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# Using instruments in the study of animate beings: Della Porta's and Bacon's experiments with plants

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## SPECIAL ISSUE

The creative power of experimentation: Bacon and Della Porta

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Doina-Cristina Rusu and Dana Jalobeanu

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## Abstract

In this paper, I explain Francis Bacon's use of plants as philosophical instruments in the context of his *Historia vitae et mortis*. My main claim is that Bacon experimented with plants in order to obtain knowledge about the hidden processes of nature, knowledge that could be transferred to the human case and used for the prolongation of life. Bacon's experiments were based on Giambattista della Porta's reports from the *Magia naturalis*, but I show how a different metaphysics and research method made Bacon systematically rework, reconceptualise, and put to divergent uses the results of the same experimental reports.

## KEYWORDS

Francis Bacon, Giambattista della Porta, instruments, natural magic, plants

## 1 | INTRODUCTION

The prolongation of human life occupies a central place in Bacon's natural philosophy. It is one of the *magnalia naturae* and has a basis in theology, as antediluvian humans had very long lives. In the same way in which humankind has the duty to rediscover the knowledge Adam had in Paradise and lost with the Fall, men should glorify

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God by prolonging their lives.<sup>1</sup> Bacon dedicated the *Historia vitae et mortis* (1622) to analysing the causes of death and finding remedies. However, in this text there seems to be a tension between Bacon's general programme of compiling natural histories, as presented in his theoretical works, and the particularly speculative and operative character of this history. Graham Rees calls the *Historia vitae et mortis* a "hybrid" between natural history and natural philosophy.<sup>2</sup> While a natural history should be compiled from observations and experiments directed towards the acquisition of knowledge, the *Historia vitae et mortis* has a very clear speculative system upon which Bacon's operations are grounded.<sup>3</sup>

I claim that the operations from the *Historia*, which seem to be based not on experiments but on Bacon's speculations, should be understood in the light of Bacon's experiments from other writings and his conception of instruments and the translation of knowledge. It has already been discussed that Bacon's natural histories are mixed with elements of natural magic—the highest operative science according to Bacon's system—and that this is a result of Bacon's transferral of both experiments and theoretical considerations from one work to another.<sup>4</sup> However, his use of instruments is a topic that has not been thoroughly studied.<sup>5</sup> In this paper, I wish to elucidate Bacon's use of "philosophical instruments" and its relevance for his conception of natural magic. My claim is that Bacon used the conclusions drawn from experimenting with plants to establish operations that could lead to the prolongation of human life. The assimilation of nourishment is the main operation leading to the preservation of the body; given that for Bacon experimenting on animals and humans was much more difficult than experimenting on plants, since the former are more complex beings, he confined himself to investigating this process in plants. The process of assimilation is best studied when grafting, as demonstrated by the experiments with plants in the *Sylva sylvarum*.

A large number of Bacon's experiments with plants, especially those on grafting, were taken from Giambattista Della Porta's *Magia naturalis* (first edition 1558, second enlarged edition 1589). It has already been discussed that, although they used the same recipes, the two authors had different aims, and that Bacon did not consider Della Porta's experiments as pertaining to natural magic as he defined the discipline.<sup>6</sup> However, the claim can be strengthened through an examination not only of the shared experiments, but also their relation to theory, and the further use of their theoretical conclusions.

In what follows, I start with an analysis of the process of grafting in Della Porta's natural magic (Section 2), before turning to Bacon's use of grafting (Section 3). On the basis of this analysis, I discuss Bacon's conception of aids for the senses. In this context, I show why plants play the role of philosophical instruments in his natural and experimental philosophy (Section 4).

## 2 | THE ROLE OF COPULATION AND GRAFTING IN DELLA PORTA'S NATURAL MAGIC

For Della Porta, animals and plants share several common characteristics. They both have two types of generation: by themselves (out of putrefaction) and by copulation (he considers grafting to be one kind of

<sup>1</sup>For although we Christians ever aspire and thirst after the Promised Land, yet in the meantime it will be a mark of Divine Favour if, in our pilgrimage in this world's wastes, these our shoes and clothes (our frail bodies, that is) be as little worn out as possible" (OFB 13, p. 143). This paper uses the standard abbreviations for citing Bacon's works. OFB, followed by the volume and page number, refers to *The Oxford Francis Bacon*, edited by G. Rees, B. Vickers, R. Serjeantson, & A. Stewart (Bacon, 1996–2012).

<sup>2</sup>Graham Rees, in OFB 12, pp. xxv–xxxiii.

<sup>3</sup>On the tension between Bacon's description of natural histories in his theoretical works and the composition of natural histories contained in the *Historia naturalis et experimentalis*, see also Jalobeanu (2010; 2015); Giglioli (2012).

<sup>4</sup>See Gemelli (2012); Rusu (2012; 2013); Weeks (2007).

<sup>5</sup>An exception to this is Jalobeanu (in press).

<sup>6</sup>See Rusu (2017). There are three main characteristics of Bacon's use of Della Porta's experimental reports. The first is the addition of causal explanations in terms of matter theory. The second is the generalization of the subjects upon which the experiment was done. The last concerns Bacon's selection of experiments from Della Porta and reorganisation of them under different headings. This leads to what can be called Bacon's interpretation of Della Porta's approach: Bacon considers Della Porta's approach to be inferior to his own. While the Italian's reports remain at the level of physics and mechanics, Bacon's own approach, based on Della Porta's physics and mechanics, rises to that of metaphysics and magic—the superior sciences according to his classification. The first level, of physics and mechanics, deals with material and efficient causes, while metaphysics and magic deal with formal ones.

copulation).<sup>7</sup> The latter has the advantage of potentially producing new creatures that have not previously existed. The book on animals deals with both types of generation, but copulation is preeminent because Della Porta's main interest is in the production of new creatures. He considers the potential number of these new creatures to be infinite: "sundry kinds of beasts coupling together, may bring forth new kinds of Creatures, and these also may bring forth others; so that infinite monsters may be daily generated."<sup>8</sup> Of course, in order to assume that an infinite variety of creatures can be produced, Della Porta rejects the generally accepted idea that the individuals of hybrid species cannot breed:

neither let the opinions of some Philosophers stay us, which hold that of two kinds divers in nature, a third cannot be made, unlike to either of the parents; and that some Creatures do not gender at all, as Mules do not: for we see, that, contrary to their first of their positions, many Creatures are generated of kinds divers in nature, and of these are generated others, to the perpetual conservation of this new kinds .... And against their second Position [i.e. mules cannot procreate], we must not think that one example of the Mules not gendering, should prejudice the common course of other creatures.<sup>9</sup>

However, although he argues for interspecies copulation, Della Porta established some rules to restrain this process: (a) the animals must be of equal size, (b) they must have the same period of pregnancy, and (c) they must have an "equal lust." But this changes drastically when Della Porta gives examples of such interspecies copulations, claiming that he actually witnessed them. It is quite obvious that he does not respect his own rules, given that he talks about copulation between a dog and a tiger, a bull and an ass, a camel and a swine, a man with a mare, an ass, a goat, and so on. These animals do not have the same proportions, the same period of pregnancy, and probably not even an equal lust, if such can be measured. It seems thus that Della Porta's examples of creating new species are intended only to produce astonishment in the readers.

When turning to the creation of new kinds of plants, Della Porta starts by describing grafting, the main method for obtaining new species. By comparison with copulation, in which only two species can interact, grafting is almost infinite: "not onely every Tree be ingrafted into every Tree, but one Tree may be adulterated with them all."<sup>10</sup> Thus, the same tree can receive grafts from "all the other species." He develops this idea few pages later:

As we heard before of diverse living creatures, that they might be mingled into one, by copulation, so now we will show also how to contrive diverse kinds of fruits, by grafting into one fruit. For grafting is in plants the same that copulation is in living creatures. Yet I deny it not, but there are other means whereby this may be effected, as well as by grafting. But above all other, grafting is most praiseworthy, as being the best and fittest means to incorporate one fruit into another, and so of many to make one, after a wonderful manner.<sup>11</sup>

In the first edition of his *Magia*, Della Porta states that the aim of his chapter on plants is to produce "unusual births and strange sprouts."<sup>12</sup> The language of birth when talking about plants reveals a great deal about his analogy between plants and animals. Rebecca Bushnell describes grafting in Della Porta's book as a kind of "magical

<sup>7</sup>In what follows, I refer to the 1589 second edition of the *Magia naturalis*, for two reasons: (a) both the books on animals and plants were much enlarged from the first edition; and (b) this was the edition used by Bacon. For a comparison of the two books in the different editions, see Orsi (1997, p. 82 and p. 86). For the English quotations, I use the English edition from 1658. On the *Magia naturalis* and Della Porta's conception of magic, see Muraro (1978); Balbiani (1990); Ingegno (1990); Paparelli (1990); Vendrine (1990); Piccari (2007). None of these studies focus on the creation of new species of plants and animals.

<sup>8</sup>Della Porta (1658, p. 33).

<sup>9</sup>Della Porta (1658, p. 33).

<sup>10</sup>Della Porta (1658, p. 58).

<sup>11</sup>Della Porta (1658, p. 63). In his *Villae*, Della Porta dedicates Book 4 to grafting, and we find here the same idea of creating an infinite number of new species by continuous grafting (Della Porta, 1592, p. 181). Although the discussion here is oriented more towards the technicalities of grafting and less to its "wonderful" effects, the general underlying theory is the same.

<sup>12</sup>Della Porta (1589, p. 34). I use here Laura Orsi's English translation: Orsi (1997, p. 61).

copulation” between different species of plants, which makes it obvious that Della Porta and his readers “did not seem to know or care to draw any line between the practical and the fantastical.”<sup>13</sup> Indeed, grafting makes plants germinate earlier or later, it makes fruits and flowers double, makes fruits grow one inside another, changes their taste or the colour, inserts medicinal virtues, and so on. What is relevant in this context, similarly to the case of animals, is the fact that Della Porta expounds some rules at the beginning of the book (which are themselves similar to those regarding animal copulation), but his own examples do not respect these rules, as is also clear from the aforementioned assertion that every tree can be engrafted upon every other tree. For example, he mentions that the two trees should have the same circles of blossom, but nonetheless uses grafting for the acceleration and retardation of germination and blossoming, irrespective of whether the graft is earlier and the scion later or the other way around, obtaining each time the desired effect.<sup>14</sup> Without taking into account the observable effects of grafting—that is, that the stock becomes the same species as the graft—Della Porta gives a variety of incompatible experimental “findings”: the resulting tree is sometimes described as a mixture of the two (as is the case with animals) and sometimes as having more of the qualities of one of them, as in the retardation and acceleration of germination.<sup>15</sup> This indicates not only that he did not perform the experiments even when claiming to have done so, but that he did not respect the very theory he sets down at the beginning of the book. This “magical copulation” had the purpose of amazing the reader with descriptions of astonishing plants, in the same way as the astonishing animals.<sup>16</sup>

Nonetheless, behind Della Porta's magical copulation is the theoretical framework that allowed him to develop such a conception. Della Porta justifies his “actions” upon plants through an analogy with animals: if a certain process is observable in animals, then the same should be possible for plants. However, there is a significant difference between animals and plants. New kinds of animals are created by copulation in a natural way: in Africa diverse creatures are made “by their copulation when they meet at the river.”<sup>17</sup> In the case of plants, however, because they are fixed and do not have voluntary motion, this cannot be done by nature alone; the magician must intervene. The natural copulation of animals from which different species arise provides the justification for the artificial imitation of the same action with plants. Of course, in order to claim that animal copulation does provide such a justification for grafting, Della Porta needs to establish a framework whereby copulation and grafting are instances of the same process. This framework is the magical theory of the union between the masculine and the feminine principles of universe, which can be found in all realms of nature. When the masculine and the feminine pertain to different species, an intermediate species will be created out of this union, and this new individual will display features inherited from both its “parents.”<sup>18</sup>

Della Porta's adherence to this theory can be seen in the fact that the analogy between animals and plants works both ways: animals are a model for plants, and vice versa. Discussing the artificial creation of monsters, he says:

<sup>13</sup>Bushnell (2003, p. 144).

<sup>14</sup>Della Porta (1658, pp. 63–64). For example, he first prescribes that earlier fruits should be engrafted into later trees (Della Porta, 1658, p. 79), but in his example the later fruit is engrafted into an earlier one in order to accelerate germination. The reverse is also possible.

<sup>15</sup>The same ideas appear in the later *Villae*, indicating that Della Porta did not change his opinion; moreover, these ideas were used mostly to impress the public, since the *Villae* is not a book on natural magic. In Chapter 24 of Book 4, Della Porta (1592, p. 215) mentions the possible uses of grafting: changing the times of generation, increasing the fertility, making the juices and the fruits sweeter, and so on. The discourse on grafting in the *Villae* remains similar to that on copulation and grafting in the *Magia naturalis*: the newly created plant will share a mixture of qualities of its “parents” when mixing fruits; changes will affect the form, colour, and taste: Della Porta (1592, pp. 220–222).

<sup>16</sup>Kodera (2014) argues that the *Magia naturalis* is like a theatre stage where Della Porta shows the public his astonishing objects. Although I agree with this interpretation in the case of both plants and animals, I believe that certain books do contain the reports of his experimental work as well as interesting theoretical claims, thus amounting to valuable scientific writing, as Borrelli (2014) and Saito (2006) have shown.

<sup>17</sup>Della Porta (1658, p. 58).

<sup>18</sup>Before Della Porta, Ficino advanced the idea of the sexes of plants: “That the masculine sex is truly everywhere mingled with the feminine, the order of signs testifies from up there, where successively in that unending order the preceding one is masculine, the subsequent one, feminine. Trees and plants testify it from down here: just like animals, they have one sex or the other .... With this in mind, Agriculture prepares the field and the seed for celestial gifts and by grafting prolongs the life of the shoot and refashions it into another and better species” (Ficino, 2002, p. 387). As I demonstrate below, the idea of grafting as prolonging the life of the stock is present in Bacon, though not in Della Porta. Orsi considers that this idea of regeneration through grafting is present in Della Porta's *Villae*, as Della Porta mentions that the moderns can surpass the ancients through grafting (Orsi, 1997, p. 144). While it is true that Della Porta sees grafting as a way of going beyond the ancients, from a practical perspective, grafting is used to create new species, but not to prolong life or regenerate, as it is for Ficino. I am grateful to Dana Jalobeanu, who drew my attention to another possible source for this theory: Pico della Mirandola's *On the Dignity of Man* and his theory of seeds.

For even after they are brought forth, we may fashion them into a monstrous shape, even as they lift: for as we may shape young fruits as they grow, into the fashion of any vessel or case that we make them grow into ... so also we may do by the birth of living Creatures.<sup>19</sup>

In this case, it seems that the operation is easier upon plants. Nonetheless, since it can be done with them, then it must also be possible with living creatures.

This theory, upon which Della Porta bases his experiments or the experimental reports in the *Magia naturalis*, is discussed at greater length in his *Phytognomica* (1588), with an analysis of the similarities between plants, on the one hand, and animals and humans, on the other. The comparison starts with the bodies of each, where the roots correspond to the legs, the stalk to the body, the branches to the arms, and the wood to the bones.<sup>20</sup> This similarity, in Della Porta's opinion, goes so far that he considers thorns to be the equivalent of horns, protecting plants and animals, respectively; leaves are like the hair, fur, or plumage; and so on. Citing statements by different ancient authors about plants and especially their relations with animals, Della Porta mentions the Pythagoreans, who listed plants among animal species.<sup>21</sup> The main difference then is the fact that animals have motion while plants are fixed.

For Della Porta, any natural or artificial process observed on plants can be performed on animals, and vice versa. Through copulation, the new individual takes characteristics from both of its parents. When these are of different species, the result will be a new species that mixes the initial two, a process that can be continued for generations. The equivalent of copulation for plants is the process of grafting: the stalk and the graft are the mother and father, and the result will be a mixture of their species. Since every tree can be engrafted on any other tree, the potential combinations are almost infinite. This is, for Della Porta, the definition of natural magic: once one knows the hidden theory behind natural processes, a countless number of effects can be produced. In this case, the theory is the "magical copulation." However, it is important to note that when he claims that he creates new species of both plants and animals, his aim is to amaze the reader with astonishing descriptions. Some of his experiments are reproduced by Bacon, but the latter's interests are different: the effects that can be produced and the theory that can be extrapolated from them, which in turn can be used for further operations. This is Bacon's natural magic, based on experience and the interplay between theory and experimentation, in which instruments play a crucial role. However, several experiments used in this endeavour are borrowed from Della Porta, though their uses and their relationship with theory are entirely changed. This will be illustrated at length in the following two sections.

### 3 | NOURISHMENT, GRAFTING, AND THE PROLONGATION OF LIFE IN BACON'S NATURAL MAGIC

For Bacon, both plants and animals are animate beings; plants are non-living and animals living. In contrast with inanimate beings, such as metals and stones, which do have some spirit in them but it is scattered, animate ones have their spirits connected and branched off. This means that their spirits can be in charge of certain processes that do not take place in inanimate beings, such as generation, growth, or nourishment. In living beings, except for branched beings, the spirit has a main cell, the brain, and can therefore perform more functions, such as memory, imagination, or will.<sup>22</sup> As such, there is a gradual movement from inanimate, to animate but non-living (that is, plants), and then to living creatures: in inanimates, spirits are discontinuous; in plants, they are continuous and branched; and in animals, they are not only continuous and branched, but also have a main cell. In short, the distinction between inanimate

<sup>19</sup>Della Porta (1658, p. 50).

<sup>20</sup>Della Porta (1588, p. 10).

<sup>21</sup>Della Porta (1588, p. 12).

<sup>22</sup>*Sylva sylvarum*, SEH 2, pp. 528–531. This paper uses the standard abbreviations for citing Bacon's works, SEH, followed by volume and page number, refers to *The Works of Francis Bacon*, edited by J. Spedding, R. L. Ellis, & D. D. Heath (Bacon, 1859–1864). Bacon does not use the term "non-living." However, he distinguishes between inanimate and animate beings, the latter of which are either plants or living beings. Based on this distinction, I take it that Bacon considers plants as animate, but non-living.

and animate, and between living and non-living, is based on the structure of their spirits: there is only one kind of spirit, which acquires more functions when its structure changes.<sup>23</sup> Because the spirits in non-living and living beings are similar in nature, having only a different structure in the latter, plants and animals share a diversity of processes, such as generation, growth, nourishment, and putrefaction.<sup>24</sup>

As I will show, grafting is a particular technique used in the nourishment process of plants, which can thus be translated to animals. First, for Bacon, grafting represents a procedure through which nourishment is manipulated; it is not a type of germination, as it was for Della Porta.<sup>25</sup> Second, it represents the technique that must be employed in order to prolong human life, for two reasons: (a) the scion finds the nourishment already concocted and, because it does not have to spend time concocting it, it can immediately begin the assimilation; and (b) the stalk is transformed by the presence of the young spirits of the scion, causing a restoration of youth to some degree.<sup>26</sup> The result is that the stalk draws more nourishment from the earth, leading to the improvement of the entire plant and an increase in its longevity, because the nourishment provides material for consumption to the innate spirit of the body without consuming the body of the plant itself. Thus, this action has a double effect: it aids both the graft and the stalk. Consequently, this knowledge can be transferred to the case of humans in two ways: (a) by finding the proper means to assist the process of nourishment and provide the body with aliments that are already concocted (as with the sap of the stalk); and (b) by finding ways to insert young spirits into an old body—which is not as simple for humans as it is for plants, because the insertion of young spirits cannot be done through anything similar to grafting. I will first reveal how Bacon's discussion of grafting differs from that of Della Porta, and then show how this knowledge can be transferred to humans with the aim of prolonging their lives.

While Della Porta uses grafting as a technique to shape all the possible changes he wants to perform upon plants, for Bacon grafting has only one effect: it makes fruits meliorate, in the sense that they can grow larger or tastier. He first refutes the notion that grafting can advance or retard germination.<sup>27</sup> Bacon then quashes the idea that grafting can make new species of flowers or fruits. Here, the reference to Della Porta is very clear—because of the reference to monsters and Africa—and directed at his assertion that grafting can create new fruits just as copulation does with living creatures in Africa:

We see that in living creatures, that have male and female, there is copulation of several kinds; and so compound creatures; as the mule, that is generated betwixt the horse and the ass; and some other compounds which we call monsters, though more rare; and it is held that that proverb, "Africa semper aliquid monstri parit?" cometh, for that the fountains of waters there being rare, divers sorts of beasts come from several parts to drink; and so being refreshed, fall to couple, and many times with several kinds. The compounding or mixture of kinds in plants is not found out; which nevertheless, if it be possible, is more at command than that of living creatures, for that their lust requireth a voluntary

<sup>23</sup>On the similarities and differences between spiritual matter in different kinds of beings, see Rusu (2018). In that article, I claim that the more complex the structure of the spirit, the more developed the being in respect to its organs and the functions those organs can perform. Inanimate beings have a life span longer than animate ones due to the fact that their spirit is not kindled and does not consume the surrounding matter. The kindled spirit is the reason why animate beings need nourishment.

<sup>24</sup>The fact that the process is similar can be seen from the fact that when Bacon discusses the respective processes, he mentions the activity of the spirits and the type of tangible matter involved, regardless of whether the individual is a plant or an animal. See the *Sylva* (SEH 2, p. 451); the *Abecedarium* (OFB 13, pp. 205–209); and the *Historia* (OFB 13, pp. 347–377). There is a correlation between the complexity of the being and that of the nourishment, but this does not affect the process itself; simply put, more complex organs can digest more complex food: "As compared with the body nourished, the nourishment should be of a lower nature and a simpler substance. Plants feed on earth and water, animals on plants, and man on animals. There are also carnivorous animals, and even man himself lives partly on plants" (*Historia vitae et mortis*, OFB 13, p. 193).

<sup>25</sup>The same idea can be found in Theophrastus's *De causis plantarum*. For him, grafting is a propagation in another tree from which the graft takes the already prepared nourishment: "All grafts grow rapidly because their food has already been worked up" (Theophrastus, 1976, p. 43).

<sup>26</sup>As shown above, this idea was already present in the work of Ficino. Several of Bacon's ideas for the prolongation of human life seem to have been influenced by Ficino, but this comparison has not been studied in detail.

<sup>27</sup>Men have entertained a conceit that sheweth prettily; namely, that if you graft a late-coming fruit upon a stock of a fruit-tree that cometh early, the graft will bear fruit early; as a peach upon a cherry; and contrariwise, if an early coming fruit upon a stock of a fruit-tree that cometh late, the graft will bear fruit late; as a cherry upon a peach. But these are but imaginations, and untrue. The cause is, for that the scion over-ruleth the stock quite, and the stock is but passive only, and giveth aliment, but no motion, to the graft" (SEH 2, p. 480).

motion; wherefore it were one of the most noble experiments touching plants to find it out: for so you may have great variety of new fruits and flowers yet unknown. Grafting doth it not. That mendeth the fruit, or doubleth the flowers, &c., but it hath not the power to make a new kind. For the scion ever over-ruleth the stock.<sup>28</sup>

It is significant that Bacon makes the analogy with the copulation of animals by emphasizing that new species of plants can be more easily created because, compared to animals, they do not need voluntary motion; in other words, they are more easily manipulated in the laboratory, whereas one has to manipulate the will of animals to achieve the desired effect. But grafting is not the required technique. Even if Bacon does not agree with the theoretical part of Della Porta's book on plants, many of the latter's reports are present in the *Sylva*. However, all are directed to enabling the melioration of plants, rather than to producing other effects, as in the original source.<sup>29</sup> There is one particular report that better explains the role of grafting and its connection with the prolongation of life. In experiment 445 from the *Sylva sylvarum*, again borrowed from the *Magia naturalis*, Bacon says:

Take seed or kernels of apples, pears, oranges; or a peach, or a plum-stone, &c., and put them into a squill, (which is like a great onion,) and they will come up much earlier than in the earth itself. This I conceive to be as a kind of grafting in the root; for as the stock of a graft yieldeth better prepared nourishment to the graft than the crude earth, so the squill doth the like to the seed.<sup>30</sup>

The *Historia vitae et mortis* contains a reference to this experiment that explains why cooked meat provides better nourishment than raw meat:

The better the nourishment is prepared, and the nearer it approaches to the substance of the thing nourished, the more productive do plants become, and the more do animals fatten. For no slip or cutting stuck in the ground gets fed as well as if it were grafted on a stock which agrees well with its nature, where it finds nourishment digested and prepared. Neither too (as they report) will an onion seed or the like produce a plant as big when planted in the ground, as when it is set by a kind of grafting on the root of another onion beneath the ground. And furthermore, it has been discovered lately that slips of Wild trees, like elm, oak, ash, and so on, set on stocks produce much larger leaves than if they had come up without grafting. Men too are better fed on cooked rather than raw meat.<sup>31</sup>

Moreover, in the *Sylva sylvarum* Bacon describes several experiments on making meats and drinks more nourishing and "restorative in consumptions and emaciating diseases." This not only involves preparing the meat in a mixture with drinks, but partly concocting the aliment before it reaches the stomach, as concoction makes the assimilation easier: "It seemth for the nourishing of aged men, or men in consumptions, some such thing should be devised as should be half chylus, before it be put into the stomach."<sup>32</sup> The following experiment, in which Bacon sets out the recipe of some capons that are macerated for 5 days in beer, explains why this type of food is the best: "it is not possible that meat and bread, either in broth, or taken with drink, as is used, should her forth into the veins and outward parts so finely and easily, as when it is thus incorporate, and made almost a chylus aforehand."<sup>33</sup> It is not surprising

<sup>28</sup>SEH 2, p. 492.

<sup>29</sup>For examples of how reports from Della Porta are converted in the *Sylva* to claims that grafting produces different effects than Della Porta described, see Rusu (2013, pp. 146–151).

<sup>30</sup>SEH 2, pp. 485–486. Though not presented as a borrowing, this experiment is based on the *Magia naturalis* (1658, pp. 76–77), where it is attributed to Theophrastus. The difference is that Della Porta puts the kernels next to the onion.

<sup>31</sup>OFB 13, p. 195.

<sup>32</sup>SEH 2, p. 359.

<sup>33</sup>SEH 2, p. 360.



that very similar recipes for nourishing food appear in the *Historia vitae et mortis*, in a chapter entitled "The Operation of the Aliment Itself to Insinuate the Same" (that is, what kinds of food are more suitable for a better digestion).<sup>34</sup>

The chyle (*chylus*) is the liquid that results from the digestion of the aliment in the stomach. In Bacon's terms, this is an instance of concoction or digestion. If someone eats food that has already been transformed (at least partly) into a chyle, the body can skip the first part of the process in which the food is digested or concocted and simply focus on the assimilation of nourishment. In a similar way, the sap from a plant's stalk represents an already concocted aliment, equivalent to the chyle.<sup>35</sup> However, the effect of receiving already-concocted aliment is different for plants and animals. Plants are still growing, so the fact that they can assimilate faster makes them grow larger and sweeter fruits (or larger leaves, for the non-fructiferous trees). Animals can also grow bigger if they are still growing, but if they have already reached maturity, the result is the prolongation of life. Instead of consuming the tangible matter around them, spirits will satisfy their appetite for their own multiplication by consuming the nourishment.

I turn now to the second aspect of grafting mentioned above: namely, the transformation of the stalk into the scion. In experiment 467 from the *Sylva*, Bacon claims that:

As grafting doth generally advance and meliorate fruits, above that which they would be if they were set of kernels or stones, in regard the nourishment is better concocted; so (no doubt) even in Grafting, for the same cause, the choice of the stock doth much; always provided that it be somewhat inferior to the scion; for otherwise it dulleth it. They command much the grafting of pears or apples upon a quince.<sup>36</sup>

What Bacon notices, but Della Porta did not, is that when grafting, the stalk transforms into the type of tree the scion pertains to. Bacon repeats constantly that "the scion over-ruleth the stock," "the stock is but passive only, and giveth aliment, but no motion, to the graft."<sup>37</sup> Bacon is suggesting here that the superiority of the scion can make the stock take the scion's form, because it transfers its inner motions. Because of this transformation into a superior species, the "new" tree (pertaining actually to the species of the scion) needs more nourishment and draws more substances from the earth. What is relevant in this case is that the tree will bear meliorated fruits not only in the beginning, when the grafting is performed, but in all subsequent years. This supplements another of Bacon's ideas about restoring youth (or at least retarding aging), as well as a comparison between plants and animals:

Aristotle did very well to note the difference between plants and animals as far as alimentation and renovation are concerned, namely that the animal body stays enclosed within its own bounds, and that once it has reached its right size food keeps it going and conserves it, but it puts out nothing new apart from hair and nails, which are regarded as excrements; so that of necessity the juices of animals age more quickly. But in trees, which now and then put out new branches, new shoots, new foliage, and new fruits, it happens that the parts that I have just mentioned are new and unstaled by time. But as everything fresh and youthful draws food to itself more strongly and eagerly than that which has started to dry out, it happens that along with this the very trunk by which this kind of aliment passes to the branches, is watered, suffused, and restored by that more abundant and plentiful aliment as it passes.<sup>38</sup>

Bacon's conclusion is that this can be done for humans by restoring those parts that can be easily restored, which will help the others in turn:

<sup>34</sup>OFB 13, pp. 313–315.

<sup>35</sup>On the central role of concoction in Bacon's natural philosophy, see Jalobeanu (2018).

<sup>36</sup>SEH 2, p. 490.

<sup>37</sup>SEH 2, pp. 492, 480.

<sup>38</sup>OFB 13, p. 163.

even after the passage of time and declining years, the spirit, blood, flesh, and fat repair easily, but the drier and more porous parts, the membranes, and all tunicles, nerves, arteries, veins, bones, cartilages, and most of the innards too, as well as nearly all the organic structures, are repaired with difficulty and some cost.<sup>39</sup>

Though difficult, restoration is not impossible. Of course, the question that arises here is: Can parts of the human body be repaired? It is clear that this is not as easy as in grafting, and Bacon argues against Ficino's claim that the vital powers of the body can be renewed by sucking the blood of a young man, because "that which nourishes from the inside should not in any way be equal to or quite like the body nourished, but to some extent inferior or subordinate so that it can be worked up."<sup>40</sup> What can be transferred from another person, according to Bacon, are the spirits:

If a man could arrange to put into an old body spirits of the kind characteristic of a young one, it is likely that this mighty wheel might put the other, lesser wheels into reverse, and turn back the course of nature.<sup>41</sup>

In the *Historia vitae et mortis*, Bacon claims that the easiest way to transfer spirits is through nourishment.<sup>42</sup> However, in the *Sylva* he seems to accept other types of transfer, commenting that "it is agreeable to reason, that there are at the least some light effluxions from spirit to spirit, when men are in presence one with another, as well as from body to body."<sup>43</sup> He further explains that old men who love young company live longer because their spirits are recreated by this company.

Analysing grafting, Bacon concludes that the tree undergoes two main transformations: (a) its fruits grow bigger because the nourishment is already concocted in the stalk; and (b) the stalk becomes a tree of the same species as the graft, which has younger and stronger spirits. The same techniques are applied, in the *Historia vitae et mortis*, to human beings, resulting in the prolongation of life. While grafting makes the fruits of plants grow bigger, for humans, already concocted food provides better nourishment to the innate spirits so that these do not consume the body. While in the case of plants grafting regenerates the old tree, for humans, the company of young people and aliments rich in spirits will "regenerate" an old person. In the following section, I substantiate my claim that plants play the role of philosophical instruments in Bacon's natural philosophy.

#### 4 | BACON'S CONCEPTION OF INSTRUMENTS: AIDS FOR THE HAND

Bacon's classification of instruments does not fit the modern distinction between philosophical and mathematical ones.<sup>44</sup> He divides instruments into different classes, establishing strong connections between the use of instruments and the use of experiments in the practice of natural philosophy. In the second book of the *Novum organum*, the aids for the senses are called the "Instances of Lamp or First Information," and they assure a correct interpretation of nature.<sup>45</sup> The first class is composed of the instances of access, which help the immediate actions of the senses, especially the sight, and which can "either let us see the unseeable, see at a great distance, or see more

<sup>39</sup>OFB 13, p. 147.

<sup>40</sup>OFB 13, p. 321. For Bacon a much better solution is to provoke bloodlettings regularly and then help the body to produce new one. For Ficino's claim, see *De vita*: Ficino (2002, pp. 197–100).

<sup>41</sup>OFB 13, p. 245. The same idea is found in the rules detailed at the end of the book: "Young spirits introduced into an old body can reverse the course of nature in short order" (OFB 13, p. 365).

<sup>42</sup>"The nature of the spirits is as it were the chief cog which keeps all the other cogs in the human body turning. Thus it ought to stand first in relation to the intention of lengthening life. Now it is better to proceed by the easier and quicker route, which is to alter the spirits, than to take another path. For the operation on the spirits is twofold: the one by aliment which is slow and roundabout; the other (also bipartite) which has immediate effect and goes straight to the spirits, namely, by vapours or the affections" (OFB 13, pp. 365–367).

<sup>43</sup>SEH 2, p. 652.

<sup>44</sup>On this topic, see, e.g., Meli (2006); Hankins & Silverman (1995, esp. pp. 3–13); Van Henden & Hankins (1994).

precisely and distinctly.<sup>46</sup> These do not amplify the sense, but correct and direct it. The second class, the “Evoking Instances,” makes the non-sensible sensible.<sup>47</sup> The first type of instruments, such as beacons and bells, bring distant things closer by stimulating the senses. The second type make manifest what is hidden inside bodies; examples include urine and the pulse, which convey information about the body’s condition that would otherwise remain hidden. The third and fourth types:

of reduction touch on very many matters and should be everywhere sought out in our investigation into things. Here are some examples .... It is evident that air, spirit and suchlike things which are fine and subtle in their entity cannot be seen or felt, so that reductions (*deductionibus*) are absolutely necessary when inquiring into them.<sup>48</sup>

Bacon’s example is the motion of spirits within tangible bodies. The true causes of all visible processes are the motions of spirits, imperceptible to the senses. Air is a good example that sheds light on how spirits need to be investigated: air itself is not perceptible to humans, but its effects, winds, can be investigated, measured, and classified. For Bacon, “all these things [spirits] are reduced to perceptible by their remarkable effects” and “the most noble and far-reaching difference of spirits ... is, by many Reductive Instances, set as it were before one’s eyes.”<sup>49</sup> The reductive instances manipulate the effects in such a way that the activity of spirits can also be investigated, measured, and classified.

There are some observations I would like to make at this point regarding these classes of aids.<sup>50</sup> First, Bacon’s distinction between the Instances of Access and those of Evoking is very subtle and needs further clarification. The Instances of Access bring the object to the senses so that the sense can directly observe it. The Evoking Instances, in contrast, bring to the senses information that “alerts” them to the presence of the object under study, but without bringing the object itself, as certain features of the body only “announce” the presence of an internal disease. The illness itself does not manifest in any other way. This means that, because the disease itself cannot be directly observed inside the body, urine and the pulse become aids for the sense only if the observer has specific knowledge—one has to know how to interpret their characteristics in order to assess that they are signs of a latent disease. It is through sensation that knowledge of the disease is acquired—not the sensation of the disease itself, but of some of its effects.

Second, and more importantly, the third and fourth classes also manifest hidden things, which in this case are the motions of the spiritual matter. Like the second class, these aids provide information that the five senses could never perceive no matter how perceptive they might be. Put differently, a very small body can be “seen” by the human eye with the help of a microscope, but the motion of spirits can never be “seen,” it can only be “reduced” to its effects in the tangible bodies. Moreover, Bacon’s use of “*deductio*” for this reduction of causes to their effect is quite deliberate. Given that the conclusion of a syllogism does not introduce information that was not already in the premises, for Bacon deduction is not the proper method for discovery in natural philosophy. But in this case, reducing hidden causes to their effects should imply an activity similar to the Aristotelian syllogism, where the structure guarantees the

<sup>45</sup>For since all Interpretation of Nature starts from sense, and leads from the perceptions of the senses by a proper, straight and secure route to the perceptions of the intellect, which are true notions and axioms, it necessarily follows that the more abundant and precise the representations or contributions of the sense, the easier and better will everything turn out.” (OFB 11, p. 341).

<sup>46</sup>OFB 11, p. 343. There are three types of these instruments: the microscope, the telescope, and the astrolabe.

<sup>47</sup>Graham Rees in the OFB translates “Eae Deducunt Non-Sensibile ad Sensibile” as “These reduce the imperceptible to the perceptible” (OFB 11, p. 347). However, given the central role played by the concept of “perception” in Bacon’s matter theory, I prefer to make the distinction between sense and perception, the latter being a much more subtle faculty than the five senses, which is present in all beings, and on which all the interactions between bodies are based.

<sup>48</sup>OFB 11, p. 347.

<sup>49</sup>OFB 11, pp. 349, 351.

<sup>50</sup>There are three other classes, but they are less relevant here. The fifth is when the object hides from the senses by a motion that is too slow or too quick, and then its motion has to be increased or decreased; the sixth kind is when the sense is obstructed by the splendour of the object, and it is made perceptible by distance or the interposition of a medium; the seventh is when the sense is burdened “by an object that has no room to let in a new one” and is specific to the sense of smell. See OFB 11, pp. 357–359.

validity. This is again connected with the existence of specific knowledge: the interpreter must understand the connections between the visible effects upon tangible matter and the "hidden" activity of pneumatic matter that caused them.

One of the main characteristics of Bacon's natural magic is to use the knowledge obtained from one class of subjects to perform changes on a different class. In the case of the prolongation of human life, this is not only possible, but necessary, due to the difficulties of experimenting with animals and humans, as explained in the introduction. Plants are used by Bacon as instruments through which hidden processes of matter can be studied. The results of experimenting with them provide new knowledge about the natural world.

## 5 | CONCLUSION

Though based on Della Porta's experimental reports, Bacon's experiments with plants serve a different purpose than in the original: the study of the hidden processes in nature. While this knowledge can be applied to the plants themselves, its main advantage is that it can be transferred to other classes of beings. This transfer of knowledge from one class of beings to another reveals some significant features of Bacon's philosophy. First, the transfer has its roots in a metaphysics in which the fundamental processes of nature are identical, irrespective of their subjects. This means that the transfer requires a thorough understanding of both classes of subjects and of the underlying process itself. This approach is completely different from Della Porta's. For Della Porta, processes are similar on the basis of his conception of natural magic and the theory of correspondences. Grafting is the correspondent of animal copulation because, as animals, plants are either male or female. The offspring share features from both "parents." The theory of the sexualisation of plants and of the process of grafting, probably inherited from Ficino, justifies Della Porta's exposition of the astonishing results one can have when trying to create new species of plants.

Bacon, in contrast, eliminates the fantastical dimension from the same experimental reports. In the two examples I presented in the second section, adapting the process observed in plants to human beings necessitated a profound knowledge of both plants and animals. For Bacon, studying the grafting of plants allows the researcher to gain knowledge about the processes of nourishment and repair of animals' bodies. Both these processes are essential for the prolongation of human life. In the case of nourishment, the transfer of knowledge is straightforward. Grafting provides concocted water, whereas concocted food can be provided to animals. What both instances have in common is that providing concocted nourishment replenishes the living organism and alleviates its continuous consumption by its innate spirit. In the case of regeneration, the transfer of knowledge is more complex. Trees grow new branches that live longer because these "young" parts of their bodies have more power and require more food, which helps the older parts revitalize. Grafting is the paradigmatic instance of regeneration in that the young scion not only gives "motion" to the stock, but it also transforms it into its own species. Humans and animals in general do not grow new parts once they reach maturity, nor can they be subject to a process similar to grafting. Humans need to seek other means of revitalizing old spirits, which can be done by seeking out young company, breathing fresh air, or feeding upon aliments rich in spirits.

In a nutshell, for Della Porta, the general theory of correspondences functions as the framework of his operative magic: plants can be manipulated in the same way as animals because they are instantiations of the masculine and feminine aspects of the world. For Bacon, there is a general metaphysical framework that establishes that processes are similar because they are produced by the action of spirits, which act identically in all matter. He uses one class of animate beings, plants in this case, to establish general rules about the processes they are subject to. Further, these rules can be transferred in order to manipulate another class than the one used to generate these rules. This is possible because, according to Bacon, there is no clear-cut distinction between plants and animals. The differences between them are simply the result of differently structured spirits.

Connecting the study of plants in the *Sylva sylvarum* with some of the techniques for the prolongation of life sheds light not only on the *Historia vitae et mortis* and its "hybrid" character, but also on one of the main features of

Bacon's natural philosophy, his conception of instruments as aids for the senses. Bacon is less interested in furthering the practical arts, such as agriculture, than in discovering the fundamental underlying workings of nature itself. This means that plants function as reductive instances. They reduce the invisible motions of spirits to visible effects, which can be studied systematically. However, a qualification needs to be made at this point. We typically consider that philosophical instruments must be artefacts, which have the aim of discovering the laws of nature.<sup>51</sup> Plants are natural objects, and even animate, but even so they can be artificially manipulated. In this artificial manipulation, plants function as instruments that make visible the activity of the spirits, which can consequently be investigated, measured, and classified.

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<sup>51</sup>For example, Borrelli, following Bertoloni Meli's conception from *Thinking with Objects*, defines instruments as “artefacts which are at the same time objects and tools of inquiry” (Borrelli, 2014, p. 41).

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