosophical Mercury, then Boyle has that implicit premise. According to Philalethes' recipe, the Philosophical Mercury is the crucial first step along the road to the Philosophers' Stone, the alchemist's 'magnum opus'. Even Starkey, in the recipe he sent to Boyle, claims that the tree his procedure produces is "truly ... the only great thing which I thinke is in al Alchemy" (Boyle, 2001, 95). Boyle too considered the Philosophers' Stone to be the noblest pursuit of the chymical *adepti*. Not only could it be used in the investigation of Nature and the production of new and powerful medicines, but it also had a distinct spiritual purpose. Boyle held the idiosyncratic belief that the Philosophers' Stone could be used to communicate with good spirits²⁰ and serve as a source of new revelation. The Philosopher's Stone is also a substance of such complexity that it can only be prepared by the most advanced chymists. Boyle says of the stone that it "may consist of Parts so minute so solid, So advantagiously shap'd, & endow'd with so much vehemence of motion, that a small portion of a matter thus qualify'd, may operate more powerfully than a far greater quantity of ordinary

²⁰ See *The Aspiring Adept*, chapter 6, for more on Boyle's motivations for the pursuit of the Philosophers' stone. Boyle's unpublished fragment of a 'Dialogue on the Converse with Angels' (1998b) is the source of this claim.

matter can do” (1998a, 257-58). Though in the same passage he gives other examples of substances that can act like this, all the other examples are parts of plants and animals or other alchemical products (ibid).

The nobility and complexity of the tree of silver as a product of human art would then be a reason Boyle chose this example for his argument – if the greatest production of humankind cannot equal even a meagre plant, then we remain justified in positing final causes for living beings even when we cannot for minerals. A lesser example would tell us little. Therefore, I suggest that interpreting this argument as a direct invocation of an alchemical *arcanum* that would have been clear to fellow adepts and persuasive to those who share Boyle’s beliefs about transmutation. It thus allows us to read it as a stronger argument than we could otherwise. In the next section, I will show how this connection between teleology and the transmutation of metals in Boyle’s work can illuminate a contemporaneous debate about the nature of matter and minerals.

5. John Ray and the Purpose of Gold

In accordance with Boyle’s lifelong habit of saving half-complete manuscripts for decades before publishing them, the DFC was mostly written years before its publication in 1688. Boyle notes in the preface that the publication of the treatise was inspired by the death of a friend who pushed him to write it – likely Henry Oldenberg, to whom the work is dedicated. Oldenberg died in 1677, which implies that the bulk of the text was composed before that time (Davis, 1994,

157). However, Boyle's preface also claims that he substantially revisited the text before publication. So, when we look for the proper context to use to elucidate the arguments of the DFC, we should look to a broad span of time up to its 1688 publication date.

Boyle makes numerous references throughout the DFC to the idea that the naturalist should be cautious in the search for final causes in nature. The fourth proposition of the final part of the text is dedicated wholly to this argument: "That we be not Over hasty in Concluding, nor too Positive in Asserting, that This or That must be, or is, the particular Destinated Use of such a Thing, or the Motive that induc'd the Author of Nature to Frame it thus" (2000e, 145). It remains unclear throughout the text who the target of this argument is. Neither of the explicit targets of the work, the Cartesians or the Epicureans, make the error of overzealously reasoning to or from final causes, and Boyle names no other opponent. However, one near-contemporaneous author who imputed final causes to natural things in a way Boyle would consider too hasty is his fellow Royal Society member John Ray. Ray's most famous work, *The Wisdom of God Manifest in the Works of Creation* (hereafter WoG), frames a vast list of created phenomena in terms of the functions for which they were designed. Highlighting a handful of key differences between the account advocated in WoG and Boyle's own account casts a clearer light on the crucial role that Boyle's belief in the possibility of genuine transmutation plays in his mature philosophy.

The WoG is divided into two broad sections: first, Ray considers general metaphysical questions pertinent to the question of how final causes may be imputed to nature; second, Ray goes through the various orders of creation in turn and describes the purpose of each. The first

section of Ray's treatise has many features in common with the DFC. Ray considers the primary function of teleological explanations for natural phenomena to be the inspiration of atheists towards proper admiration of God, and he emphasizes the apparent fit of animal parts for their environments as evidence thereof. He also develops sustained arguments against Descartes and the Epicureans. Indeed, Ray considers himself to be writing in much the same tradition as Boyle and cites him in many places as inspiration (1691, 1, 50, 122), including a mention of the DFC in a list of authoritative sources on the subject of final causes (1691, 1). But Ray is no friend of the mechanical hypothesis. A sustained thread of criticism of Boyle and the mechanical hypothesis runs through WoG. There are several important differences between the two texts, but I will argue that one of the key components of the divide between DFC and WoG is that Boyle and Ray accept different background claims about the genuineness of alchemical transmutation.

Though WoG was published in 1691, the year that Boyle died and three years after the publication of DFC, Ray notes that the text had been under construction for at least thirty years prior (98). This consideration places the writing of WoG and the writing of DFC in nearly the same time and place. These similarities, however, throw the differences between WoG and DFC into greater relief. The account of metal teleology in WoG differs from the account Boyle gives in DFC in three major ways: first, metal species have genuine divinely ordained purposes; second, we are qualified to infer these purposes from the quantities of metal present in the earth; and third, that the formation of metals in the earth was not a chance event but an event mediated by divine influence through a plastic principle. Boyle denies all these. I claim that we are better-equipped to understand how these differences fit together if we interpret Boyle's silver tree argument as alchemical. This contrast demonstrates the degree to which Boyle's belief in the

possibility of genuine alchemical transmutation affected and were affected by his more open metaphysical commitments.

Ray offers many of the same cautions as Boyle to the over-enthusiastic seeker of final causes, particularly those who assume that whatever uses humans have for things in nature are the same uses for which they were designed, or the only uses for which they were designed (Broke 2000, 201). However, he is noticeably less cautious than Boyle in the range of phenomena he believes show the fingerprints of design. The most obvious case is Ray's willingness to claim that particular metal species have purposes unique to them. That a given kind of metal has a divinely-designed function is shown by two congruent lines of reasoning: that the metal can, in fact, be used to perform that function; and that the quantity of the metal present in the earth is well-fitted to the performance of that function. Ray approvingly quotes Cockburn's argument that gold can be used to make currency; but that it would be useless for that purpose unless it was scarce. It is in fact scarce, so we can conclude that it was in fact made for that purpose by its Creator (Ray 1691, 96-97). Similarly, iron has a multitude of uses, and is present in the earth in great quantity so that it may serve them. By considering the actual quantities of particular metal species, Ray can make additional inferences from Creation to the uses of particular mineral bodies. He notes, for instance, that the terrestrial substances that are useful both to humans and animals are present in greater abundance than the metals, which are useful to only humans.²¹ Boyle, on the other

²¹ "It is here to be noted, That, according to our Hypothesis, the Number of the Atoms of each several Kind that is of the same Figure and Magnitude is not nearly equal, but there be infinitely more of some Species than of others, as of those that compound those vast Aggregates of Air,

hand, does not use any species-level characteristics of metals, including their quantities, to ground inferences of teleology. His focus throughout the discussion of inanimate teleology is on particular instances. One reason that Ray can infer more teleology in inanimate matter than Boyle can is that he has access to an additional inferential method that Boyle does not consider.

Ray also held, explicitly counter to Boyle, that inanimate matter is indirectly affected by divine power through a plastick nature. His immediate source for this view was Ralph Cudworth and other of the Cambridge Platonists. Plastick natures, which Boyle usually refers to as seminal principles, are active principles in material things. Among English scholars in the 17th century, the plastick nature took on both the role of explaining the fact that inanimate matter followed regular laws of motion and the role of the vegetative soul in Peripatetic metaphysics in explaining the growth of plants and animals (Hunter, 200). Plastick natures were divinely made but not the direct influence of the divine. Ray repeats arguments given by Ralph Cudworth for the presence of plastick natures in inanimate matter in *WoG*. Particularly relevant to the current project is the claim that plastick natures explain the hand of the divine in the humblest of places, including objects of creation that do not rise to the level of complexity that would indicate obvious design. Ray quotes Cudworth as arguing that without some intervening explanatory principle, a Christian would have to allow that God should, “set his own Hand as it were to every

Water, and Earth, more abundantly than of such as make up Metals and Minerals: The Reason whereof may probably be, because those are necessary to the Life and Being of Man and all other Animals, and therefore must be always at Hand; these only useful to Man, and serving rather his Convenience than Necessities” (1691, 99).

work, and immediately do all the meanest and triflingst things himself drudgingly, without making use of any inferiour or subordinate Ministers” (Ray 1691, 51). and that He would therefore be responsible for “...those Errors and Bungles which are committed when the Matter is inept or contumacious, as in Monsters, &c.” (ibid). The same baseness and randomness of matter that Boyle gives as evidence for the chance nature of the production of alchemical products is to Ray evidence for some active intermediary between God and creation. These plastick natures serve as broad explanatory principles for the properties of metals as well as vehicles for their divine purposes.

Boyle countenanced the possibility of plastick natures for inanimate bodies in several of his earlier natural philosophical works but had abandoned the doctrine by the time of the writing of the DFC. Initially, Boyle considered plastick natures (or seminal principles, as he more commonly called them) to be essential explanatory principles for the existence of fossils and certain complex minerals. However, through the 1660s, Boyle’s enthusiasm for the seminal principles of minerals gradually waned. As Anstey documents, Boyle’s mature position on the presence of seminal principles in minerals and metals is a cautious denial. Though Boyle “leaves the door ajar” for the explanation of the oxidation of metals in air by something like a seminal principle, he does not avow it, and denies it of other minerals (Anstey 622-3). No invocation of seeds or seminal principles accompanies Boyle’s account of the generation of alchemical products by chance in the DFC. Indeed, though Boyle leaves open the possibility that certain animal-like fossils may have been generated by some sort of seed, he explicitly makes a distinction between these more complex minerals and the “...the *Inanimate* Bodies here below, that proceed not from Seminal Principles, have but a more parable Texture, (if I may so speak) as

Earths, Liquors, Flints, Pebbles” which are the subject of the argument given above (2000e, 106). Though Boyle was not consistent at all times about whether or not minerals are generated with the aid of plastic principles, he was explicit that the subjects of his alchemical argument in the DFC are not.

These three differences between Boyle and Ray’s otherwise very similar accounts are explained by their different accounts of the possibility of genuine alchemical transmutation – the production of real metals by human arts. Ray claimed that metals, “...do pertinaciously resist all Transmutation; and tho’ one would sometimes think they were turned into a different substance, yet [they]... may be reduced again to their natural form and complexion” (Ray 1692, 98). Boyle, I have shown in Section 2, explicitly holds the opposite view, that all substances can be transmuted into each other through a sufficiently subtle art or by use of the Philosophers’ Stone. Belief in the intertransmutability of metals implies that the amount of a particular metal in the earth as it was created is irrelevant, since more gold or iron could always be made by sufficiently clever humans. Therefore, because Boyle avows the possibility of genuine transmutations, he cannot avail himself of the extra evidential source that Ray uses to determine the purposes of the metals.

Ray’s claim that the metals cannot be transmuted into each other is based in two arguments about their composition, which he explained in a letter from 1685 to his correspondent Tankred Robinson (who was also the source of much of his geological evidence). These arguments rely on the premise that each metal species is composed of corpuscles of a specific shape and attempt

to establish that these corpuscles are not intertransmutable (and hence, that the metals themselves are not). First, Ray argues that if there were not a fixed number of possible shapes of corpuscles, we could not see the emergence of a fixed number of stable species of minerals in the world. If the shapes of corpuscles were changeable, they would have to change continuously through different shapes, and thus there would be infinitely many such shapes to form compounds of infinite variety, and thus there would never be stable productions of species. Ray's second argument is empirical: he notes that crystals of salt form regular and symmetrical shapes and hypothesizes that this must be due to the uniformity of the particles that make them up, down to their smallest constituents (Ray, 1848, 168-170). And, if there are finitely many kinds of unalterable corpuscles at the fundamental level, then the only transmutations that are possible are ones that result from the rearrangement of those corpuscles, like the dissolution of salt in water. The transmutations of metals are not of this kind, and thus are not possible.²²

²² Ray makes a curious aside in the published version of *WoG* that the claim that transmutation is impossible is one he had written "Thirty years since, when [he] thought [he] had Reason to distrust whatever had then been reported or written to affirm the Transmutation of Metals one into another" (Ray 1692, 98). Ray does not explicate this cryptic remark further. Moreover, we find him asserting the impossibility of transmutation as late as 1685 in correspondence. Even if Ray was, by the time of *WoG*'s publication, ready to recant his stance against transmutation, the arguments in the work remain intact. This implies that, though Ray had perhaps changed his mind by 1691, he had not yet reviewed his connected beliefs in light of this.

Boyle has a handy response to Ray's argument from the regular shapes of crystals. In his "Essay on the Porousness of Solid Bodies" of 1684, Boyle presents the inverse argument for the claim that even hard solid bodies such as gems have pores between their constituent corpuscles: "since 'tis no way likely, that Corpuscles of various and very irregular Figures, such as those of most Liquors of the terrestrial Globe are wont to be, can be so brought together, especially by chance, cold, or any other such agents, as not to intercept little Intervals or Pores between them" (2000d, 132). Boyle's description of this process as a chance process is a consequence of his rejection of plastick natures or seminal principles in their formation. These considerations, along with his belief in universal intertransmutability of metals, contribute to Boyle's unwillingness to use species-level characteristics of metals, like the amount of one kind present in the earth, to infer additional premises for the Physico-Theological arguments necessary to determine the divine purpose of a metal.

Therefore, we can understand the difference between Boyle's denial of any knowledge of teleology in minerals and Ray's endorsement of particular purposes for metal species as resulting from different interlocking ideas about chymical transmutation and matter. Boyle denies that we have knowledge of any of the divinely designed purposes of inanimate matter because metals and other materials are produced by chance and so may also be created by human arts, and that no species-level considerations can be used as evidence. Ray affirms that we have knowledge of the purposes of metallic species, since these purposes are hinted at by the amount of a given metal present in the earth, and none can be created by human arts. The strong connections between alchemical beliefs and beliefs about teleology suggest a view of the role of alchemy in the thought of Boyle and his contemporaries in which alchemical considerations strongly interact

with natural philosophical premises. Belief in transmutation should thus be seen not as an extraneous mysticism disconnected from Boyle's more celebrated mechanical natural philosophy, but as part of it.

6. Conclusions

In this paper, I have argued for two claims: the first is that the reference to the silver plant in the second part of the DFC is likely a reference to a specific alchemical procedure; and the second is that understanding the silver plant in this way allows us both to interpret Boyle's argument in the DFC more charitably and to better understand the interplay of concepts in contemporaneous discussions of inanimate teleology. The broader question that this investigation sought to answer in part is that of the interaction between Boyle's now well-documented alchemical interests and his philosophy more broadly. In this case, we see that Boyle's natural theology uses an argument derived from alchemy and is differentiated from close contemporaries by that alchemical argument. This supports the claim that Boyle's thought was integrated along this axis. 'Chymical' beliefs were not cordoned off from metaphysics or even theology. Alchemy in the seventeenth century was a complex discipline and belief system composed of physical, metaphysical, and spiritual beliefs, laboratory practices, and publishing conventions. The same, however, can be said of the mechanical philosophy itself. Against this backdrop, reading authors who engaged with both traditions with both traditions in mind can reveal new depths even in seemingly simple arguments.

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