The Secret Nature of Seeds

Science & Seed Improvement c.1520-1700

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Declaration

I declare that this thesis is entirely my own work and that no part of it has previously been submitted for any other degree or professional qualification.

A short article relating to Moses Cook and entitled ‘From the Pen of a Gardiner’ was published in the July 2013 edition of Rural History Today.

Elizabeth Scott [2016]

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'He that knows a thing well, must know what it was, is, and shall be.'

Moses Cook[1]

[1] Moses Cook, *The Manner of Raising, Ordering and Improving Forrest Trees* (London, 1676), 20

INTRODUCTION

Abstract

The seed is an extraordinary time capsule that can travel across socially constructed and humanly defined borders and boundaries. While certain characteristics of the seed have been captured in botanical, agricultural, economic and garden history, what the seed also carries is a social history. The human relationship with the seed is complex, with the seed itself invested with different social and cultural meaning over time, place and periods in history. For the purposes of this research, a history of the seed is constructed in the early modern period in England, using as its narrative, the development of scientific knowledge. To understand how knowledge was accumulated and transmitted, the research argues that the 'social' everyday lives of men and women were formative in the creation of a scientific 'culture', that permeated this period in history. The thesis argues that the outcome of the scientific endeavours described in the treatises written by horticulturalists and husbandmen, led ultimately, to the social construction by the Puritan improvers, of a 'model' seed and the advent of the nurseryman.

Methodology

The primary sources used for this research are the first horticultural and husbandry treatises written in, or translated into, vernacular English. This was a particular period in the early modern period when the impact of the print press led to a burgeoning of treatises, often described as to-do-books, or gardening books. However, a different reading of these publications revealed a different interpretation concluding that they were, in fact, early modern scientific treatises. Far from science being carried on in laboratories or scientific institutions, this research argues that the seeds of scientific knowledge were being sown and propagated in the the literary landscapes of fields, woodlands, forests, orchards, seascapes, vegetable plots and flower gardens throughout England.

The research sets out to answer a series of questions.

- What kinds of people were involved and how did they describe themselves?
- How did they create their investigative environments?
- What were the scientific activities, and how were they defined?
- How was knowledge built and transmitted?
- Is there any evidence to suggest that theory influenced practice?

Research subjects were selected as representative of particular social groupings active during the period. The Renaissance botanists and gardeners of 1520s-1600s include John Gerard, John Parkinson, John Goodyer and Thomas Johnson, who introduce us to the context of the horticultural world. The first English authors Fitzherbert (published in 1540) and Tusser (published in 1557 & 1573), as well, as continental translations from Googe (1586) and Surflet (1606), familiarize us with estate management, husbandry and horticulture. Gervase Markham was an enthusiastic collator and plagiarizer of other people's work, but nevertheless, by circulating and re-circulating material, he was contributing to the building of scientific knowledge. The scientific involvement of Francis Bacon and Hugh Plat, both central in experimental philosophy, lead us into the contributions of Puritan improvers from the 1620s and the Hartlib circle. (See section Research Subjects).

Theoretical framework

The Social

Key concepts: networks, centres of calculation, cycles of accumulation,

The theoretical framework that underpins this research is Bruno Latour's Actor-Network-Theory. While there is interest in the conclusions of authors from their observations and investigations, the research is also concerned with how they constructed knowledge. Latour's framework offered the researcher a modern structure from which an interpretation of scientific enterprise could be formulated. The thesis argues that knowledge, as understood in any period of history, was socially constructed, a notion presented in the critical theory of Michel Foucault. Foucault uses the term 'power/knowledge' to signify that power is constituted through accepted forms of knowledge, scientific understanding and 'truth':

> 'Truth is a thing of this world: it is produced only by virtue of multiple forms of constraint. And it induces regular effects of power. Each society has its regime of truth, its "general politics" of truth: that is, the types of discourse which it accepts and makes function as true; the mechanisms and instances which enable one to distinguish true and false statements, the means by which each is sanctioned; the techniques and procedures accorded value in the acquisition of truth; the status of those who are charged with saying what counts as true.'[2]

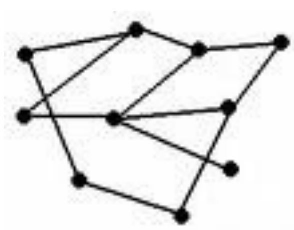
Foucault's regimes of truth or general politics are formulated through scientific discourse and reinforced and redefined constantly. Through their actions and interactions people use language to create a shared reality and common understanding. In some respects this language is developed as a means of signposting, so the term 'seed' appears to have some kind of universal recognition, something that might be commonly

[2] Michael Foucault, Power/Knowledge Selected Interviews and Other Writings 1972-1977 (Edited by Colin Gordon. Random House USA Inc; 1988), 131

understood. But while we may say there appears to be consensus to call 'it' a seed, we don't know at all the constituent properties of 'it'. In other words, what makes a seed a seed? It is only when we look through the lenses of different interests, that we find the seed has many different properties, characteristics and interpretations. In the early modern period, as in any other historical period, different religious, political, economic, social and cultural lenses were used to define 'it'. If all these views were abandoned, what could be said about the seed? Exactly nothing, so the seed was constructed into a 'model', an ideal, with all the constituent parts observed and defined.

Networks

Latour considers the anthropological and sociological concept of 'social' designates what is already assembled. Rather than a top-down global perspective, he contends, we need to start at the local and with local actors, both human and non-human. In Latour's terms the 'social' is about connections and relationships, which, he describes in his actor-network-theory. The actor-network-theory relates to the interaction between humanistic and non-humanistic agents, which, according to Latour, constitutes a network between the two actants. So, for example, collectors of tulips in the Dutch Golden Age during the early part of the seventeenth-century, led to a networking where the artefacts, bulbs, interacted with the human. If the artefact is passed around and shared by whatever means, this creates new and interlinking networks.



To provide an example relevant to this research, each of the dots represents a network interaction between a human and a seed, bulb or plant. The artefact, in this case a seed, creates a response in the human, which may be emotional, intellectual or both. In this scenario, the artefact itself - or the observation and experience of the artefact - is shared with another. This creates a second network and so on.

Centres of calculation

Latour & Woolgar use the example of life in a laboratory, in which they follow the activities, conversation and movements on a day-to-day basis of those involved. Theirs was a study of the formation of a scientific 'culture' and they concluded that any scientific realm came about as a result of operations within the social world. That is, the relationships, activities, exchanges, agreements and disagreement, from all of the contributors in the laboratory system whether they are technicians, administrators or scientist.[3] We can conclude from the work of Latour & Woolgar that a scientific culture is built from the 'social'. The literary landscapes of the horticulturist and husbandman are defined within this research as socially constructed centres of calculation.

Cycles of accumulation

Tracing actor-network interactions historically is extremely difficult, but not impossible. How science was realized and portrayed in the early modern period is, for this research, most fruitfully explored through the vernacular publications of the period. For Latour, scientific knowledge is embedded in the procedures of *inscription*, and as authorship in husbandry, horticulture and botany flourished in the early modern period, this research has been based almost exclusively on texts written at this time.

[3] Bruno Latour and Steve Woolgar, *Laboratory Life The Construction of Scientific Facts.* (Princeton University Press, 1986) 15-41.

A word about words

Science: It might feel anachronistic to use the word science, when, in fact, it was not a word generally used. However, in their intellectual and practical study of nature and the physical world, horticultural and husbandry authors did not have a scientific language to describe the evidence they were observing and recording. The writing of treatises in vernacular was new and the setting of a literary genre was a developing art. The word science, therefore, is used in this research where it is felt there is evidence of an understanding and exploiting of nature.

Blueprint: The word blueprint is used to describe a characteristic in the seed as identified by authors. The characteristic they were describing was an innate feature of the seed which was species specific, immutable, and which guided the plant throughout its growth. More generally, authors used religious metaphors, *nativity* or *genesis*, but this usage underplayed the conflict they voiced when investigating or experimenting with God's design. There was no single word that could separate their vernacular science from their religiosity, and so blueprint was chosen as an indicator of this tension.

Literature review

There has been no systematic study of the scientific development of knowledge of plant seeds in the early modern period. As a result this research has taken a broad approach, and each chapter has its own review of the literature relevant to the topic under discussion. Secondary sources have been drawn from the disciplines of history of science, history of ideas, intellectual history, the history of agriculture and gardens, botanical science, sociology, social anthropology and geography.

The chapters are laid out in a pattern. Section I provides an overview of how nature was constructed and explained using examples from Europe and England. Section II provides examples of scientific thought and trials of nature. For ease of access to the information, this section is divided according to the expected growing pattern of a plant, from seed to seed. However, it should be noted that this was not the order in which most treatises were arranged. There was no standard chronology and the dispersal of material was different in every treatise. Individual pieces of scientific investigation were collated and placed within a biological sequence in order to build a picture of scientific knowledge as it developed and was transmitted. Finally, Section III considers examples of how scientific theory was translated into practice.

Part 1

Constructing Nature

Chapter 1 considers the concept of networking using Latour's actor-network theory. In exploring the complex web of relations between humans and artefacts the chapter argues that the study of printed treatises is a useful tool for tracing the development of scientific knowledge. Whereas much of the historiography has focused on European countries, Ogilvie (2006), Cooper (2007), Findlen (1994), Goldgar (2007), this chapter considers scientific enterprises and collecting in England, Harkness (2007), Willes (2011), Thirsk (2006). Networks are traced through treatises and the writings of natural histories, floras, chorographies, and the collections of Samuel Hartlib.

Chapter 2 is concerned with the style and format of botanical and horticultural treatises, and the construct of literary landscapes. The chapter provides a brief overview of herbals and floras, before a detailed discussion of horticultural treatises, and the development of specialist sites for vegetables, timber, orchards and flowers. Latour describes the outcomes of investigation as *inscriptions,* or the translation of an interest into material form. Inscriptions in this context are the literary landscapes of the specialist treatises as sites of scientific investigations. Eamon (1994), Findlen (1994), Daston & Lunbeck (2011), Schama (1995), Hoskins (1955), Cosgrove (1984), Mendyk (1986), Thick (1998), Thirsk (1997).

Chapter 3 discusses how the propagator in these literary landscapes is constructed, and given authenticity and authority as a Baconian style scientific investigator. Historiographies of the self-fashioning and social construction of collectors and virtuosi in the early modern period include, Greenblatt (2005), Yeo (2014), Findlen (1994), Houghton (1942). Having constructed specialist literary landscapes, this chapter will enlarge on the theme of self-fashioning as authors presented themselves as authentic and authoritative.

Chapter 4 presents some of the difficulties in presenting knowledge. The concept of a scientific fact, Shapiro (2000 & 1983), is found to be difficult, as early modern commentators did not commonly use the word. A more common usage is the notion observation, Park (2011), Pomata (2011), Daston (2011). The chapter considers the move from individual observations to the collective, as in Bacon's proposal for a state funded, 'Multitude of Observers'. In this chapter the seed as the transmitter of knowledge, is illustrated through three case studies from Hugh Plat, Francis Bacon and Nehemiah Grew. Each demonstrates different, and sometimes conflicting, philosophical and scientific approaches. The conclusion of this chapter and Section 1 is the outcome from different scientific and philosophical contentions lead to the social construction of the 'model' seed.

Part II

Trials of Nature

This section follows the scientific journey of the model seed through the literary landscapes of the authors. There is very little secondary literature relating to the science of the seed as it was developing during this period.

Chapter 6 discusses how, within the phenomenon of collecting, seeds became collectable as material objects, open to observation and investigation, MacGregor (2008), Thick (1994). When seeds were collected and from which plant was central in the construct of the model seed. This was also a period when Bacon's proposed experiments for creating mutating seeds, led to a discourse in the literature about species change. It is here that the notion of a blueprint is introduced.

Chapter 7 reviews early modern responses to the science of germination, biological inertia, and seed storage, Gorham (1957), Summerfield (1972), Fussell (1965 & 1972), Thick (2010). By replicating nature, authors artificially induced these states in seeds, and observed their performance. In constructing their model, the seed required a botanical robustness that was sustainable in artificial environments.

Chapter 8 is concerned with the soil and the influence of Aristotle's elemental theory and Galen's humoral theory on seed performance. Kirby (2013), Jones (2012), Debus (1974 & 2004), Thick (1998 & 2010). Particular emphasis is given to the works of Hugh Plat and Gervase Markham, early authors who collated classical and continental examples, and wrote in detail on topics including soil fertility and manure, seed nourishment and seed selection.

Chapter 9 considers the fertility of plants as example seeds were sought and reported upon from Europe and from indigenous environments in England. As the population increased, the demand for high yielding crops intensified. One means of increasing yield was by putting more land under cultivation, and this was a key objective of the improvers in their bid to improve the fertility of 'rank' and 'fenny' land, Thirsk (2006), Evans (1980). Less prominent in the texts, but nevertheless of significant, were botanical investigations into whether the seed could be constructed as a high yielding model.

Chapter 10 moves onto the final stage of the construction of the model seed. Sowing seeds is covered in agricultural history, Fussell (1972), Thirsk (1990). This chapter expands on their research by considering the specific requirements of the model seed as presented in the literary landscapes, and takes into consideration the trials and investigations undertaken in the specialist environments. Finally, the botanical knowledge gained from horticulture is transferred into technological innovations of drilling and planting machines in the agricultural landscape.

Part III
Trading Nature

Chapter 11 addresses commercial ventures, particular, nurseries. Researchers in this particular area are notably Harvey (1974), Webber (1968) and Thick (1990). As knowledge of the seed grew, so nature was traded in ever expanding commercial enterprises. But someone needed to carry this knowledge, and so the generalist became the man networked with the nursery – the nurseryman.

Research subjects

Brief biographies of authors used in this research.

Husbandry 1520s-1580s

John Fitzherbert (1464-1531) who farmed in Derbyshire on 'cley grounde' published Boke of Husbandry in 1523. This minutely practical work on farming was written by a man familiar with the Peak of Derbyshire, and became, and for more than half a century remained, a standard work on English farming. According to Fitzherbert, any man of property should have knowledge of husbandry at the very least to ensure that his steward and servants were acting correctly.

Charles Estienne (1504-1564) During the 1530s and 1540s Estienne produced a series of small books intended to teach the terminology of classical (Latin) agriculture to the young. In 1554, he put them in a single volume, which he published under the title, *Prædium Rusticum*. There is some contention as to whether *Maison Rustique* was a translation of *Prædium Rusticum* or, whether it was a re-write Estienne undertook in collaboration with his son-in-law Jean Liebault (1535-1506). In any event *L'agriculture et maison rustique* was published in 1554 following the death of Estienne. An immensely popular publication, it was translated into Dutch *De landtwinninge end hoeve* (1566) and into English by **Charles Surflet** in 1606. Following Surflet's death **Gervase Markham** revised and enlarged the 1616 edition.

Thomas Tusser (1524-1580) wrote *One Hundred Good Pointes of Good Husbandrie* (1557) later expanded into *Five Hundred Pointes of Good Husbandrie*, *united to as many Good Pointes of Huswifery* (1573). Tusser farmed in Essex, Suffolk and Norfolk and became a champion of enclosures. His work was repeatedly reprinted and quoted by subsequent writers including Walter Blith in his *English Improver Improved* (1649) and by Worlidge in the *Systems Agriculturae* (1668-9).

Conrad Heresbach (1496-1576) *The Foure books of husbandrie* originally appeared on the English market in 1586. Heresbach was a Rhenish reformer and educator with an impressive library of over 2,000 books. He wrote his own works and edited texts of classical antique authors. Written in Latin *The Foure books of husbandrie* was translated into English by the poet **Barnabe Googe** (1540-1594) and later edited by **Gervase Markham** for the 1630 edition.

Horticulturalists/Botanists 1550s-1650s

Thomas Hill (1528-1574) [pseud. Didymus Mountaine] was an astrologer, author and translator. His first book entitled *A most briefe and pleasante treatise, teachying how to dresse, sowe and set a garden,* was published around 1558. His second book *The Profitable Arte of Gardening* published around 1560 and dedicated to Sir William Cecil ran into nine editions but Hill died before his third title *The Gardeners Labyrinth* was published in 1577.

John Gerard (also known as John Gerarde, 1545-1611 or 1612) began to supervise Lord Burghley, William Cecil's garden in London and it was to Cecil he dedicated his *Herbal* (1597).

Sir Hugh Plat was baptized in 1552 and died in 1608 most probably in his late fifties. Son of a brewer and property owner in London with a family seat in Hertfordshire, Plat was raised a well-educated, well-read, wealthy gentleman. He produced a number of treatises four of which provide material for this research *The Jewel House of Art and Nature* (1594); *Sundre New and Artificial Remedies against Famine* (1596); *The* *new and admirable Arte of setting Corne*, (1600) and *Floraes paradise* (1608) published again as *The Garden of Eden* (1654).

Francis Bacon (1561-1626) was Lord Chancellor to Queen Elizabeth, a politician and philosopher. He was an erudite author and two of his prominent works *New Atlantis* (1627) and *Sylva Sylvarum* (1626) are the main sources for this research. *New Atlantis* was an unfinished work with various editions published posthumously, as was the completed work *Sylva Sylvarum*.

William Lawson (1553/4-1635) was a writer on gardening and a Church of England clergyman. His only book, *A new orchard and garden, or, The best way for planting, grafting, and to make any ground good for a rich orchard; particularly in the north parts of England*, was published in 1618. It was the first published work on gardening in the north of England, and its second section, *The Countrie Housewifes Garden*, was the first horticultural work written specifically for women. Markham collated much of Lawson's work into a treatise entitled *A Way to Get Wealth*.

John Parkinson (1567-1650) produced two major works, *Paradisi in sole paradisus terrestris* (1629) and *Theatrum Botanicum (The Botanical Theatre or Theatre of Plants)* (1640). He was apothecary to James I and botanographus and royal gardener to Charles 1.

John Goodyer (1592-1664) was born in Hampshire and employed as an agent or steward for the Bilson household. He travelled extensively on business, which afforded him opportunities to botanize. Miscellaneous papers show he was occupied with the business of estate management, as well as notes concerning the gardens he had visited. Starting on scrappy bits of paper in around 1616 the notes gradually became more methodical and descriptive, and by 1618 his interest in field botany was evident.

Thomas Johnson (1600-1644) was born in Selby in Yorkshire, probably between 1595 and 1600 of unknown parentage. In 1620 he trained as an apothecary and in 1628 he took his freedom in the Society of Apothecaries. Johnson published two small, but not insignificant, floras *Mercurii botanici pars altera* (1634) and *Iter Plantarum* (1629). Following Gerard's death Johnson was commissioned by John Norton to undertake corrections and amendment Gerard's *Herbal*. Johnson was careful to ensure his corrections were marked with a dagger † and additions with a double dagger ‡.

Gervase Markam (1568-1637) was an energetic author and modernizer of the works of others. He updated and enlarged Heresbach and Estienne to make it more applicable to an English audience and the English climate. Wishing readers to recognize his own contribution, Markham marked his additions beginning with a (hand) and ending with *. From his many books on gentlemanly pursuits his *The English Hvsbandman* (1613) and *The English Huswife* (1623) are the main sources for this research. Born into the landed gentry his father was a member of parliament with property in Nottinghamshire. Following a period as a soldier, it appears he married in around 1601 and moved to the country where he worked as a tenant farmer on the estate of relatives in Huntingdonshire. *The English Hvsbandman* was an important contribution to a growing interest in soil management and the role of the husbandman as custodians in maintaining the health and fertility of the soil.

Improvers 1620s-1680s

Samuel Hartlib (1600-1662) was born at Elbing, the Baltic town then part of western Poland moving to Cambridge (1625-6) to study. After a brief spell back in Elbing he finally settled in London in 1628. Hartlib is best known as an educational reformer, and author of almost 65 publications, many of them pamphlets. Sources for this research include Samuel Hartlib, *His Legacy* first published in 1651 with subsequent editions and the numerous letters and papers held at Sheffield University.

Walter Blith (1605-1654)

Blith wrote two books on husbandry. *The English Improver, or, A New Survey of Husbandry* (1649) with a further edition in the same year. A 'much augmented' third edition *The English Improver Improved, or, The Survey of Husbandry Surveyed* was published in 1652 with a further edition in 1653. Blith was a member of the Hartlib circle and enthusiastically engaged in land improvement. He concerned himself particularly with drainage of the fen, and was a supporter of land enclosure.

Ralph Austen (1612-1676) was born into a yeomans family in Leek in 1612 and had no university education, or official status. He was a radical Puritan and nurseryman who lived most of his life in Oxford, where he worked for the parliamentary Visitors at the University, which gave him access to the Bodleian library. Austen's own book *The Spirituall Use of an Orchard; or Garden of Frvit-Trees* (1653/1657/1665) attempts to carve out a place for its author amidst the developing interest and experimentation in fruit and timber growing and horticulture. Critical of many of Francis Bacon's experiments, Austen published *Observations upon some part of Sr Francis Bacon's Naturall history as it concernes fruit-trees, fruits, and flowers* in 1658. Austen propagated some seventyfive varieties of fruit-bearing trees, bushes and vines, and he sowed thousands of timber trees and was closely associated with and a correspondent of Hartlib. He apparently built up a small nursery in the 1650s, and was an enthusiastic follower of Hartlib, and it was to Hartlib he dedicated a *Treatise of Fruit-trees* published in 1653.

Cressy Dymock, (*fl.* 1629–1660) a collaborator in the Hartlib circle. Inventor and Nottinghamshire farmer, he reported on farming arrangements in newly drained Axholme fen. He shared Hartlib's concern for improvement of agriculture, and was one of the proponents of a College of good husbandry, as well as of new techniques of sowing and manuring.

Gabriel Plattes (1638-1640) was an advocate for the creation of a College for Inventions in Husbandrie. Both Plattes and Hartlib argued that once land and labour were sensibly managed, England contained sufficient wealth and resources to provide amply for its people.

John Worlidge or John Woolridge (1640–1700) was a writer on agriculture from Hampshire. Contributor to the Hartlib circle, supported the improvers in the benefits of cultivating vegetables and fruit as profit for the gentry and to improve the diet of the poor. *Systema agriculturae,* or *The Mystery of Husbandry* went through five editions.

Moses Cook was baptized in 1665 and died in 1715. He remains almost unknown with archival evidence placing him as a man of some means leasing land in the area of Little Hadham. He was employed as head gardener at Cassiobury the estate of Arthur Capell, 1st Early of Essex (1631-1683). In 1676 Cook published *The Manner of Raising, Ordering and Improving Forest and Fruit-Trees* with a second edition in 1679. Cook's book is particularly important, for in the narrative of rural landscapes and estate management, the voices of head gardeners and gardeners are missing. Cook was a founder member of the Brompton Park Nursery (1681).

Robert Sharrock (bap.1630-1684) published *The History of the Propagation and Improvement of Vegetables* in 1660 with later editions in 1666 and 1672. His library passed to his son who doubtless added to it, but at its sale on 11th February 1711 the Bibliotheca Sharrockian consisted of more than 2000 volumes in several languages, encompassing divinity, history, natural sciences, medicine and law.

Samuel Gilbert (died.1692) called himself Phileremus on the title page of his treatise *Florist's vademecum and Gardener's Almanack* published in 1683. (Subsequent editions in 1690, 1693, 1702, and 1713). Gilbert was an English cleric who seems to have lived with his father-in-law the gardener John Rae in Kinlet near Bwedle. When Rae died in 1681 Gilbert took over his extensive plant collection, which he continued to expand. The significance of Gilbert's book lies in the period it was produced representing as it does a crossover between collecting and commerce. Gilbert was a plant breeder consciously using selection as a means to produce new and diverse varieties.

Botanist

Nehemiah Grew (bap.1641-1712) was a doctor by occupation and his knowledge of plants would initially have been founded on their medicinal use. Grew's investigations were meticulously recorded and presented as a series of lectures to the Royal Society. The lectures were eventually gathered together and published in *The Anatomy of Plants with an Idea of a Philosophical History of Plants* in 1682. This was a particularly important change in the way information was produced and presented, a new kind of systematic study, where the illustrations in particular were presented as a form of scientific proof. Grew was a regular contributor to the Royal Society and his botanical work is well known. In 1674 he read his paper *Concerning the Nature, Causes, and Power of Mixture* to the Royal Society.

PART 1

Constructing Nature

Chapter 1

Networking

One of the most complex attributes of seeds is that they can travel all over the world. Humans, animals, insects and birds, air, water, earth and even fire, all play their part in transporting these cleverly adapted entities. Plant seeds have received considerable attention from geneticists and biologists, but surprisingly little attention from historians. More recently, historical research has focused on the movement of seeds in agricultural and horticultural practices. Mauro Ambrosoli traces changes in agricultural practice in Europe between 1350 and 1850 through fodder crops.[4] Joan Thirsk's work on agricultural yields,[5] and Malcolm Thick's research into seeds,[6] all contribute to a developing historiography of the interaction between humans and seeds, an interaction hidden in the grander narratives of natural history. Selecting a starting point for unravelling and metaphorically 'digging deep' into this relationship is perhaps best served by presenting an overview of the historiography of natural history and how this was facilitated by the activities of networks.

The concept of networking is not commonly used in the early modern historiography of science and ideas. More generally, communication and exchange mechanisms have been discussed through the Republic of Letters or the 'commonwealth of learning'. Described as 'forging communities, establishing literacies, while engaging in hands-on practices,' Harkness presents an overarching description of the Republic

[4] Mauro Ambrosoli, *The Wild and the Sown* (Past & Present Publications: Cambridge University Press, 1997)
[5] Joan Thirsk, *Agrarian History of England* (Cambridge University Press 1990)
[6] Malcolm Thick, "Garden Seeds in England before the late eighteenth-century 1: Seed Growing" in *Agricultural History Review* 38.1 (1990). "Garden Seeds in England before the late eighteenth-century: 11 – The trade in seeds to 1760" *Agricultural History Review* 38.2 (1990)

of Letters as an autonomous community.[7] Daston describes the eighteenth century Republic of Letters as a long term 'moral history of objectivity',[8] while Goldgar argues that a moral economy functioned to regulate processes of inclusion and exclusion,[9] further described by Jaumann as 'those who violate the norms are excluded from communication.'[10]

Thus a more realistic version of the republic might include conflicts, rivalries, disputes and acts of plagiarism.

An alternative method of understanding aspects of these complex and disparate groupings is to view them with an anthropological approach using theories of networking. Networking was a key component in developing and expanding scientific knowledge in the early modern period across Europe and beyond. Circumventing wars and fragile political relations, groupings revolved around a diverse range of institutional structures, informal relationships and people, including scholarly institutions, elite collectors and courtiers, plant hunters, wealthy merchants, émigrés and, increasingly in the seventeenth-century the 'middling' sort. They met, worked and conversed in botanical gardens, gardens of the elite, alchemical laboratories, museums, and libraries. They botanized in the fields and surrounds of cities and towns and they met in the streets and gardens in towns and villages. Wherever they met, conversed, and exchanged artefacts and knowledge they were creating, in Latourian terms, centres of

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[7] Deborah Harkness, *The Jewel House: Elizabethan London and the Scientific Revolution* (Yale University Press 2007), 11-18

[8] Lorraine Daston, "The Factual Sensibility" in *Isis*, Vol.79, No.3, A Special Issue on Artifact and Experiment (1988), 452-467

[9] Anne Goldgar, *Impolite Learning: conduct and Community in the Republic of Letters 1680-1750* (Yale University Press, 1995)

[10] Herbert Jaumann cited by Marian Füssel, "On the Means of Becoming Famous in the Learned World" in Holenstein, Steinke & Stuber (eds) *Scholars in Action* (2013), 127. See also Dena Goodman, *The Republic of Letters: A Cultural History of the French Enlightenment* (Cornell University Press, 1994). Peter Burke, "The Republic of Letters as a Communication System, An essay in periodization" in *Media History,* Vol. 18, Nos. 3-4, (2012)

calculations. These were places where science and technology was 'in the making' as opposed to 'ready made science and technology'.[11] For Latour, there is no separation between nature and culture or people and objects. The idea that humans consciously act on artefacts precludes the role of other actants in the process. For example, medieval artefacts, according to Daston and Park, instilled wonder into the onlooker and wonder stimulated the quest for knowledge. Wonder was not simply a 'private emotional experience, but rather, depending on context, a prelude to divine contemplation, a shaming admission of ignorance, a cowardly flight of fear into the unknown, or a plunge into energetic investigation.'[12] Intricate artisanship, paradoxical beauty and often the horror of nature fused with fear all played a part in mixing or making cultural messages. This is no more apparent than in the phenomenon of tulip mania in early seventeenth-century Holland where the networking of a small group of enthusiasts with the tulip bulb activated a financial hiatus. [13]

Putting it into the early modern botanical framework, we might want to ask to what extent have humans manipulated plants and to what extent have plants influenced the process of manipulation? Was the sixteenth-century preoccupation with plant classification a result of a continuous influx of new and exotic species? In other words was it the interaction of *plants* with *humans* that pushed the boundaries of investigation because new varieties constantly interfered with a human perception of order? Certainly Cook argues the sheer volume of collecting encouraged a move towards objectivity in the assessing and categorizing of objects. [14] Contradictions of observation and experience contributed, according to

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[11] Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society* (Harvard University Press, 1987), 4

[12] Lorraine Daston and Katherine Park, *Wonders and the Order of Nature* (Zone Books, 1998), 14

[13] Anne Goldgar, *Tulipmania, Money, Honor, and Knowledge in the Dutch Golden Age*. (The University of Chicago Press, 2007)

[14] Harold J. Cook, *Matters of Exchange, Commerce, Medicine, and Science in the Dutch Golden Age* (Yale University Press, 2007)

Ogilvie, to natural historians and medical humanists developing new ways of observing, describing and cataloguing.[15] At a micro level, how people interacted in their world was 'not a solid continent of facts sprinkled by a few lakes of uncertainties, but a vast ocean of uncertainties speckled by a few islands of calibrated and stabilized forms.'[16] This 'ocean of uncertainties' was a constant reminder of the vastness of nature, and one of the ways early modern humanists responded to this challenge was by collecting natural history. Collections were a means of establishing a sense of certainty as an artefact could be viewed, held, even smelt and tasted.

> '[T]hat I have seen with my own eyes, touched with my hands, dissected, and likewise conserved one by one in my little world of nature. They are preserved in image and in example in our museum for the utility of scholars', stated Ulisse Aldrovandi (1522-1605).[17]

Early modern networks were created by a complex web of relations between humans and artefacts, both of which acted upon and influenced each other within a range of contexts. Renaissance letters and manuscripts that might have linked individuals to an artefact are, by nature, ephemeral and degradable.[18] That we know about these collections and networks is due to what Eisenstein describes as a print revolution, a period when the printed word not only linked authors to a readership, but also to each other. By following some of the participants we can begin to determine not only who might have been involved, but also how texts, artefacts and humans all played equally important roles

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[15] Brian Ogilvie, *The Science of Describing* (University of Chicago Press, 2006)

[16] Bruno Latour, *Reassembling the Social, An Introduction to Actor-Network-Theory.* (Oxford University Press, 2005), 245

[17] Cited in Arthur MacGregor, *Curiosity and Enlightenment Collectors and Collections from the Sixteenth to the Nineteenth Century* (Yale University Press, 2008), 19

[18] An example of a botanical network formed between two men in the 1720s is found in Andrea Wulf, *The Brother Gardeners* (William Heinemann, 2008). Wulf utilizes correspondence to trace the exchange of seeds and plants between Quaker Peter Collinson in London and John Bartram, plant hunter in America so we can understand how the network was structured, and how it worked, and where the controversies lay.

in the construction of networks. By studying the activities and the institutions that were built up around these networks we gain insight into the interplay between landscapes, technologies, knowledge, texts, money and people. Much of the historiography has focused on European countries like Italy, Germany and France where, it is claimed, some of the most important botanical developments happened during the fifteenth and sixteenth centuries.[19] However, many of the activities identified in Europe were also happening in England.

Writing nature

Although the roots of natural history can be traced to the classics and the *Natural History* of Pliny the Elder, the study of natural history was not clearly defined and was subordinate to natural philosophy and medicine. In the sixteenth-century, however, naturalists began to think of themselves as distinct from natural philosophers and engaged in studying the world as they observed it, rather than as it was presented in philosophical and encyclopedic literature. Francis Bacon, defined natural history as a distinct discipline in his *Advancement of Learning* published in 1605 and his *Sylva Sylvarum* was an ambitious attempt to record a natural history of England. While Bacon's interest in natural history might have been etched with his desire to 'discard these fickle and wrong-headed philosophies', his primary task was to marshal empirical knowledge through co-operative work leading to an intellectual regeneration, 'a return of man's dominion over nature which had been sacrificed at the Fall.'[20] Jalobeanu argues that natural history in the time of Bacon was richer than previously considered by historians. Rather than one overarching natural history, the landscape was made of many

[19] In particular, the works of Alix Cooper, *Inventing the Indigenous* (Cambridge University Press 2007). Brian Ogilvie, *The Science of Describing: Natural History in Renaissance Europe* (University of Chicago Press, 2006). Ambrosoli, *The Wild and the Sown.* Paula Findlen, *Possessing Nature, Museums, Collecting, and Scientific Culture in Early Modern Italy* (University of California Press 1994). Daston and Park, *Wonders and the Order of Nature* (Zone Books 1998)

[20] Charles Webster (ed), *Samuel Hartlib and the Advancement of Learning* (Cambridge University Press 1970), 3

natural histories. Rather than Bacon relying on Pliny and others it was Senecan natural history that most influenced him.[21] On the other hand, Findlen identifies three different meanings originating from works of Aristotle, Pliny and Dioscorides. She argues natural history was an encyclopaedic science, in which broad sectors of society participated but not as a unified group.[22]

Natural history as a discipline in its own right grew slowly out of medical training, an essential ingredient of which was field research designed to 'deepen students understanding of the healing powers of medicinal plants.'[23] The works of early naturalists and botanists set the tone for future investigative procedures. Brunfels (1488-1534), Bock (1489-1554) and Fuchs (1501-1566) are important examples because they represented the start of a study of nature based on personal observation. They also attempted to describe and illustrate local flora. The methodology of personal observation, describing and illustrating was transmitted through their work and reflected in later herbals and natural histories. German botanist Hieronymus Bock (1498-1554) clearly based his illustrations and text on personal observation. In *New Kreuter Buch* he was the first botanist to recognize the need for botanical classification and did so by placing plants that resembled each other into categories. Bock was one of the first botanists to record his findings phytographically in that he sometimes included plant taxonomy.[24] Instead of solely relying on historical descriptions, he went out and observed nature to write his own descriptions and in the process he

[21] Dana Jalobeanu, "Francis Bacon Natural History and the Senecan Natural Histories of Early Modern Europe" in *Early Science and Medicine* 17 (2012), 197-229. A case study focused on Juan Luis Vives (1493–1540) demonstrates the empirical study of nature should be based on a 'close observation' of natural phenomena and the testimonies of 'gardeners, husbandmen, shepherds and hunters'. Such a study is seen as provision, collaborative, introductory and subject to further improvement a preparative phase according to Jalobeanu for a more scientific study of nature.
[22] Paula Findlen "Natural History" in Park & Daston (eds), *The Cambridge History of Science,* (Vol.3 Early Modern Science, Cambridge University Press 2006), 435-437
[23] Ogilvie *The Science of Describing,* 38
[24] Taxonomy the science that finds, describes, classifies, and names living things.

noted localities, habitats, property of soil and flowering seasons of the plants. These key works from four German botanists set the scene for later studies in natural history and Bock's work, in particular, was a forerunner of the local flora.[25]

There was richness in the diversity of what was perceived as 'natural history' in the Elizabethan period and the early 1600s. Publications on the topic of natural history began to appear in England from around the 1520s. One of the first treatises penned by Laurence Andrew (1510-1537) entitled *The noble lyfe a[nd] natures of man of bestes, serpentys, fowles a[nd] fisshes [that] be moste knoweu [sic]* was published in 1527. Widening the range beyond herbals, treatises address topics including zoology, astrology, and the human body. William Turner (?1508-1568), fellow of Pembroke College Cambridge, produced lists of English plants and animals which he published as *Libellus de re herbaria* in 1538. Turner also produced the first printed treatise devoted to birds he personally observed on his ornithological trips. *Avium praecipuarum, quarum apud Plinium et Aristotelem mentio est, brevis & succincta historia* was published in 1544. Alexander Ross (1591-1654) published *Arcana microcosmi, or, The hid secrets of man's body discovered* in 1652. One of the earliest books claiming to be a natural history was John Maplet's (d. 1592) *A greene forest, or A naturall historie* published in 1567. Basing his categorization of the earth's resources on classical texts, Maplet focused on the qualities of 'Earthes', soil types, stones including gems and 'Mettales', relating them to the elemental theories of

[25] Bock's *New Kreuter Buch* was first published in 1539 in German and did not include illustrations because Bock could not afford them. Following editions beginning in 1546 included illustrations. The herbal was widely known after its publication in Latin in 1552. His intricate descriptive records in the herbal led to its popularity: at least twelve more editions were printed. It used some woodcut blocks from Fuchs' *Herbarum Vivae Eicones*. John Goodyer had copies of Clusius, Bauhin, Dodoens, Caseplinus, Fuchs, Brunfels and Bock among many others in his library. For full catalogue details see R.T. Gunter, *British Botanists and their Gardens,* (Oxford 1922), 197-232. See also Ernst Mayr, *The Growth of Biological Thought* (The Belknap Press of Harvard University 1982), 147-209

Aristotle. In 1593 the prolific author and plagiarist Gervase Markham wrote his *A Discourse of Horsemanship* followed by other popular treatises on horsemanship and the farrier. In the early 1600s titles still offered a catchall medley of the organic and inorganic. In 1630 John Payne (d.1647?) published a book of illustrations entitled *A booke of beast [sic], birds, flowers, fruits, flies, and wormes, exactly drawne with their liuely colours truly described.* This collection of animals, insects and plants seemed to be an attempt to collate a world index and demonstrates the influence of the Americas. In 1665 he published *Flowers, fruicts, beastes, birds and flies exactly drawne* again drawing on non-native species.

Some of these works will have drawn on other treatises others drew their inspiration from collections. What is difficult to trace through historical accounts are the individuals or specific artefacts that formed part of the networking process. There is however, some evidence within the publications in England that exchanges were being made of plants and seeds both within England and across the continent. At best we can trace some of the communities that were historically intellectually important, and identify activities in which they were involved. Those who were part, even if only on the fringes of natural history networks, were largely involved in collecting a wide range of curios and artefacts found in the natural world, as well as art and literature. Eclectic assortments of artefacts were either publicly displayed or privately consumed in libraries and cabinets of curiosity. Renaissance collectors revitalized Aristotelian natural philosophy, and Plinian natural history, and returned to the text of Theophrastus and Dioscorides. The revival of classical text was enhanced by collections of ancient coins, sculptures and objects from antiquity, combining text and artefacts in what is described by Impey as 'the essential tools for fundamental research'.[26]

[26] Oliver Impey and Arthur MacGregor (eds) *The Origins of Museums The Cabinet of Curiosities in sixteeth and seventeenth-century Europe.* (House of Stratus 2001)

Collections of artefacts and text, and a rekindling of classical natural history, was further enhanced by witnesses of natural phenomena, 'gardeners, husbandmen, shepherds and hunters' and, as discussed below, the importance of vernacular or 'vulgar' knowledge, described by Thick as 'useful' knowledge, was identified and recorded by Hugh Plat.[27] Natural histories were formed through the collaboration of many people, but not necessarily as a unified group. As with Foucault's power/knowledge discourse, Findlen accords collaborations and collections with 'a precise mechanism for transforming knowledge into power.'[28] Naturalists searching for ways to come to terms with uncertainty and the unstable field of knowledge used literature, cabinets of curiosity, museums, botanical gardens, and the fields and landscapes beyond, as 'paradigmatic space(s) in which to philosophize.'[29]

The Catholic regions, especially in Italy, witnessed a Platonic revival in the study of natural philosophy with Renaissance natural history, energized by sixteenth-century scholarly communities, centred in botanical gardens in Padua, Padova and Bologna. The first physic garden was founded at the University of Pisa in 1543, and botanic gardens opened in Cologne and Prague in the sixteenth-century, with the first botanical garden in England at the University of Oxford 1621. Early museums were formed around collections, as artefacts from the New World, Africa, South-East Asia and the Far East revolutionized the way people visualized and responded to the world. Many of these high level and expensive collections belonged to royalty or the elite, but at a more conservative level, and perhaps as a response to the value of exotic and curious objects and artefacts, collectors began to take an interest in

[27] Malcolm Thick, *Sir Hugh Plat. The Search for Useful Knowledge in Early Modern London* (Prospect Books 2010)
[28] Findlen, *Possessing Nature*, 23.
[29] Findlen, *Possessing Nature,* 57. See also Richard Drayton, *Nature's Government* (Yale University Press 2000)

indigenous artefacts in their own surroundings.[30] Articles of peasant culture found their way into collections including tools and costumes. These collecting enterprises led to what Arnold describes as museum-science where 'a disparate group of researchers and more humble 'curioso' collectively fashioned a methodology, in which factual information could be extracted from discrete bits of the material world' transforming 'the relationship between the realms of knowledge and the physical world.'[31]

Most curiosities in private collections were housed in cabinets of curiosity, and reflected the collecting ambitions of their owners. Increasingly collections were classified and organized accordingly, while others were more narrowly focused to a particular field of interest. In many respects botanical gardens similarly displayed collections of plants. As centres of study and intellectual pursuit they were principally designed for the training of medical students. As a result many apothecaries had their own private collections of medicinal plants. John Prest theologically described botanical gardens as a recreation of an earthly Paradise or Garden of Eden. He claims that both Catholics and Protestants held that the first home of mankind lay in the Garden created and planted by God, 'where the climate was always mild and the trees flowered and bore fruit continuously'.[32] Herein the recovery of ancient knowledge and wisdom could be garnered by bringing animals and plants together. In somewhat of a contradiction, Prest then goes on to argue the first and foremost purpose of botanical gardens was for the apothecary. Collections of plants from around the world were planted in quadrants representing the four continents, Africa, Asia, Americas and Europe. Botanical and physic gardens became 'a depot for the collecting

[30] Oliver Impey and Arthur MacGregor (eds) *The Origins of Museums The Cabinet of Curiosities in sixteeth and seventeenth-century Europe.*
[31] Ken Arnold, *Cabinets for the Curious - Looking Back at Early Museums* (Ashgate 2005), 1-12
[32]John Prest, *The Garden of Eden, The Botanic Garden and the Recreation of Paradise* (Yale University Press 1988), 1-10

and storage and distribution of new plants.' [33] A place where men met, conversed, debated and exchanged knowledge, plants and seeds. It was a centre of learning a 'living catalogue of plants.'

Botanical gardens arrived later in England where most plant collections were privately owned. New chemical drugs and exotic herbs required locations, and as collections grew in private gardens the sites became a source for botanical research, in similar fashion to the botanical and physic gardens of the universities in sixteenth-century Europe. Plant collections contained a vast array of specimens, some of them popular and known, while others were newly acquired. Cataloguing private collections became as important as the cataloguing of indigenous plants on botanizing trips. It was not unusual to request a contemporary to attest accuracy of the plants recorded, as Gerard requested l'Obel to confirm his published 1596 *Catalogus arborum, fruticum ac plantarum tum indigenarum, quam exoticarum in horto Johannis Gerardi*. [34] Catalogues, and particularly published catalogues, contributed to the formal registration or recording of collections and as noted by MacGregor, the 'standing of the collector himself [and] the collectors achievements…enhanced social status.' [35] Gunter identifies fourteen catalogues of garden plants from the mid sixteenth-century into the mid seventeenth-century with additional catalogues of seeds and exotic plants.[36] But they were not just lists of plants, in some examples, the

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[33] Andrew Cunningham, "The Culture of Gardens" in *Cultures of Natural History,* N. Jardine, J.A. Secord and E.C. Spary (eds) (Cambridge University Press 1996), 51

[34] Robert T Gunter, *Early British Botanists and their Gardens* (Oxford University Press 1922). John Goodyer was associated with cataloguing the plants in the gardens of Parkinson, Coys and Franqueville. Other early garden lists include the Holborn garden of Gerard (1596), of George Gibbes garden in Bath (1634) and the Lambeth garden of Tradescant the Elder (1634). Other gardens were noted as sites of special interest and collections including the gardens of William Coys botanist and horticulturalist, James Cole (son-in-law of l'Obel), and Lord Zouche's physic garden. See also Anna Pavord, *The Naming of Names, The Search for Order in the World of Plants.* (Bloomsbury Publishing (2005), 328. Zouche's Hackney garden was an important meeting place for botanists.

[35] Arthur MacGregor, *Curiosity and Enlightment Collectors and Collections from the Sixteenth to the Nineteenth Century* (Yale University Press 2008), 60

[36] Gunter, *Early British Botanists,* 303-372

place of purchase and supplier are noted, a clear indication of the connections within England and across Europe. 'The plants were purchased in France and Holland. Cornellis Helin lived at Haarlem. 'Master Robyns' a famous botanist of Paris and first curator of the 'Jardin des Plantes.'[37] Although less prominent in the notes, but of equal importance, was the recording of plants and seeds that had been collected from the 'wilde'. The comprehensive catalogue of the garden of living plants attached to the Tradescant house and museum gives names in English rather than Latin, 'that nothing may be wanting which at present comes within views and might bee expected.'[38] Tradescant opened his museum and garden to the public for a small fee, so this important departure from the Latin made his venture more accessible for popular consumption, and moved it out of the realm of botanical specialism.

The history of collections of exotics and plants from around the world is well established.[39] Collecting plants and seeds from the wild is however less well researched. The tensions between the information contained in classical text, and a contemporary understanding of the countryside and local environs is played out in botanical investigations most particularly botanizing. The arrival of exotic plants and herbs led to comparisons between 'indigenous' species and 'foreign' plants. The Paracelsian declaration that local medicinal plants should be used for local illnesses was not universally received, and there were probably compounding reasons that drove botanists into the countryside. Eisenstein argues the idea of observing natural phenomena came directly from Aristotle, and that journeys into the countryside were as much a response to an over-reliance on hand-copied books for the excellent reason that they

[37] Gunter, *Early British Botanists,* 329. Notes from Goodyer.
[38] Quoted in A. MacGregor, "A Magazin of All Manner of Inventions" in *Journal of the History of Collections*, Vol.1 No.2 (1989): 60
[39] Anna Pavord, *The Tulip,* (Bloomsbury 1999). See also Andrea Wulf, *The Brother Gardeners* and Richard Drayton, *Nature's Government.*

degenerated over time.[40] As indigenous artefacts made their way into museums, a similar pattern was happening with an increasing interest in the collection of indigenous plants and seeds.

Botanizing became a crucial element in medical training in the universities of Italy, and less formally among apothecaries and botanists in England. Humble plants, so often the terrain of women root collectors and 'folk' herbalists, took on a new meaning, purpose and value. Whereas field trips in the early scholarly communities were ostensibly to survey local flora for medical purposes, they increasingly became a method used for taking an inventory of the natural world. In order to record at some speed, and to aid their memory, and ensure as accurate a survey as possible, a pocket notebook became a practical aid in investigative field studies.[41] A range of natural objects, shells, minerals, fossils, were also noted alongside plants, but there was a significant major difference from the lists of plants so often associated with herbals. By the 1600s it was not uncommon for botanizers to subscribe an emotional experience to specific sites, and to fix the landscape in the memory by describing the journey, the weather, the people, food and lodging. An early example of this combination of botanical exploration with a travel journal is found in England. In 1629 a group of young men, described by their leader Thomas Johnson as 'Ten Fellows of the Society', set off on a trip to Kent for the express purpose of 'discovering plants', and for the 'sake of finding plants' in their 'natural habitats'. [42]

Thomas Johnson's youthful, vivid and lively chronicle of this journey of discovery was both a travelogue, and an itinerary of plants. Written in Latin it was not intended for publication, but 'privately printed for the

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[40] Elizabeth L. Eisenstein, *The Printing Revolution in Early Modern Europe.* (University of Cambridge 2005), 209-285
[41] Cooper, *Inventing the Indigenous*, 58
[42] Thomas Johnson, "Iter Plantarvm Investigationis" (1629) in J.S.L. Gilmour (ed), *Thomas Johnson Botanical Journeys in Kent & Hampstead.* Facs.29

sake of a few readers'.[43] Despite many difficulties on the trip, for travel was by no means easy, Johnson's enthusiasm for plant hunting is evident, and the publications he produced as a result of this and other botanizing trips, are regarded as important contributions to the establishment of a British Flora.[44] Johnson undertook a trip for the 'sake of finding plants' in their 'natural habitats' in Kent in the August of 1632, followed by trips to Hampstead Heath. His botanizing trips took him as far as Wales, when in 1639 he travelled with some companions to record and catalogue plants subsequently publishing the findings in *Mercurii botanici pars altera* in 1641. This was Johnson's last publication, for in November 1643 he joined the King's forces and having sustained a shot in the shoulder died in 1644. Why Johnson selected the areas he did for his botany trips is not known, but he may have been following in the footsteps of l'Obel and Gerard, both of whom botanized in Kent and l'Obel also in Hampstead.

Johnson's original work, *Iter Plantarum* published in 1629 received, by his own admission, mixed reviews with his emphasis on fieldwork drawing the most criticism. 'For some folk not only ridiculed our labour as vain and superfluous but derided all more precise knowledge of plants as useless, supposing that it is enough to know them merely by name and from reading.'[45] Johnson was cataloguing plants growing in wild and humble environments. This was the terrain of 'women who deal in roots', and his status as an apothecary and authority was clearly being challenged. What his catalogues do indicate, however, is that he was not only actively seeking 'simples' he was producing some early natural histories of specific sites.

[43] Thomas Johnson, "Descriptio Itineris Plantarvm" in J.S.L. Gilmour (ed), *Thomas Johnson Botanical Journeys in Kent & Hampstead* (1632) Facs.73-4
[44] Precise account of texts and local flora in Cooper *Inventing the Indigenous,* 72-86
[45] Johnson, *Iter Plantarvm*, (1629) Facs.73-74

Recordings from a further trip to Kent and Hampstead in 1632 published the same year under the title *Itineris Plantarum* provide a more measured and reflective account than his *Iter,* which he described as written with a 'hurrying pen'. There are a greater number of finds in this account, and along with plants, Johnson notes an assortment of shells, starfish and sea urchins familiar in medical practice, but also, along with fossils, becoming part of the broadening scope of natural history. "Echinus marinus, Spatagus, Rond,' he wrote, 'but so delicate and fragile that it could scarcely be handled'.[46] In both publications Johnson provided an inventory of the plants in Latin with variant learned names, there are no descriptions and just two illustrations of unidentified plants on the back cover of *Itineris Plantarum.*

Johnson's group of collaborators, which included Goodyer, left evidence of a system of collecting and collating data. They recorded the specific place where specimens were found, for example, seashore, woodland, wayside or marsh, while conditions generally focused on the growing medium, for example, sandy, clay, water, or rocky. Time was recorded through meals, overnight lodgings or the tide. The weather measured by stormy interrupted journeys or heat-laden days where thirst threatened to undermine confidence. The localities along the journey include roads, lodgings, bridges, gardens, churches and even ships. Personal comfort and safety vividly, if somewhat dramatically, described. "We were equally afflicted with hunger in that inhuman wilderness where there was no town within reach, no smoke to be seen, no barking of dogs to be heard, none of the usual sights of habitation by which we could arouse our fainting spirits to any breath of hope."[47] Facts and peculiarity intertwined to shape the experience.

[46] Johnson, *Descriptio Itineris* (1632) Facs.84
[47] Johnson, *Iter Plantarvm* (1629*)* Facs.37

European networks

Along with many of his contemporaries, Tradescant travelled, an activity considered by Daston as 'the alpha and omega of collecting, being both the source of the bulk of the objects…and the occasion for inspecting them'[48] Tradescant's travels and collections are well researched,[49] and John Gerard recorded his travels to 'Denmark, Swevia, Poland, Livonia or Russia' in his *Herbal.*[50] One particular community in Elizabethan London seemed to have strong connections in Europe. Any correspondence, catalogues or indication of the artefacts that were being exchanged have been lost. The community comprised a group of natural historians, apothecaries and gardeners, predominantly European immigrants, networked intensely. However, the sporadic references in herbals and treatises, suggested to Harkness that the Lime Street community was a thriving centre of activity and intellectual pursuits in Elizabethan London.[51] It was clearly a community of naturalists of some significance, who were likely to be involved in charting, exchanging, discussing, and organising and cataloguing natural history. A key player in this group located in Lime Street was Matthias de L'Obel (1538-1616) who, along with contemporaries Daléchamps (1513-1588) Rembert Dodoens (1516-1585) and Carlus Clusius (1526-1609), produced botanical works. L'Obel, trained as a physician at Montpellier University, and became integrated into English society through marriage, and eventually gained patronage in his role as Royal Botanist to James I. L'Obel returned to Europe on many occasions, maintaining his contacts among whom was a community of *liefhebbers* (enthusiasts) in Middleburgh (the modern

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[48] Lorraine Daston, "The Factual Sensibility", *Isis* Vol.79, No.3, A Special Issue on Artifact and Experiment (1988): 145-161

[49] Mea Allan, *The Tradescants: their plants, gardens and museum, 1570-1662* (Michael Joseph Ltd 1964); Arthur MacGregor, *Tradescant's rarities: essays on the foundation of the Ashmolean Museum, 1683*. (Clarendon Press 1983); Jennifer Potter, *Strange Blooms: The Curious Lives and Adventures of John Tradescant* (Atlantic Books, New edition 2007); Jens P. Nielsen, "John Tradescant's Diary of his Voyage to Russia June-September 1618" in *Acta Borealia: A Nordic Journal of Circumpolar Societies,* Vol 22, Issue 1 (2015)

[50] John Gerard, *Herbal,* (London 1633), 1223

[51] Harkness, "Living on Lime Street" in *The Jewel House,* 15-56

capital of Zeeland) engaged in the buying and selling of tulips.[52] This small local group was part of an extensive continental intellectual community, and L'Obel's association undoubtedly cross-fertilized knowledge between the English and Dutch communities.[53] This interconnection between Europe and England was clearly important during the Elizabethan period as a means of disseminating knowledge. However, the publication of the botanical works of L'Obel, Dodoens and Clusius, cited by Gerard, Parkinson, Johnson and Hugh Plat, illustrates the importance of these men within what was likely to have been a loosely connected European intellectual community.[54]

Collecting books

According to Eamon, the move from scribal to print culture brought together 'scholars, craftsmen, merchants and humanists engaged in common pursuits.'[55] Text was as important in networking, and the elite were not only collectors of plants and curiosities, as Willes records in detail, they also collected books.[56] Yale observes that naturalists were often also antiquarians, and became concerned with the preservation of paper and manuscripts. Not simply because so much was written at the time, but because in Baconian style, this was the 'stuff of knowledge, repositories of facts and observations for future generations of naturalists.'[57]

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[52] Middleburgh was also the main staple port for the English cloth trade for a while.
[53] Goldgar, *Tulipmania*.26; Pavord *Tulip* 2000
[54] L'Obel like Daléchamps and Clusius, had been a student of the influential Guillaume Rondelet (1507-1566), Professor of Medicine at the University of Montepellier. The botanical works of L'Obel, Clusius and Dodoens were published by the same printing house, Christopher Plantin at Antwerp. For further information regarding this and other networks see Brian Ogilvie, "The World of Renaissance Natural History" in *The Science of Describing,* 25-86
[55] William Eamon, *Science & the Secrets of Nature* (Princeton University Press 1994), 94
[56] Margaret Willes, "Spreading the Word" in *The Making of the English Gardener* (Yale University Press 2011), 93-122
[57] Elizabeth Yale, "With Slips and Scraps, How Early Modern Naturalists Invented the Archive", *Book History*. Vol.12 (2009), 1-36

In his play *Gesta Grayorum* Bacon advising on the study of philosophy recommended the 'Second Councellor' create:

> 'a most perfect and general Library', 'a spacious, wonderful Garden', 'A goodly huge Cabinet', and a 'Still-house so furnished with Mills, Instruments, Furnaces and Vessels, as may be a Palace fit for a Philosopher's Stone.'[58]

In this imaginary research facility nature was to be reconstructed within a microcosm, creating an artificial world of knowledge, in which the scholar experimented with nature in order to conquest 'the Works of Nature'. Research emanating from this facility would lead to a comprehensive history of nature, so books not only served to document natural history they also served as sources of knowledge. Given the cost of publications, it is possible to speculate that treatises may well have been circulated among contemporaries, and it is certainly possible that gardeners and nurserymen attached to these estates had access to the libraries.[59] Among the elite William Cecil, Robert Dudley, Christopher Hatton and Bess of Hardwick owned extensive libraries. Many of the gardens were strongly influenced by the European model, and books in libraries reflected this, although dating purchase of books is problematic. Dudley's library, for example, was scattered, and only a few books can be identified as belonging to his family.

It was not just the elite who bought books. By the beginning the 1600s, publications became more accessible and cheaper to produce. One of the most important historical libraries to be catalogued belonged to John Goodyer. Goodyer collaborated with Thomas Johnson and John Parkinson, and had connections in 'Lyne Street' (Lime Street) where he

[58] Francis Bacon, *Gesta Grayorum* printed in 1688 from a manuscript from the 1590s.
[59] Blanche Henrey, *No Ordinary Gardener: Thomas Knowlton 1691-1781*. (Natural History Museum Publications 1986)

visited James Cole, son-in-law of L'Obel. When he died in 1664, he bequeathed his collection to Magdalene College in Oxford. Goodyer had been collecting books for many years, and the catalogue of his library provides insight into the volume, variety, and availability of books covering botany and natural history. As he acquired books, so he recorded the date of acquisition and price, with one of his first books by Flemish doctor and botanist Carlos Clusius *Curae posteriores* purchased in 1616.[60] What also makes Goodyer's library so important is not just the richness of his collection, but he also annotated and made copious marginal notes, demonstrating the value he placed on these books as sources of scientific and botanical information.

This move from natural philosophy and medicine towards a distinct discipline of natural history was gradual over time. But common among these local inventories of indigenous flora and fauna was a conspicuous absence of local people. Environments were surveyed and recorded, but local knowledge often described as '*vulgar',* was seldom collected or recorded, so Hugh Plat citizen of Elizabethan London was somewhat exceptional. Plat published *Floraes Paradise* in 1608 a treatise that was issued again in 1652 under a new and somewhat ambitious title *The garden of Eden, Or, an accurate description of all flowers and fruits now growing in England*.[61] Plat was an indefatigable communicator with contacts throughout England and he drew on their local knowledge to build his Garden of Eden. Echoing the sentiments of others, he stepped away from 'schoolmen, who had alreadie written many large and methodicall volumes' which 'have furnished our Studies and Libraries, but little or nothing altered or graced our gardens.'[62] Rather than writing

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[60] For a full catalogue of Goodyer's library see R.T. Gunter, *Early English Botanists and their Gardens,* 198-229. Goodyer's library contained 239 separate printed treatises. There are a few examples of *incunabula* or works printed in the fifteenth-century, a hundred treatises belong to the sixteenth and the rest the first half of the seventeenth-century. Goodyer also translated Dioscorides and Theophrastus into English.
[61] Further editions, 1553, 1654, 1655, 1659, 1660, 1675
[62] Hugh Plat, *The Garden of Eden* (1655), 12

an herbal or a flora, Plat chose to write a text combining flora, as well as local knowledge, provided by 'manual workers' and 'stirring workmen'.[63] It was a treatise with a difference however, for not only did it attempt to provide an inventory of known plants in England, it also set out an improvement agenda in the 'altering, multiplying, enlarging, planting, and transplanting..of fruites & flowers..'[64] Plat's treatise is perhaps the first English attempt at a countrywide horticultural survey made possible through the involvement of people with local knowledge. The extent to which his network stretched across the country is hard to gauge, as Plat's geographical references were sporadic and inconsistent, but that he valued local knowledge was evident. Recorded in extensive notes and publications Plat's connections ostensibly involved the men and women of the streets of London who worked the markets and gardens and despite Plat's concentration of male informants, he did correspond with and note the activities of women in horticulture. Instructions on the planting of Carnations, wallflowers and stock gilli-flowers were provided by 'Mistris Hill'.[65]

The Sociability of Seeds

The transmitting of botanical and horticultural knowledge in England took many forms, but the most difficult to research are the mechanisms by which knowledge was exchanged at a community level. This is the level of oral traditions and one of the most difficult arenas of knowledge to research due to the paucity of historical references. There are sporadic observations in sixteenth-century literature to community interaction where seeds and plants were exchanged between neighbours, most often women. With the exchange of seed, came the exchange of knowledge, as women growers planted and harvested their vegetable plots. An early observation from Tusser concluded:

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[63] Hugh Plat, *The Garden of Eden* (1655), 12

[64] Plat, "The Author's Epistle", *The Garden of Eden,* 11

[65] Plat, "Flowers, hearbs and Seeds", in *The Garden of Eden* (1659), 69. Ogilvie, *The Science of Describing*, 71

Good huswifes in sommer will save their owne seede,
Against the next yeere, as occasion neede.
One seede for another, to make an exchange,
With fellowlie neighbourhood seemeth not strange.[66]

Observations of women growers at a neighbourhood or market level were less prevalent in the literature, as women were generally positioned in the domestic arena with primary responsibility for household produce including vegetables. Thirsk describes women's groupings as less structured and formal than the organised commercial market ventures of men, although she also notes that many of the exchanges among men were in fact informal.[67] Small-scale businesses organised on a neighbourly basis was one method by which women could exchange produce, but by the 1550s women were breaking into the commercial markets. Women as marketers were not always, however, portrayed in a positive light. Writing in 1558, Thomas Hill claimed the (vegetable) market had been the preserve of the husbandman, but with the growth of vegetable plots among 'the meaner sort the charge and the chiefest care of the same, was committed unto the wyfe..'[68] References from Fitzherbert, Hill, Plat and others certainly indicate that women were wholly involved in horticulture and by the 1600s a new genre of treatises appeared on the list of publications. *The English house-wife* a generalist book from Markham and Lawson's *A Country house-wives garden* contained in *A new Orchard and Garden* were directed specifically to a female readership.

An overview of centres of communication in England, from around 1550s, illustrates a mosaic of activity rich in diversity. Bonds appeared strongest in groupings where there were common religious and political

[66] Thomas Tusser, *Five Hundred Points of Good Husbandrie* (1599), 98
[67] Joan Thirsk, *Food in Early Modern England (*Hambledon Press 2006), 44
[68] Thomas Hill, *The Gardeners Labyrinth,* (London 1652), 3

experiences, such as the emigrants in the Lime Street community, and the Puritans of the Hartlib circle. However, there were common threads running through these groupings in the manner in which they sought information. Using a broad range of investigative sources, contemporaries undertook empirical and descriptive studies of the natural world using books, testimonies, journals, travel reports, correspondence, exchanges of artefacts, plants, seeds and personal observations. What is more, they began to write about natural history.

The 1620s witnessed a new form of engagement, one that connected through the publication of books, but more specifically the connection was through the development of scientific and botanical knowledge, in what Bacon describerd as 'matters of fact'. Bacon considered that witnessed and verified 'matters of fact' provided the foundation for a new natural philosophy. He perceived the Aristotelian observation of nature as passive, whereas, an actively constructed natural philosophy should be based on observation combined with experiments. 'Vexing' nature's anomalies, and her accidents, would, Bacon believed, yield facts.[69] This was a significant juncture in the development of scientific thought as the search for 'useful knowledge' gave way to a Baconian natural history built on 'matters of fact'. In terms of seeds and plants, Bacon's approach to gathering knowledge in the form of facts, interfaced with a move from collecting, describing and displaying natural phenomenon, towards a scientific community, linked through the publication of scientific and botanical treatises. In terms of disseminating knowledge through literature, it has been estimated by Henrey, that five times as many books on botany and horticulture were published in England in the seventeenth-century compared to the sixteenth.[70]

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[69] Barbara Shapiro, *A Culture of Fact England, 1550-1720* (Cornell University Press 2000), 105-112
[70] Blanche Henrey, *British Botanical and Horticultural Literature before 1800.*

A developing science of horticulture was made possible through the many groups and individuals engaged in natural history. Books, correspondence and the exchange of specimens, plants and seeds were the most important mechanism by which knowledge was disseminated. Often driven by individuals in the sixteenth-century, such as L'Obel, with a passion to maintain and organise activities, or botanists like Johnson, who were reliant on patronage. For those without a scholarly or courtly establishment, the main means of maintaining the interest and exchange of knowledge was through the Republic of Letters. Travel, particularly in the sixteenth-century, was difficult, often dangerous and expensive, so correspondence bound a scattered population of natural historians in an imaginary network. The scholarly interests of sixteenth-century naturalists were not confined to a limited circle of correspondence. 'Rather, they were the concern of an abstract literary public, a public that naturalists imagined when they composed their letters and compiled their books.'[71]

As this scholarly and literary community developed and took hold so, building on the endeavours of their predecessors, natural historians began to turn their collections and herbaria into research tools. Here was a process of incremental growth of knowledge as, over time, naturalists developed the skills of personal observation, data collection and recording useful information that was both place-specific and site-specific. Knowledge was pushed forward through collective enterprise, and then shared through exchange mechanisms, and as correspondence flowed so naturalists developed a 'technical descriptive language'.[72] In sixteenth-century England groupings were diverse and included apothecaries, botanizers and natural historians. By the seventeenth-century, however, these began to be formalized and specialisms

[71] Ogilvie, *The Science of Describing,* 84
[72] Ogilvie, *The Science of Describing,* 6

appeared notably in the forming of societies such as Worshipful Society of Apothecaries in 1617 and Worshipful Company of Gardeners 1605.

Samuel Hartlib was indebted to Francis Bacon's programme of improvement, and in particular, his programme for educational reform. An emigrant from Europe, he achieved a central role in the intellectual life of Puritan England. In a reflection of the European connections of l'Obel and the Lime Street community of the sixteenth-century, Hartlib maintained his connections overseas, revisiting and resettling on a number of occasions. It was to England, however, that he finally returned where he became engaged in an ambitious, Baconian influenced, educational programme. The programme concentrated him for long periods, and was not without distractions and financial restrictions, but even during his greatest levels of public engagement, Hartlib continued to collect and collate correspondence, artefacts, treatises and scraps of information from his many collaborators. Hartlib, and his contemporary John Drury, formed an Invisible College (ca.1645), forerunner to the Royal Society. This enterprise was committed to investigating activities, 'as may be profitable to the health of the body, to the preservations and increase of wealth by trades and mechanical industries, either by sea or land; either in peace or war.'[73] Their Baconian utopia, captured in *The Kingdom of Marcia* (1641), was dedicated to the 'knowledge of causes and secret motions of things', and to a 'total agricultural, commercial, and medical improvement in society[74] During the Civil War, Hartlib turned his attention to husbandry and horticulture, and began to collect and publish information on agriculture, horticulture and the mechanical arts. For this particular programme Hartlib communicated with collaborators in England, Brabant in France and the

[73] Carolyn Merchant, *The Death of Nature* (Harper Collins 1980), 187 and attributed to Walter E Houghton, "The History of Trades: Its Relation to Seventeenth-Century Thought," in *Roots of Scientific Thought,* 361
[74] Merchant, *The Death of* Nature, 187. Attributed to Samuel Hartlib, but possibly written by Gabriel Plattes.

Low Countries. Hartlib planned an Office of Address, an institution that would co-ordinate and analyse international correspondence. The proposed institution was akin to the programme presented by Bacon in Solomon's House and described in *New Atlantis* 1627. According to Webster, Hartlib petitioned Parliament for funding, and to defend their rights 'against some there are, which without public Authority, and to the prejudice of your petitioners proposals and perhaps to the disadvantage of the public, go about to set it up.'[75]

Some time in the late 1640s, Hartlib gained a copy of *Irelands naturall history* written by a Dutch physician Gerard Boate. Boate himself never visited Ireland, but he gathered information from his brother Arnold, and some of the English who had been expelled by the Irish rebellion of 1641. Boate completed his 'Natural History' in 1645, although publication was deferred. This, the first natural history of a northern European country, was dedicated to Oliver Cromwell, and was originally designed to support the opportunistic interests of adventurers to Irish lands. The English, Boate declared, had since the Conquest, invested in Ireland to 'civilize' the 'Natives and their old Fashions, Lawes and Customes'.[76] This was a long and strongly held belief, that in some way the indigenous population failed to master the economics of craft and trade in increasing wealth. Boate declared 'Ireland a very fruitfull Country', and characterized the country as rich in natural resources, plentiful water, productive shorelines, good pasture and fruitful mines, but deplete of wood due mainly to over harvesting by English settlers. At the end of his dedication to Cromwell, Hartlib moved to declare a programme of tree plantations. Whether he conceived the removal of indigenous peoples and plants remains ambiguous, but in any event the

[75] Charles Webster, *Samuel Hartlib and the Advancement of Learning* (Cambridge University Press 1970), 46
[76] Arnold Boate, *Irelands naturall history* (1657), image 7

country would be improved by the introduction of non-indigenous species both human and vegetative.

> I lookt also somewhat upon the hopefull appearance of replanting Ireland shortly, not only by the adventurers, but happily by the calling in of exiled Bohemians and other Protestants also, and happily by the invitation of some well affected out of the Low Countries, which to advance are thoughts suitable to your noble genius, and to further the settlement thereof, the Natural History of that countrie will not be unfit, but very subservient.[77]

The declared driving force behind all the projects was Hartlib's interest in bringing in huge revenues, and that, 'the whole kingdom is become like to a fruitful garden'.[78] Hartlib was reading Irelands natural history from a literary landscape, a landscape drawn of observations from the critical eye of Boate. This was a model programme, a reflection of Robert Cecil's sixteenth-century desire to invest in and profit from the country's natural resources. Hartlib was setting a precedent as he set his agenda for improvement. The kingdom's metaphoric 'fruit garden' would be born out of educational reform and scientific and technological innovation. His Baconian influenced restoration programme was an intellectual magnet to a group of Puritans.

As networks evolved, so scientific knowledge was *inscribed* in print. Herbals and floras, catalogues and itineraries, were all contributors to the building of natural histories of local areas. Networks of actants congregated in particular spaces, in botanical gardens, museums and

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[77] Gerard Boate, "The Epistle" written by Samuel Hartlib in *Irelands naturall history* (1657)

[78] Gerard Boate, "The Epistle", *Irelands naturall history.* See also Charles Webster, *Samuel Hartlib and the Advancement of Learning.* Carolyn Merchant, *The Death of Nature.* Charles Webester (ed) *The Great Instauration: Science, Medicine and Reform 1626-1660.* Mark Greengrass, Michael Leslie, and Timothy Raylor (eds) *Samuel Harlib and Universal Reform: Studies in Intellectual Communication.* Deborah Harkness, *The Jewel House, Elizabethan London and the Scientific Revolution,* 251-252.

libraries. These were the sites of scientific endeavour, the ‘’centres of calculation’ in Latour’s theory. We have some evidence of artefacts contributing to networks, with the example of the tulip in Holland. We can also observe objects and animals involved in networking in the natural histories of the period. Minerals, rocks, fossils, birds and horses, and in the case of Ireland, indigenous flora, fauna and people were all part of this networking activity.

Chapter 2

The great book of Nature and the little books of men

> He who wishes to explore nature must tread her books with his feet…Writing is learned from letters. Nature however by travelling from land to land: One land, one page. This is the Codex Naturae, thus must its leaves be turned.[79]

God, according to Paracelsus (1493-1541) was the author of the Book of Nature, and only by reading the Book of Nature would the true path to wisdom be found. As noted by Temkins, Paracelsus found his answers by 'reading' the heavens and the elements, the world as a library, each country a page, and the stars the words. Combined together they all created 'meaningful sentences'.[80] This view was reiterated in titles such as Konrad von Megenberg's *Hye Nach Volget das Puch der Nature* (1472), translated as '*Here Now Follows the Book of Nature',* which contained, according to Drayton, the first collection of botanical illustrations.[81] In his rejection of classical tradition, Galenic medicine, and what he described as 'paper books', Paracelsus intellectually and metaphorically read the book of nature. Despite his own aversion to the classics and bookish learning, like many others involved in the investigation of nature in the early modern period, Paracelsus wrote prolifically. A number of factors contributed to a burgeoning authorship during the early modern period, most particularly, according to Eisenstein, the impact of the printing press. Manuscripts had a precarious existence, were subject to deterioration, and written for a limited few, while print physically secured text and images for public

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[79] Quoted in William Eamon, *Science and the Secrets of Nature,* (Princeton University Press 1994), 161

[80] Owsei Temkin, "The Elusiveness of Paracelsus in Medicine: Renaissance to Twentieth Century" in *The Double Face of Janus and other Essays in the History of Medicine*. (The Johns Hopkins University Press 2006), 236

[81] Drayton, *Nature's Government*

consumption.[82] The ability to replicate numerous copies, whether they were printed versions of classical text, translations, contemporary writings, illustrations, maps or diagrams, accurate, or near accurate, duplication meant that every reader had access to the same information.

The previous chapter highlighted some of the centres of calculation, those places where scientific activity was happening. Newly found territories in the New World, and local indigenous environments, have been researched by historians, anthropologists and social and cultural historians. In her research on 'sites of knowledge', Findlen focuses on museums (within which she includes botanical gardens), and centres of academic pursuit like universities. 'Natural history, like all forms of philosophy at this time, was a communicative enterprise. Displaying nature was a prelude to conversing about natural history.' But collecting, she continues, did not start in museums, but rather museums were an end point: 'the resolution of a long and complex voyage beginning at the moment an object was possessed by human hands.'[83] One of the best ways to preserve the 'memory' of an artefact, particularly if an artefact was liable to degeneration, was to record it textually. Text, in the Latourian framework, is the end product of a network interaction.

This chapter will consider how, within Latour's cycle of accumulation, herbals, floras and mapping territories, influenced a developing genre of husbandry and horticultural treatises. The advent of specialist topics and treatises was, to a large extent, influenced by what Thirsk describes as agricultural diversity, and the introduction of horticulture into the farming agenda. The construction of specialist treatises created spaces, centres of calculation, for the close scrutiny of plants and seeds and

[82] Elizabeth Eisenstein, *The Printing Revolution in Early Modern Europe* (University of Cambridge 2005)
[83] Findlen, "Sites of Knowledge" 97-154 and "Pilgrims of Science", 155, in *Possessing Nature*.

where the landscapes of orchards, forests, vegetables and flowers were formulated in text.

Researching network activities, or as Latour describes, 'the collection and description of observations of scientific activity…*in a particular setting*',[84] is far more complex when archives so often present the enquirer with 'an end product', for example letters or maps. 'Following the scientist' into his or her investigative environment may be possible in a modern laboratory, but is far from straightforward when seeking to respond to network activities of the early modern period. In other words, how might we trace what was required to happen, and in what scenario, to understand how ideas, events and thoughts were formulated? Herein lies a further difficulty. In *Pilgrims of Science,* Findlen weaves her way through a multitude of examples identifying, what she describes as 'theatres of nature'. From the well-known naturalists and collectors like Aldrovandi, to market vendors and fish sellers, Findlen uses correspondence, books, museums and the artefacts themselves to present a picture of network activities.[85] What Findlen demonstrates is the complex nature of the formation of 'knowledge', and reinforces Latour's view that sites where people interacted were full of contradictions and uncertainties.

The artefact to be used in this chapter as a means of tracing 'science in action' is 'the book'. Text, Latour argues, is the outcome of activities, a final product and compilation of many layers described by him as *inscriptions*. For example, Latour explains that the creation of a map required frequent trips to a particular territory. Each exploration led to new *inscriptions* or maps and as more were produced so each new map added to the existing pile of maps. The whole process Latour describes

[84] Latour and Woolgar, *Laboratory Life,* 28
[85] Findlen, "Pilgrims of Science"*,* in *Possessing Nature.*

as a ‘cycle of accumulation’, with each *inscription* ultimately reduced to written documents, which were then ‘durable and transportable.’ [86]

Thus far this preamble has focussed on the importance of text as an end product, with each text contributing to a *cycle of accumulation*. At this point, however, it is worth returning to the network itself, for at the heart of Latour’s network activity is the interaction between actants, comprising the human and the artefact.[87] An essential ingredient within this network mix is ‘observation’, in this case of ‘nature’. Generally placed within an Aristotelian framework by historians, there is a notable absence of what ‘observation’ actually means. Identified as an attempt to write one of the first histories of scientific observation, Daston and Lunbeck consider how the history of experience has been ‘shaped and sharpened to scientific ends: how the senses have been schooled and expanded: how practices for recording, correlating, and displaying data have been developed and refined; and how the private experiences of individuals have been made collective and turned into evidence.’[88] Historical research of ‘observation’ has, they argue, more often been connected with research into the development of instruments of observation such as microscopes, telescopes or cameras, what Latour would describe as the instruments of *inscription*. The senses, however, have, according to Daston and Lunbeck, been largely overlooked; a point well made when authors in the early modern period evidently used their senses in true Aristotelian style to ‘shape and sharpen’ their scientific observations. Observation was central to science in action from Ulisse Aldrovandi’s eyes and hands, to the seventeenth-century plantsman Moses Cook, who tested the viability of his collections of seeds by

[86] David Jones, “In Conversation with Bruno Latour: Historiography of Science in Action”, in *History of Science* (2005) See also Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society (*Harvard University Press 1988)
[87] See Ulisse Aldrovandi in Chapter.1
[88] Lorraine Daston and Elizabeth Lunbeck, *Histories of Scientific Observation* (University of Chicago Press (2011), 2

looking, touching, listening and tasting them. These human senses were in Daston and Lunbeck terms, central to scientific observation linking and bonding the actants in the network.

This chapter is divided into two sections. The first will focus on what Latour describes as 'cycles of accumulation', and will argue that the publications of catalogues, herbals, floras, chorographies, maps and estate maps, built layers of observations which interlinked forming 'new drafts… constructed by the juxtaposition of two sources of literature, one originating outside and the other being generated within the laboratory.'[89] The use of the word laboratories in this context will refer to collections and environments, otherwise referred to as 'centres of calculation.' The second section will focus on the inscriptions that influenced the development of a new style of horticultural book.

Landscapes - observing the world

Before setting forth their observations, authors had to construct a horticultural environment, a landscape in which to formulate their 'science'. The historiography of landscapes, which also includes aspects of geography, is extensive and a full analysis is beyond the scope of this work. However, the flavour of some of the academic discourse is included to demonstrate different cultural and social interpretations. One of the first academics to consider landscape as a topic worthy of intellectual pursuit was geographer Carl Sauer. With a Paracelsian influence, Sauer argues that nature does not create culture, but instead, culture working with and on nature, creates ways-of-life. He considered human impacts on the landscape to be a manifestation of culture, stating that in order to understand a culture, a geographer must learn to

[89] Latour and Woolgar, *Laboratory Life*, 48

read the landscape.[90]

Breaking down barriers between history and other disciplines was the intent of the French Annales School. Braudel's emphasis on the *longue durée* was an attempt to write a total history on the Mediterranean, in which, he argues, despite political and social upheavals, the landscape itself remains almost inert and slow to change. Marxist interpretations of landscape include Cosgrove, who argues landscape as an ideological concept, and supports his contention with interdisciplinary examples including a reinterpretation of iconographic methods of analysis. His argument conceives the landscape as a product of human relations between people and the world they inhabit to subsist. Landscape, claims Cosgrove, carries multiple layers of meaning extending across the arts, painting and literature, architecture and environmental planning. Landscape 'is a way of seeing the world', and he continues his theme with the idea that landscape achieved prominence during the transition in European societies from feudalism to capitalism. 'The landscape idea emerged as a dimension of European elite consciousness at an identifiable period in the evolution of European societies: it was refined and elaborated over a long period during which it expressed and supported a range of political, social and moral assumptions and became accepted as a significant aspect of taste.'[91] Hoskin, on the other hand, traces the British landscape from the pre-Roman period, and seems less inclined to incorporate a strong continental influence. He is more attuned to the human and animals influence over time.[92]

Schama's narrative guides us through woods, water and rock as he seeks to challenge the historiography of landscapes as a 'dismal tale: of land

[90] Carl Sauer, 'The Morphology of Landscape' in *University of California Publications in Geography* 2,2 (1925), 19-45

[91] Denis E Cosgrove, *Social Formation and Symbolic Landscape,* (University of Wisconsin Press 1984), 1.

[92] William G. Hoskins, *The Making of the English Landscape* (Little Toller Books 2013)

taken, exploited, exhausted; of traditional cultures said to have lived in a relation of sacred reverence with the soil displaced by reckless individuals, the capitalist aggressor.'[93] Schama proposes, and through his examples seeks to demonstrate, that Western society has 'sacralized landscapes energetically and made them come alive.' His work reflects historical interpretations of nature through myth, pictorially and textually, and sets to challenge the Marxist exposition of the landscape as a capitalist mode of production. The notion of reading the landscape was taken up by Schlereth in 1980 who, in a reflection of Sauer's earlier work, studies trees as material records of rural history describing vegetation as 'highly visible natural shards.'[94] Plants and vegetation, he states, are important aspect for study in landscape history.

Thus far the historiography has addressed how some historians and geographers have interpreted the landscape through the lens of time. Others have used their own biographical experience. In 1962 Rachel Carson published a book entitled *Silent Spring,* in which she presents an ideological town and countryside full of abundance, prosperity and hope. Until that is, the environment was visited by a blight that slowly began to kill and destroy humans, animals and vegetation. Like Schama's fables, the town did not actually exist, but the blight did, and afflicted towns and countryside all over America. The blight, Carson maintains, was visited on the earth by 'man's assaults upon the environment' resulting in 'contamination of air, earth, rivers, and sea with dangerous and even lethal (chemical) materials.' [95] Carson was reading the landscape, and all the signs and signals indicated nature was in trouble,

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[93] Simon Schama, *Landscape and Memory* (Vintage Books 1995), 13. See also Thomas Schlereth, "Plants Past: The Natural Material Culture of the American Land", in *Cultural History and Material Culture: Everyday Life, Landscapes, Museums* (Charlottesville, 1990), 40 and William Cronon, "The Trouble with Wilderness; or Getting back to the Wrong Nature". Article: williamcronon.net

[94] Thomas J. Schlereth "Plants Past: The Natural Material Culture of the American Land," in *Cultural History and Material Culture: Everyday Life, Landscapes, Museums.* (University of Virginia 1990), 40

[95] Rachel Carson, *Silent Spring*, *(*Houghton Mifflen Co. 1962), 6

and rather than a longue durée, the influence of man was changing her world rapidly with 'sinister and little-understood interactions, transformations, and summations of effect.'[96] Carson's 1962 political analysis of scientific intervention continues a long history of 'witness statements' about the environment. Carson was, in fact, reading a landscape, rather than creating one, and what has been described is her personal interpretation. It is to the early modern witnesses that we now turn to discuss how they portrayed their landscapes textually and how the landscape as observed, was woven into and used in the scientific exploration of plants and seeds.

Landscapes were mentally held in the mind of the observer, and textually created in maps, diagrams, illustrations, and of course, art, with the Dutch Golden Age offering a particularly prominent example. Landscapes, or *landschapsschilderkunst*, and cityscapes, often painted in the studio, represented the artist's interpretation. As the artist symbolically reassembles the landscape in his mind, so also we can observe a similar reassembling of horticultural and agricultural landscapes in the texts of the early modern period.

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[96] Carson, "Surface Waters and Underground Seas" in *Silent Spring,* 39. For feminist arguments on ecology and the environment see also Carolyn Merchant, *The Death of Nature,* (1980) and Merchant (ed) *Radical Ecology: The Search for a Livable World.* (Psychology Press 1992)

Figure 1. Farm buildings in a landscape (painted 1625-1628?) Salomon Van Ruysdael (1606-1670)[97]

The Landscapes of plants

Cooper describes botanical gardens as 'living classrooms….in which living objects could be manipulated, and thus take on new symbolic arrangements'. [98] A botanist's range could be anything from the structured format of gardens, botanizing in the countryside, waiting at the harbour for a returning boat, exploring markets, and observing each other's collections. New and expanding horizons led to what Morton identifies as a fresh impulse, which turned botanists away from the classics to 'critically distinguishing and describing the living plants around them.'[99] Ways of capturing the world of plants was enabled, according to Morton, by two innovations that substantially furthered the progress of botany. The first was the technique of drying plants so specimens could be preserved in herbariums where they could be examined and re-examined over time. The second innovation was the use of realistic illustrations, often life-size, which he claims was

[97] Salomon Van Ruysdael, Dutch Golden Age landscape painter.
[98] Alix Cooper, *Inventing the Indigenous* (Cambridge University Press 2007), 61
[99] A.G. Morton, *History of Botanical Science* (Academic Press 1981), 115-164

influenced by the painting and sculpture movement of the period and new techniques of painting. Both these technical innovations were, as Eisenstein has pointed out, subject to degeneration over time, and it was the innovation of printing and woodblock illustrations that not only changed the way in which information was imparted, but opened up the readership.

According to Talbot, medieval physicians relied on herbals for use in study and practice. Tracing the arrival of books on medicine to England from southern Italy, he concludes they found their way from Italy in the seventh and eighth centuries. Here they were copied and lodged in monasteries which, as centres of medical practice during the medieval period, held repositories of books and treatises complimented by the close proximity of herb gardens. Practical application of alchemical processes and distillation to formulate medicines meant that practitioners were actively interacting with plants and seeds. This essentially practical attitude to medicine led, according to Talbot, to less reliance on descriptions of diseases in the herbals, and an increasing 'accumulation of recipes'.[100] Minta Collins takes a different route. She studies the iconography of plants in manuscripts dating as far back as Arabic and Greek editions and tracks the production of herbals into the medieval period. 'A typical chapter from a herbal treatise names the plant, gives a list of synonyms, describes its characteristics, its distribution and its habitat, reports what earlier authors have said about it, its medical properties…recipes..and contra-indications.'[101] However, Collins does not support the traditional view of herbals used solely for medicinal reference, nor does she believe these early manuscripts were written in monasteries by monks to aid the *infirmarius.* She finds that

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[100] Charles H. Talbot, "Medicine" in David C Lindberg (ed) *Science in the Middle Ages* (Chicago History of Science and Medicine 1976), 391-428. Talbot charts the increasing role of hospitals and a break with apothecaries as 'quacks engaged in the peddling of secret remedies.'

[101] Minta Collins, *Medieval Herbals, The Illustrative Traditions* (British Library 2000), 25

herbals offered multiple uses, from the practical applications of herbal remedies to employment as a teaching tool. She also queries whether the survival of a few examples was less to do with continued use over time and more concerned with collections, and the special interests of bibliophiles. Using examples, Collins demonstrates how herbals were, over time, built in layers with texts from one collection being integrated into new compilations and concludes, '[this] codex of natural philosophy is more likely to have been conceived as a volume of antiquarian, literary and even sentimental interest than as a purely medical book.'[102] Collins concludes that herbals were not primarily used for medicinal practice, but were copied 'in order to preserve the illustrated treatises' and were, in fact, collectable artefacts. Collins research reveals an interesting issue concerning the networking process, and raises questions as to whether selection of specimens was based purely on medicinal qualities or, whether there was something else going on in the networking process. An interaction between the collector or artist and the plant is clearly evident in early medieval manuscripts and herbariums and one might consider to what extent curiosity and the senses played a part.

The herbal provided an illustrative cataloguing of plants, as a means of recognition for the botanist and apothecary, and as such served as an important focus of botanical information. Rohde and Arber consider the beginning of a distinctive English herbal tradition to be between the first work of William Turner in 1551, the translation of Dodoens (first published in 1554) and Gerard's *Herbal* and Parkinson's 1640 *Theatrum Botanicum.*[103] These were the first authoritative printed works to appear in English. Given the first botanical garden was founded in Oxford in 1620, there is no possibility that this would have informed these works.

[102] Collins, *Medieval Herbals, The Illustrative Traditions*, 46
[103] Eleanour Rohde, *The Old English Herbals: Medical Authority and Englishwomen's Herbal Texts 1550-1650* (CreateSpace Independent Publishing Platform 2015) and Agnus Arber, *The essence of herbs: Herbals: Their Origin and Evolution* (Cambridge University Press 1912). Dodoens original herbal *Cruijdeboeck* written in old Flemish and published in 1554. French translation by Clusius published in 1563.

However, according to Morton, as a protestant, Turner was forced by the Marian persecution to spend some years on the continent where he visited Italy and attended the Italian physician and botanist Luca Ghini's lectures in Bologna. Drayton placed Turner with Swiss botanist Conrad Gessner (1516-1565) and German botanist Leonhart Fuchs (1501-1566) during the 1540s.[104] To this end Turner would have been influenced, but how and from where he drew his collection for his herbal is uncertain. Gerard's *Herbal* was a translation of Dodoens, to which he added examples from his botanizing trips and collections from the New World including the potato. Gerard had his own garden, and was the supervisor of William Cecil's private garden Theobalds Park so his knowledge of plants was extensive. His herbal, however, was not original to him and like most herbals of the period incorporated classical and continental plants. Gerard's *Herbal* does, however, provide an example of a centre of calculation, when a contributor urges that 'laboratories of an industrious chymist, [should be erected] by the sweete garden of flourishing simples.'[105] The final English publicist was Parkinson, who produced two extensive botanical works, *Theatrum Botanicum* and *Paradisi Botanicum. Theatrum Botanicum* was a specialist book written in Latin and presented a landscape of plants from home, the continent and the New World. *Paradis*i had the flavour of a horticulturalist and gardener. Parkinson's textual collection was based as much on his own endeavours in gardening and botanizing as the exploits of the plant hunters he clearly had contact with. Again we can see an influence of previous and continental works. Each time a plant was textually visited either through its previous history in classical or continental sources, textual references, illustrations and art, house décor and even fashion, there will have been an interaction between the artefact and the

[104] A.G. Morton, *The History of Botanical Science*, (Academic Press 1981), 118. Richard Drayton, *Nature's Government*, (Yale University Press 2000), 7
[105] George (?) "To the well affected Reader and Perufer of this Booke, St. Bredwell Physician, greetings" in John Gerard, *The Herball or General Historie of Plantes* (1633 edition)

human. Couple this with sensory observation, the choosing of specimens must balance the traditional perhaps 'known' with the unexpected and 'curious' and personal response.

There remains however, the fact that English authors did not have access to wide ranging and eclectic collections of plants, despite many attempts to nurture foreign plants into life. To a large extent, they were dependent on classical and continental text, with all four authors claiming extensive knowledge of their precursors. According to Laroche, English authors sought to synthesize the knowledge that came before them incorporating the arguments and experiments of eminent botanists as Jean Ruel, L'Ecluse, Fuchs and Mattioli. But unreliable knowledge was a concern, as demonstrated by the remonstrations from L'Obel and Johnson (both involved in editing and correcting) on the number of errors found in Gerard's *Herbal*. It seems the reputation of the author was mostly at stake, and certainly Turner was conscious of his reputation. For him sources of mistakes lay within continental texts, which were too readily drawn on. According to Laroche, Turner considered fault lay with '*illiterate, or Latin-illiterate*' 'herb wives', women who collected plant material for physicians and apothecaries, and the apothecaries themselves. Shapin also notes that in the scientific discourse in the seventeenth-century, unreliable testimony was routinely labelled as 'old wives tales'.[106] Herbals drew on many sources, from plants in botanical gardens, private gardens, to botanizing and discoveries from the New World. But they also drew heavily on other publications, inevitably recycling errors. The history of herbals does, however, demonstrate that each 'new draft' produced was integrated into a cycle of accumulation constructed from literature originating outside and the other within the 'laboratory'. Each new draft was

[106] Steven Shapin, *A Social History of Truth Civility and Science in Seventeenth-Century England* (The University of Chicago Press 1994), 90

building towards a 'scientific' landscape, one that combined the plant and seed with the land, and the human.

Floras were a different genre of scientific documentation to herbals, as they engaged the botanist in a 'living' landscape and direct contact with plants *in situ.* As botanists went out into the countryside to collect and note plants, they took with them small 'pocket' books. According to Cooper, these books were used by students and professors in identifying, comparing and noting their botanical finds thus locating them in time and space. No longer dislocated from their origin, these local floras were 'book(s) of nature' which not only 'represented local nature, but came for early modern Europeans to forge a new way of looking at it.'[107] Using the radical medical reformer Paracelsus as an example, Cooper quotes his critical rejoinder on the use of non-native resources when there were ample resources within Germany. Paracelsus's comments carry a greater sense of rhetoric than may at first be apparent. The dichotomy of German 'nature' and 'nature' of foreign lands, or the indigenous and exotic, was a debate that assumed an importance in the writings on health and nature in sixteenth-century Europe, as contemporaries began re-evaluating the European indigenous. Paracelsus was an influential figure in England, not just because of his medical challenges but, more widely, because of his theories and writing on alchemy. This re-evaluation of the indigenous was played out in the herborizing and botanizing that occupied scholarly communities, botanists and apothecaries during the sixteenth-century. It slowly led to a re-evaluation of what knowledge should be collected and how this knowledge could be disseminated. The literary landscape of the flora contained minimal information as nature was pared down to its simplest descriptor, usually the Latin name. There was little or no description of the plant itself, with names in Latin presented in catalogue

[107] Cooper, *Inventing the Indigenous*, 72-86

format. In its most extended version, the flora of plantsman John Ray was an attempt to provide a textual mapping and landscape of English flora. It was the local nature of floras that, according to Cooper, came to be challenged as 'insufficiently universal for a world transformed in many ways by the new sciences.'[108] However, when discussing the inception of horticultural literature there is clearly evidence that authors drew on the literary landscapes of herbals and floras.

Landscapes of total vision

Figure 2. "The Prospect of Constantinople" Melchior Lorck (1526/7-after 1583)[109]

Although herbals were considered to be concerned with medicine and medical practice, as new discoveries were made the later herbals of Gerard, and the *Theatrum Botanicum o*f John Parkinson, sought to become collections of 'universal' knowledge. Floras, on the other hand, were local and sought to collect indigenous knowledge, an altogether smaller scale enterprise. A similar pattern was occurring in the mapping

[108] Cooper, *Inventing the Indigenous*, 16
[109] Lorck was a Renaissance painter and printmaker.

and surveying of territories and land. The definition of 'land' changed during the early modern period when, as Swann argues, the gentry of landed property began to view it as a tangible *thing,* rather than a set of rights, accompanied 'by an increased emphasis on depicting lands as a physical entity.'[110] It was new technologies in print culture, along with travel and exploration that increased diversity and complexity in the field of geographical representation. But it was also a return to classical traditions such as Ptolemy's *Geographia*, which, when printed in the late fifteenth century ran, according to Brotton, into five hundred copies creating what he describes as a 'book-buying' community across western Europe.[111] Maps took on a political, social and cultural domain as '[M]apping places by means of drawing portraits of the world' recorded 'visual choices, cultures and spatialities.'[112] Mapping in the early modern period created, according to Brotton, the possibility 'for social and political change across a wide variety of spheres, including juridical, diplomatic, imperial, historical and commercial contexts.'[113]

Not only were early modern collectors interested in artefacts, they were also interested in collecting landscapes - territories and land. It was the combining of the two that led to the early modern chorographer described by Swann as a collector of physical entities. McRae comments that the association between surveying and mapping with 'new geometric methodsu of land measurement effectively strip(ped) away moral concerns', representing the land as a tangible personal possession rather than a site of reciprocal community obligations.[114] Mendyk traces descriptions and mappings of particular regions written in Britain up to

[110] Marjorie Swann, *Curiosities and Texts the Culture of Collecting in Early Modern England* (University of Pennsylvania Press 2001), 100
[111] Jerry Brotton, *Trading Territories Mapping the Early Modern World* (Reaktion Books 2013), 35
[112] Lucia Nuti, "Mapping Places, Chorography and Vision in the Renaissance" in Denis Cosgrove (ed) *Mappings* (Reaktion Books 1999), 108
[113] Brotton, *Trading Territories Mapping the Early Modern World,* 21
[114] Andrew McRae, *God Speed The Plough* (Past and Present Publications, Cambridge University Press 1996), 18-19

the end of the fifteenth-century, *concluding* they did not form a verified whole.[115] The sixteen-century, however, witnessed a rapid increase in the production of chorographic studies in Britain leading to broader more cohesive 'histories' of local communities in much the same way as natural histories were formulated. According to McRae, many of the regional chorographers included detailed representation of agricultural and economic processes, and within this can be found the development of estate maps. Medieval landholding was, according to Buisseret, generally based on 'metes and bounds' giving rise to parish perambulations. Estate maps emerged in the later period of the sixteenth-century as a result of development in the mode of agricultural production.[116] Mapping was a central component in creating a perception of order and control on rural estates as estate management became a preoccupation. McRae and Bending's overview on the writing of rural England concludes that '[T]exts may be seen as active agents involved in constructing a culture's sense of reality.' Textual analysis becomes concerned with how and why cultures 'produce and naturalize particular constructions of reality, how those constructions interact or conflict with rival representations of reality and what the political implications of those constructions of reality are.'[117]

In the 1570s a new cartography emerged in the form of the estate map. Different from other map forms it delineated only one economic unit. These were generally in manuscript form and accompanied by a written register of the property. The estate map, according to McRae, became 'a significant status symbol, ankd was especially popular among new

[115] Stan Mendyk, "Early British Chorography", *Sixteenth-Century Journal*, 17:4 (Winter, 1986), 459-481
[116] David Buisseret, "The Mapmakers' Quest Depicting New Worlds in Renaissance Europe", *The Sixteenth-Century Journal* 17 (1986), 459-81
[117] Stephen Bending and Andrew McRae (eds), "Introduction" in *The Writing of Rural England 1500-1800* (Palgrave Macmillan 2003), xi

landowners'.[118] Other forms of mapping were developing including chorographies described by William Cunningham in 1559 as showing '…the portes, Rivers, Havens, Fluddes, Hilles, Mountaynes, Cities, Villages, Buildings, Fortresses, Walles..' as the English 'took effective visual and conceptual possession' of their nation.[119] In an extension to plant cataloguing in private and botanical gardens, maps of gardens began to appear and natural scientists turned to maps both celestial and terrestrial, as they sought to explain their theories. Mapping of estates and gardens was also found in husbandry and horticultural treatises, both of which incorporated aspects of estate surveying and chorography.[120] What seems on the face of it be a literary description of a single economic unit in an extraordinary manifestation, we find instead a universe of knowledge and enquiry wrapped within the leaves of these books. In true Paracelsian style, each leaf turned revealed a microcosmic survey and landscape of the universe.

Literary landscapes

Some of the first books to evolve from a new literary drive were husbandry manuals, texts described by McRae as giving a 'shape and force' that underpinned the impending 'revolution' in both agricultural practice and socio-economic thought.'[121] These books appeared on the market at a time when strong political rhetoric about the state of the country's agrarian economy was to be heard from many quarters. It was a period where the prospect of crop failure, dearth and famine was a constant fear and the role of the farmer and the estate manager never more important. The Secretary of State, William Cecil (1572-1598) urged all those living in the country who were acquainted with the plough to

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[118] McRae, *God Speed the Plough*. For a fuller discourse see pages 169-197

[119] Mcrae, *God Speed the* Plough, 231-232

[120] For further discussion on mapping see Denis E. Cosgrove *Social Formation and Symbolic Landscape.* Alessandro Scafi, "Mapping Eden: Cartographies of the Earthly Paradise" in Cosgrove (ed) *Mapping.* Cosgrove "Gardening the Renaissance World" in Cosgrove (ed) *Geography and Vision, Seeing, Imagining and Representing the World,* (I.B. Taurus & Co.Ltd., 2008) 51-68

[121] McRae, *God Speed the Plough*, 137

till the land.[122] Markham called farmers, 'the nerve and sinew which holdeth together all the joints of monarchy.'[123] In 1652 Nathaniel Newbury, minister of God's word at Ludenham, hailed the work of Markham, and described husbandry in his lengthy sermon as, 'an employment not unworthy a king' referring to his congregation as 'the pith and substance of the county.'[124]

Early publications in this period include the first two books on husbandry written in English. John Fitzherbert's *Boke of Husbandrye* (1530?/1598) and Thomas Tusser's *One Hundred Good Pointes of Good Husbandrie* (1557) followed by *Five Hundred Pointes of Good Husbandry* (1573). Both these books focus on the practicalities of estate and farm management. Two further books modelled on the classical tradition of the great estate include Googe's 1577 translation of Heresbach *The Foure books of husbandry* and Surflet's 1600 translation of Estienne's *Maison Rustique, or The Countrie Farme*. These books were later updated by Markham to fit the English environment, ways and customs, but the landscape of these estates remained reminiscent of the classical style of the Roman agronomists Cato, Varro and Columella. Looking around the vistas and lands in their own countries the authors and editors of husbandry manuals wished to align contemporary and late medieval husbandry practise with the classical Roman and Greek model. Revitalizing Cato, Aristotle, Pliny the Elder and others provided a new confidence and assurance that husbandry, hard as it might be, was an honourable occupation.

Books presented some theoretical understanding about the quality of soil, and the role of dunging, but they were steeped in the classical

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[122] See McRae's observations on a radical new language of thrift. *God Speed the Plough,* 143-151. Thomas Tusser, "The Ladder of Thrift" in *Five hundred points of good husbandry* (1573)
[123] Albert Schmidt, *The Yeoman in Tudor and Stuart England,* (Folger Shakespeare Library 1961), 19
[124] Nathaneal Newbury, *The Yeoman's Prerogative or The Honour of Husbandry,* 7

tradition and notions of estate management and focused on the practice of farming rather than how or why things worked.[125] The quality of the seed and its potential role in crop failure or crop success was absent in the grand narrative of these tracts, but was picked up by others including Plat, Markham and later in the period, Puritan improvers Blyth and Hartlib. Specialist treatises and husbandry manuals of the time were well received into estate libraries, and were commonly found along with classical text in the libraries of gentlemen. Cato's *Libro de re rustica and Methodus rustica Catonia*, Columella *De l'agrocultura, libri xll* and Estienne's *Praedium rusticum* is catalogued in Holkham Hall and Googe's translation of Heresbach, Pliny and Aristotle catalogued in the LeStrange family library in Hunstanton. What is significant is the strong evidence that books were not only read but were used as working documents alongside classical tracts. In his research tracing the development of agricultural practice across Europe between 1350 and 1850 Ambrosoli, among his many discoveries, found a highly annotated copy of Heresbach's *Husbandry* almost certainly belonging to one Thomas Rowland. It was bound with a translation of Xenophon's *Oeconomicon*. Reviewing the annotations and comments in the original text Ambrosoli speculates on the impact on the reader and notes, 'The tendency of sixteenth-century readers to equate the two cultural situations is reflected in the fact that the two copies were bound together.'[126] With antecedents in classical tracts, contemporaries contemplated Aristotle, revitalized Epicurus, and reviewed the chemical philosophy of European counterparts like Paracelsus, Palissy and Gassendi.

Husbandry had a strong classical pedigree, but it was interest in horticulture that really expanded during the early modern period. Described as a horticultural revolution, Willes attributes this to an

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[125] Paul Warde, "The idea of Improvement c.1520-1700" in *Custom, Improvement and the Landscape in Early Modern Britain* (Ashgate 2011)
[126] Mauro Ambrosoli, *The Wild and the* Sown, (Past & Present Publications, Cambridge University Press 1997), 232

overriding interest in collecting among the elite including grand gardens. It was also driven as well by the political and economic agenda espoused by William Cecil.

The primacy of horticulture

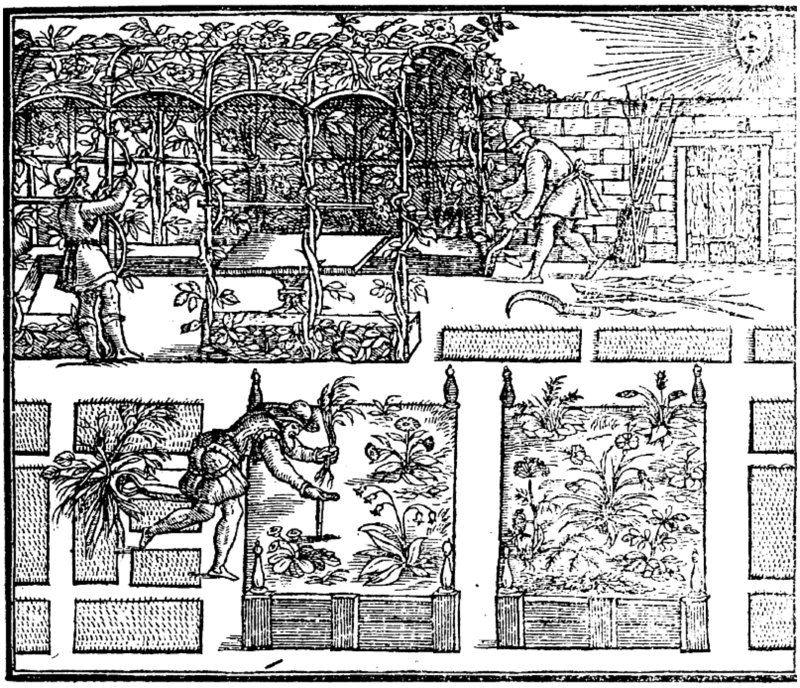

Figure 3. Thomas Hill, The Gardeners Labyrinth, 1577[127]

Around 1557 a small book written by one Thomas Hill (Hyll) (1528-1574), citizen of London, appeared on the list of a London publisher. Using the pseudonym Dydymus Mountaine, he entitled his treatise *A most briefe and pleasante treatise, teachying how to dresse, sowe and set a garden.* The treatise was so popular it was reworked, given new titles, and eventually reached nine editions.[128] Described by Willes as possibly the earliest known treatise dedicated to gardening, it was an extremely

[127] Thomas Hill, *The Gardeners Labyrinth* (1577) image 6

[128] Thomas Hill. *A most briefe and pleasaunt* treatys. Conclusion dated Anno 1563. *A proffitable arte of gardening* annexed to two previous treatises 1568. Collation of editions 1572. Further editions 1574, 1579, 1586, 1593. *The arte of gardening* 1608. See Blanche Henrey, *British Botanical and Horticultural Literature before 1800.*

important book in the scientific history of horticulture.[129] To a large extent it followed the format of the herbal, and included many medicinal plants one might expect to find used for healing and healthcare in an Elizabethan household. Despite lifting the botanical information from the classical tracts of Pliny, Columella, Varro and others, and including plants found in medieval herbals with their specialised Latin orientation, Hill's book was unique because he wrote in the vernacular and used a style suitable for an increasingly literate readership. At a time of great influx of plants from overseas, Hill settled for what he probably estimated to be tried and tested plants, ones that would prosper in any English garden. Many of the plants he named were considered to be indigenous, collected from the wild and propagated in gardens over time, while others were herbs with long standing Mediterranean connections, and still others were flowering plants imported from foreign lands and acclimatized to English environments. Hill's garden was a functional mixture of flora designed for pleasure and profit. The centrality of Hill's book lay not so much in its design and content but, rather he moved the garden away from the grandiose designs of the elite at one extreme, and the humble peasant plot at the other, placing it firmly within reach of the citizens of Elizabethan London. His garden was a technical project that could be fulfilled by anyone 'because the art of gardening it selfe verie profitable, and bringeth most necessarie commodities, bothe to the Citties and Townes..'[130]

Henry Dethicke edited the 1577 version of Hill's work and entitled it *The Gardeners Labyrinth.* Dethicke dedicated this edition to William Cecil and proffered the treatise as a contribution to Cecil's ambitious projects aimed to increase the wealth of Elizabethan England.[131] Cecil was engaged in supporting, financially and politically, a wide range of

[129] Margaret Willes, *The Making of the English Gardener,* 56
[130] Thomas Hill, *The gardeners labyrinth* (1577), 3
[131] Henry Dethick, (d.1613). *The gardeners labyrinth* by Dydymus Mountaine (Completed by H. Dethick 1577)

technical projects aimed at exploiting the natural resources of England.[132] Faced with near bankruptcy, levels of domestic poverty, an economic imbalance between trade and imports, and threats from foreign powers, Cecil promoted an advancement of knowledge and skills in a wide range of activities.[133] From the transmuting of base metals into gold by alchemical means, to exploiting mineral wealth through mining, glass making, weaponry and navigation, and with the introduction of new machines and engines, technological innovation was all embracing.[134] Cecil's new industries and projects required practitioners and experts for mining and drainage projects, surveying, cartography, agriculture, cloth dyeing and the production of saltpeter for gunpowder. The projects were expansive, but horticulture was strangely missing an omission observed by Hill, and his editor Dethick in his dedication to Cecil. Cecil's interest in plants and gardens is well recorded, and he was an avid plant collector for his many properties and private gardens.[135] As a result of these interests, Dethick undoubtedly believed he would have the listening ear of Cecil when he presented his edited version of Hill's little treatise as one more project for the nation. This was a model project with guidance drawn from practitioners with 'longe experience and continuall practyse of painefull men in trying and searching…' The wealth of the country, claimed Dethick, could be 'augmented by the diligent care and vigilans paines of the wise observed and skilfull Gardeners.'

Some four decades later Hugh Plat produced *The Jewel House of Art and Nature* in 1594 described by Harkness as a book of "vernacular science". Plat's treatise covered engineering, chemistry, nutrition, medicine, botany, agricultural science, and physics as achieved through the

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[132] For explanation of Elizabethan scientific technology see Harkeness "Big Science in Elizabethan London" in *The Jewel House,* 142-180
[133] Bruce Lenman, *England's Colonial Wars 1550-1688* (Pearson Harlow 2001), 132
[134] Harkeness "Big Science in Elizabethan London" in *The Jewel House,* 143-181
[135] Willes, *The Making of the English Gardener,* 19

endeavours of citizens of London people, who in Harkness's view, experimented and progressed within these areas.[136] In 1608 Plat published *Floraes Paradise*. This was an altogether different formula, described by Janacek as an 'exemplary example of an early modern craft book.'[137] On one level this was a work about gardens and gardening as Plat filled his house with a botanical landscape of flowers and plants. In the same treatise, however, Plat moves into esoteric and secretive mood presenting his garden as a 'laboratory', a centre of calculation, where plants and the environment were subject to experimental alchemical processes. Along with many of his contemporaries, Plat was not averse to a little plagiarism, and one of his favourite informants was Della Porta, who had a particular interest in the occult, alchemy, astrology, mathematics and natural philosophy. His most renowned work was *Magiae naturalis* published in 1558, and revised and expanded throughout the author's lifetime. An English translation entitled *Natural Magic* was published in 1658. Whether in Latin or English, the contents filled some twenty books and would have been familiar territory for natural philosophers and philosophical alchemists. Indeed, we can observe the influence of Della Porta on the work of Plat who sets out *The Jewell House of Art and Nature* in almost identical style and content. Topics included observations on geology, medicines, poisons, cooking, plant life, husbandry, metallurgy and magnetism as well as cosmetics, perfumes, gunpowder and invisible writing.[138] Plat was an energetic author on a range of topics, and a strong contributor to what Harkness describes as a scientific revolution in Elizabethan London. It is not possible to ascertain how popular his publications were, but his work was certainly incorporated into the Hartlib collection.

[136] Deborah Harkness, *The Jewel House*
[137] Bruce Janacek, *Alchemical Belief, Occultism in the Religious Culture of Early Modern England* (Penn State University Press 2011), 140-142
[138] For a fuller discussion on the activities of Hugh Plat see Malcolm Thick, *Sir Hugh Plat, The search for useful knowledge in early modern London.* (Prospect Books 2010)

In the early part of the seventeenth-century a new style of book evolved, one that incorporated many aspects of herbals and floras, but one that might appeal to a wider readership by providing a literary landscape that was less specialized and likely to be familiar with a rural and urban appeal. These new style books also engaged with activities familiar to anyone who had access to land and it is in these books we find the first concentrated attention to seeds. The literature that developed out of the sixteenth and into the seventeenth-century was unique to the period and in style and content are early examples of scientific treatises precursors to the *Philosophical Transactions* of the Royal Society founded in 1660.

The growth of horticultural literature began in the late sixteenth-century and expanded rapidly in the seventeenth. The literary landscape retained elements of the expansive macro world-view of the herbal and the tightly scoped micro surveys of local flora. What emerged was a landscape that was intended to be recognizably English. Heresbach and Estienne's model of patriarchal classical style gave way to a closed and bordered arena as authors scoped the different landscapes and habitats. In the same way as botanists scanned their research areas setting the investigation in time, place and site, so authors formatted their chapters in similar fashion. This process of mental mapping led to a designation of space, and created specialisms such as fruit, timber, vegetable and flower growing. Each chapter was a model, offering a prime environment for allocated plants, a place where nature could be controlled or at least the vagaries of nature ameliorated. With a strong resemblance to a cabinet of curiosity, the garden plan in which speculation, observation and experimentation took place was clearly defined physically, and metaphorically, by fences, hedges, walls, walkways and mental imagery. Not only were these books designed for the preservation of knowledge, but here, within the confines of a specific space, the collector and his contemporaries could ponder, question, compare and categorize, order and organise his collection.

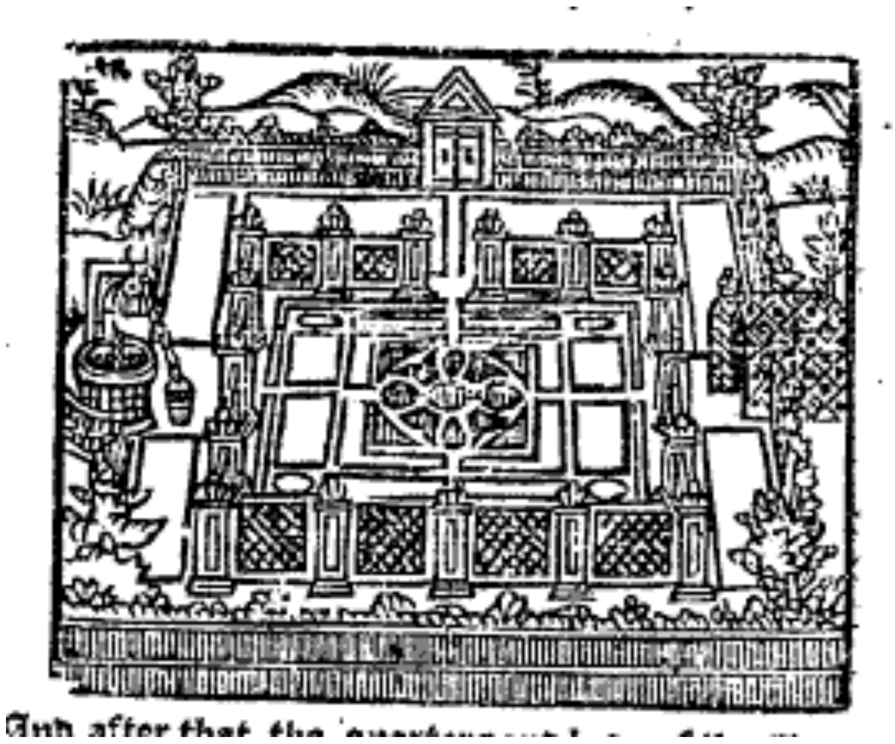

Figure 4. Thomas Hill, *The Gardeners Labyrinth*[139]

One of the earliest maps of an English garden is contained in Hill's *The Gardeners Labyrinth.* In a style mirroring an estate survey, the garden is clearly defined and bordered. Outside the fencing can be seen a rural landscape of hills, grassland and trees, while inside the garden is divided into sections with easy access to a well and water. An ordered garden was symbolic of an ordered society, hierarchical in structure and to quote Markham reflective of the 'physical and moral well-being of the nation.'[140] But this model served a number of purposes as one way to manage the invasion of what might be described as information overload - creating borders and boundaries, defining the space, and displaying your findings. Here order could be created out of disorder,

[139] Thomas Hill, *The Gardeners Labyrinth,* 1577, 41
[140] Jill Francis, "Order and Disorder in the Early Modern Garden*, 1558*-1630" in *Garden History* Volume *36,* (2008), 22

and importantly, within this controlled environment experimentation and trials could be undertaken.

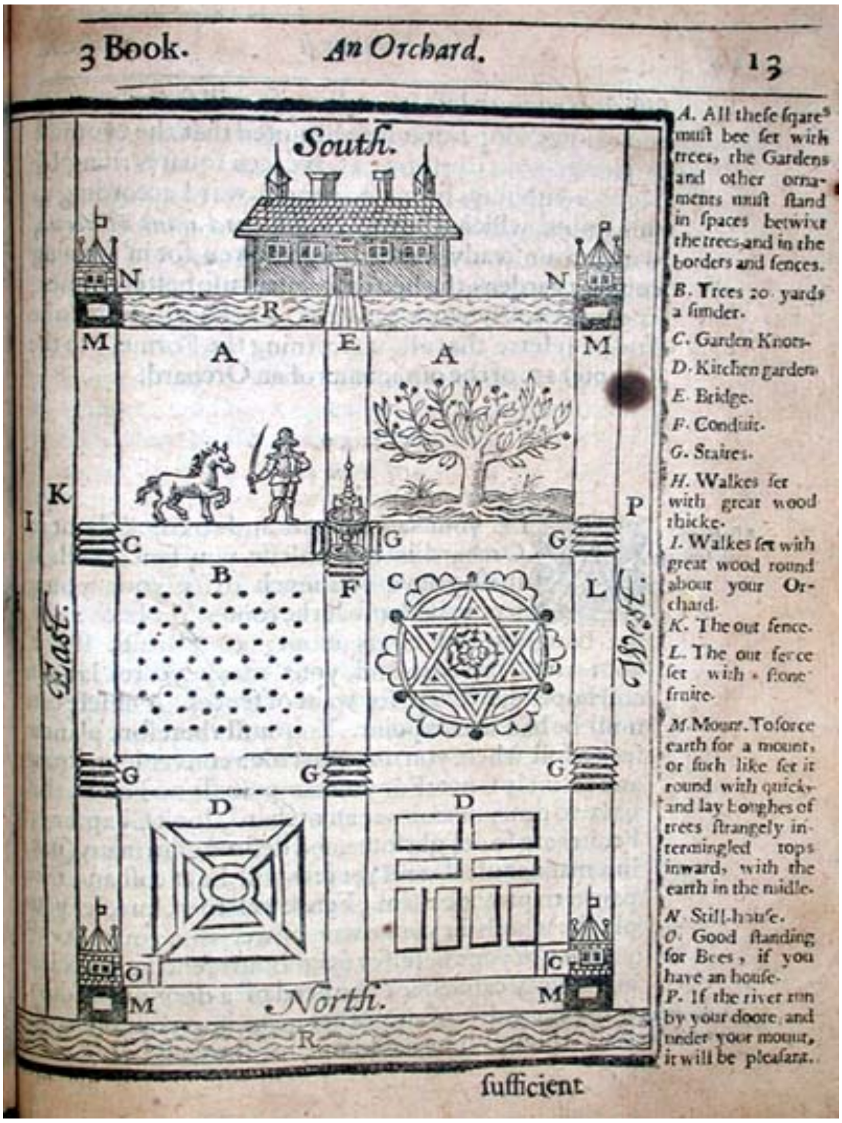

Figure 5. William Lawson, *Nevv Orchard and Garden*[141]

William Lawson's model contained in his *New Orchard and Garden,* although not published until 1618, is representative of an earlier Elizabethan style. It is extremely unlikely that many households emulated such a design, as this was an ideal, an imaginary projection, and one found reflected in the ordering of chapters in books written

[141] William Lawson, *A Nevv orchard and garden* (1631), 13

during this period. In Lawson, the structure of the garden plan resembles a cabinet, ordered, systematic and hierarchical with sculptures and specialist areas for orchard trees and flower leading away from the house towards the vegetable garden. The strong stylized design certainly shows the influence of French and Italianate garden designs and architecture, designs that were being incorporated into the gardens of courtiers and the elite in England during the period. The design feature that is most important for the purposes of this research, however, comes from the fact that the garden is bordered and bounded creating a constructed space of human control. It was also a design that allowed the 'master' and 'mistress' visual appreciation and ownership of a specified environment. In Findlen terms, they were 'possessing nature'.

This concept continued (and continues) well into the 1700s with some small changes. The mapping of the estate in Worlidge's 1688 publication of *Systema horticulturae* bears the influence of estate surveys and the chorographical recording of physical entities. Here we find the internal structure of the garden defined and illustrated, along with physical entities in the countryside including a church, trees and grassland. In an extension of the garden, typical of the grand estates, the land as it stretches outwards into the surrounding parkland is defined for leisure, relaxation and reflection. Within the garden we observe purposeful perambulation reminiscent of the 'metes and bounds' of the medieval parish perambulations.

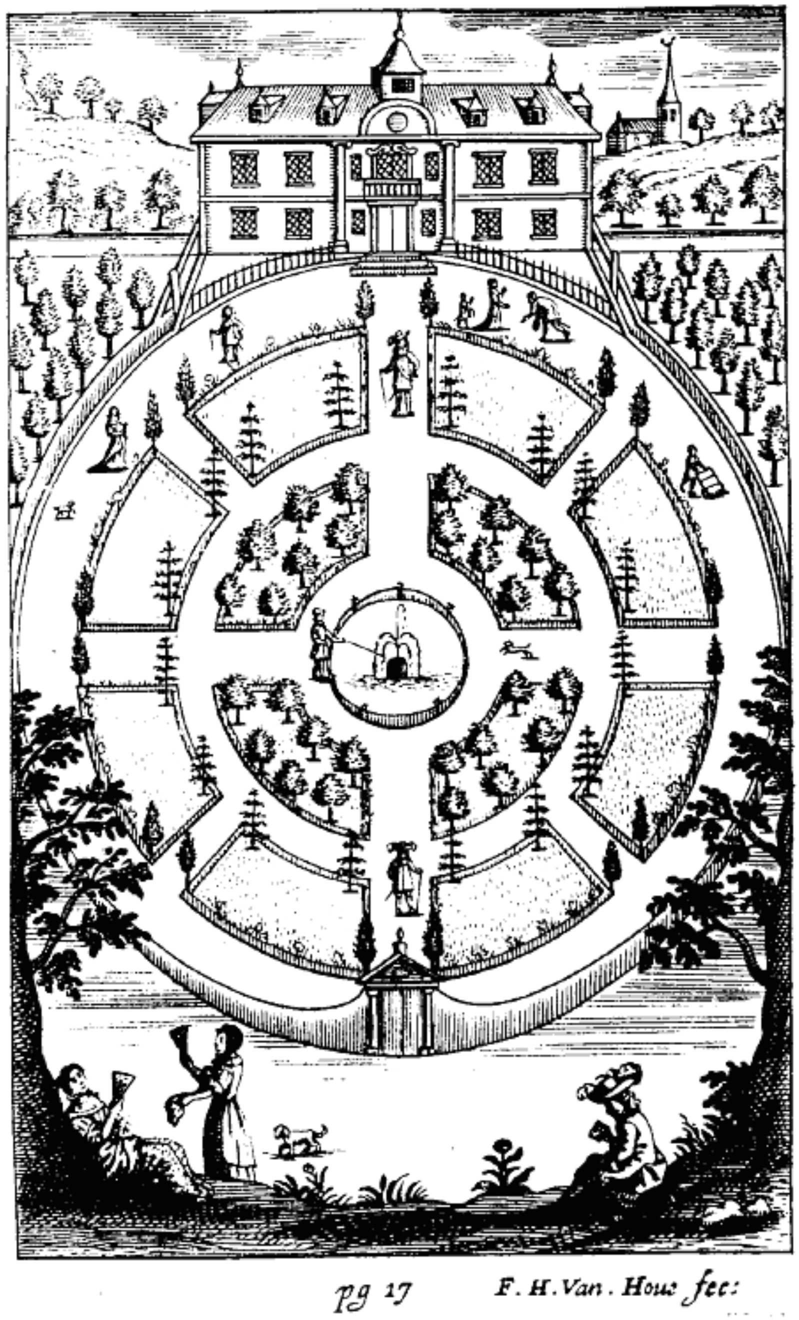

Figure 5
Figured 6. John Worlidge *Systema agriculturae*[142]

The setting of the text mirrored the visual representation. At a generic level, gardens had access to the best quality water, offered shade and

[142] John Worlidge *Systema horti-culturae* (1677), 17

sun, protection from the cold, circulated clean and fresh air (choking coal smoke was a problem in cities), and where pests and disease could be controlled. Clearly defined chapters addressed site-specific areas in the garden landscape, the position of the garden itself, siting of the house, pleasure garden, orchard, fruit, flower, kitchen and herb gardens. In a reflection of herbals, herbs were listed with their medicinal qualities and recipes. Planting and propagating activities were described along with methods to improve the soil, water and protect plants from the elements. John Parkinson's *Paradisi* is a good example of this style of book, which breaks with the herbal tradition with its eclectic mix of horticultural advice, botanical nomenclature, plant virtues and varieties.

According to Thirsk, the branch of alternative agriculture designed to assist farmers in the early modern period was horticulture. With an increase in interest in vegetables, fruits and herbs among the gentry, it is no surprise that specialist horticultural books began to appear. One of the earliest specialist books to be published was on hop growing attributed to Reginald Scot's (c. 1538 –1599) *Perfect Platform of a Hop-Garden* (1574). This book was unusual during this period, and it was not until the 1600s, at a time of political and social upheaval, that specialist books became popular with authors. An alternative agriculture, as described by Thirsk, emanated from the sixteenth-century in response to price fluctuations in corn and overseas imports. As a result estate owners began to grow basic vegetables for the market. Their interest was complimented by a private consumption of luxury foods such as artichokes, asparagus, and cherries, grown in newly constructed or reinvigorated vegetable gardens and orchards.[143] Estate owners also began, according to Thirsk, to experiment with what she describes as 'novel industrial crops', madder, woad, flax and hemp, but perhaps the most inclusive branch of alternative agriculture was horticulture, and

[143] Thirsk, *Alternative Agriculture*, 27-43

certainly the fads and fancies of the gentry encouraged the growing of vegetables and fruits. Specialization began to creep into the market, and Thirsk provides evidence of estate owners requesting fruit, vegetables and herbs from tenants, a demand that provided the rural population with profitable use for their garden land. In the same way as botanical gardens and botanizing influenced the nature of herbals and floras, so the estates and nurseries of the elite, influenced the literary landscapes of horticultural treatises.[144]

These books were not solely for horticultural advice and, as advanced in the next chapter, we find authors were exploring the science of husbandry and horticulture. Their observations led them away from cataloguing and categorizing to considering how plants and seeds worked. In setting their garden map they were setting the organization of their treatises. In addition, specialist books provided a unique opportunity for seventeenth-century authors such as Moses Cook's forest garden, the orchards of Ralph Austen and Samuel Gilbert's flowers, along with others, to offer a depth of scientific enquiry hitherto unknown.[145] Within each discrete horticultural chapter or section, authors were able to refine their observations. Instead of drawing and describing plants in isolation or segmenting seeds, roots, leaves, flowers for medicinal use, they began to ask fundamental questions about the nature of plants, the environment in which they grew, and how they could be improved. In each specialist chapter they literally froze the plant and seed in time and space.

This was a period of significant change in the way botanical information was presented. From the large format herbals, to the specialist floras,

[144] For a discussion of nurseries see Chapter 10.
[145] Moses Cook, *The manner of raising, ordering, and improving forrest-trees* (1676). Ralph Austen, *A treatise of fruit-trees, shewing the manner of grafting, planting, pruning, and ordering of them in all respects* (1653). Samuel Gilbert, *Florist's vademecum and Gardener's Almanack* (1682)

the building of a literary landscape was captured in the horticultural and husbandry manuals from the 1540s through to the 1700. The most prolific botanical texts in the 1600s were horticultural, in which literary landscapes were designed and created for the ultimate control of nature. Within these centres of calculation, these literary laboratories, the propagator investigated, trialled and tested his plants and seeds.

Chapter 3

Inventing the Propagator

The previous chapter discussed how books were fashioned from early herbals and floras, to the specialist treatises concerning husbandry, timber, fruit, vegetables and flowers. Having constructed their literary landscapes, this chapter will consider the social construction of the propagator and consider how the virtuosi contributed to the collecting phenomena. The role of Francis Bacon as he 'invented the scientist' will be considered, and the advent of the improver, and the rise of the specialist.

Men are not born but fashioned, the Dutch humanist Desiderius Erasmus wrote in 1513 in his book on manners. The sixteenth-century, as Stephen Greenblatt noted, was the age of 'self-fashioning' adding there appeared to be 'increased self-consciousness about the fashioning of human identity as a manipulable, artful process.'[146] Greenblatt's approach is drawn from Clifford Geertz[147], and, in particular, Michel Foucault's theory of cultural practices in relation to or, as expressions of power. In his analysis of literature from the Renaissance period, one of Greenblatt's conclusions was that self-fashioning led to 'profound' social mobility facilitated by an author's ability to construct an identity. Interpreting text, he argues, leads to an understanding of the 'interplay of their symbolic structures with those perceivable in the careers of their authors and in the larger social world, as constituting a single, complex process of self-fashioning and, through this interpretation, come closer

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[146] Stephen Greenblatt, *Renaissance Self-Fashioning, From Moore to Shakespeare* (University of Chicago Press 2005), 2

[147] For Geertz, culture is "an historically transmitted pattern of meanings embodied in symbols, a system of inherited conceptions expressed in symbolic forms by means of which men communicate, perpetuate, and develop their knowledge about and their attitudes toward life" (Geertz 1973d:89). Foucault moved away from an analysis of power as an instrument of coercion held by 'actors' and applied within certain structures, towards a notion that: 'Power is everywhere' and 'comes from everywhere' so in this sense is neither an agency nor a structure' (Foucault 1998: 63)

to understanding how literary and social identifies were formed in this culture.'[148]

Self-fashioning in the collecting world is particularly noted by contemporaries in the early modern period, although they conceived themselves in somewhat more favourable terms. Referring to collectors in his *The Compleat Gentleman* (1643) Henry Peacham wrote: 'Statues, Inscriptions, and Coynes…such as are skilled in them, are by the *Italians* called *Virtuosi'.* In England the fashioning of 'virtuosi' has predominantly been attached to members of the Royal Society who, according to Yeo, applied the label to themselves.[149] Or, as Whitaker suggests, becoming a 'curiosi' or 'virtuosi' was something learned by aristocratic and aspiring young gentleman as they undertook their continental grand tour.[150] However, this somewhat narrow interpretation of virtuosi does not represent the composition of what Hunter describes as a 'scientific community'. Rather than 'virtuosi' being predicated on elite and gentlemanly 'amateur' activities, virtuosi comprised a rather more inchoate group and these lesser collectors, theorists and enthusiasts, he argues, were familiar to conte[151]mporaries.[152] Findlen notes that among members of the patrician elite, 'collectors were virtually obsessed with the question of identity…They explored this problem in their writings and in the presentation and interpretation of objects in their museums. Their patrons, visitors, and readers contributed to the discursive

[148] Greenblatt, *Renaissance Self-Fashioning*, 5-6
[149] Richard Yeo, *Notebooks, English Virtuosi, and Early Modern Science* (University of Chicago Press 2014)
[150] Katie Whitaker, "The Culture of Curiosity" in N Jardine, J.A. Secord and E.C. Spary, (eds) *Cultures of Natural History* (Cambridge University Press 1996), 75-91. See also John Stoye, *English Travellers Abroad, 1604-1667: Their Influence in English Society and Politics,* (Yale University Press 1989)
[151] Henry Peacham, *Compleat Gentleman* (1634), Ch. 12, 105. The first edition, which did not contain this chapter on antiquities, appeared in 1622.
[152] Michael Hunter, *Science and Society in Restoration England* (Cambridge University Press 1981). Hunter analysed 65 British born scientists active in the late seventeenth-century. From his sample he found 40% were landed gentry, 23% were sons of Anglican clergy, 12% were sons of merchants. Artisans, yeomen and others of lesser social status accounted for 14% with a further 6% unknown.

formulation of the identity of the collector by confirming the appropriateness of the images with which collectors represented themselves, and by adding their own embellishments to the canon of the exemplary figures.'[153] Shapiro and Frank stress the overlap of interests between antiquarians and physicians in the early Royal Society, and the operation of an intellectual framework that did not demarcate historical and natural observations.[154] Yeo refers to the English 'virtuosi' as one who pursued Baconian natural history, including botany and zoology, indeed every subject that did not fall under the heading of civil history. Houghton takes a middle line between the earnest young traveller, and the Baconian natural historian. He describes two kinds of virtuosi, the amateurs or dilettantes, and the '"sincere" inquirers into nature, with or without the Baconian purpose of ultimate use.'[155] Houghton claims that patronage of learning was taken seriously once the nobility became engaged. The virtuoso was a fusion of the courtier and the scholar into a 'gentleman-scholar'. Again we find historiographical accounts tend to focus on the elite, courts and wealthy gentleman with leisure to spare. According to Houghton, the virtuoso was called an antiquary until 1641 suggesting to him there was limited association with science. Indeed, Harkness does not apply 'virtuosi' to her research subjects (some of whom, until researched by her, were obscure in history), but presents them as contributors to an Elizabeth scientific movement.[156]

Authors selected for discussion in this chapter have been chosen because they represent the strength of scientific discourse in the period, and because they demonstrate that a scientific movement as presented

[153] Paula Findlen, "Inventing the Collector" in *Possessing Nature*, *Museums, Collecting, and Scientific Culture in Early Modern Italy* (University of California Press 1994), 293
[154] Barbara Shapiro and Robert Frank, *English Scientific Virtuosi* (University of California Press 1979)
[155] Walter E. Houghton, Jr., The English Virtuoso in the Seventeenth-Century: Part I in *Journal of the History of Ideas*, Vol.3 No.1 (Jan 1942), 51-73
[156] Deborah Harkness, *The Jewel House*

by Harkness stretched beyond the streets of London. By the 1600s botany was no longer the preserve of scholarly communities. It remained incumbent on these new authors to present themselves as authentic, and with an authority previously reserved for the wealthy collector or the virtuosi. Patronage, social, political and religious associations and personal experience became important trademarks towards fixing their identity.

Googe dedicated his translation of *The Foure books of husbandrie* to the politician and one time Lord Justice of Ireland, William Fitz Williams.[157] Dedicating literature to the wealthy and elite was a method used by many to authenticate their works, but such aspirations were beyond the social and political means of others. Plat dedicated *The Jewel* House to the Earl of Essex, but was at pains to present himself as a man of the people and transmitter of knowledge, 'having out of mine own experience, as also by long conference with divers Gentlemen of the best skill and practice.'[158] Johnson held the patronage of the Warden of the Society of Apothecaries, who funded his botanizing trips, while the prolific author and plagiarist Markham recommended himself as a soldier and farmer, and claimed authority from hands on experience 'yet did I for nine years follow the plow'.[159] In the 1670s Cook ascribed his authenticity to his long-term employment as gardener to the Earl of Essex with his authority, which he never doubted, seemingly self-evident. Likening his book to a plantation 'which, though I have endeavoured to keep as well pruned from Errors, and as clean from Weeds as I could' he continued, 'I have been long in taking true Observations…I have not bufhelled my Light, but have fet it to the Publick view; which if it enlighten thee in the good and true way which I

[157] Googe/Heresbach, *The Foure books of husbandrie*
[158] Hugh Plat, "To the stvdiovs and well-affected Reader" *Floraes Paradise,* (1608)
[159] Gervase Markham, *The English Huswife* (1653), xii

intended.'[160] Austen heightened his authenticity as a spiritual Puritan, and his authority through his skills as a nurseryman, while improver Blith dedicated *The English Improver* to Oliver Cromwell.[161] Worlidge broke with a growing tradition and dedicated his book *Systema Agriculturae* to the 'Gentry and Yeomanry of England'.[162]

To truly cement authenticity and authority, authors needed to demonstrate they were well read and could refer and critically appraise classical text of Roman agronomists such as Columella, Cato, Varro and Palladius, Greek philosophers Xenophanes, Aristotle and Cato, and natural philosophers, for example, Pliny and Theophrastus. The early English husbandry manuals from Fitzherbert called on classical text, while Tusser poetized his way through the calendar year.[163] Along with the translations from Surflet and Googe of Mediterranean husbandry, these four manuals, according to McRea, formed a backbone from which the science and economies of husbandry expanded into the seventeenth-century.[164] The alchemical philosophy of Paracelsus was significant, while the fermenting qualities of nature, as described by van Helmont and Palissy, was countenanced by authors in sixteenth and seventeenth literature. By the 1650s authors like Sharrock and Grew were investing in a revival of atomism through the works of Epicurus and Lucretius, the contemporary writing of Pierre Gassendi, and the mechanical atomistic approach of Descarte.[165] Amidst all of this, with the most significant impact on the landscape of natural histories, was Francis

[160] Moses Cook, Epistle and To the Reader in *The Manner of Raising, Ordering and Improving Forest and Fruit-Trees* (1669)
[161] Ralph Austen, *A treatise of fruit-trees, shewing the manner of grafting, planting, pruning, and ordering of them in all respects,* 1657. Walter Blith, *The English Improver, or, A New Survey of Husbandry* 1649
[162] John Worlidge, *Systema agriculturae,* or *The Mystery of Husbandry,* (1668)
[163] John Fitzherbert, *The boke of husbandrye,* (1530?/1598). Thomas Tusser, *A Hundreth Good Pointes of Husbandrie,* (1557)*; Five hundred points of good husbandry,* (1573)
[164] McRae, *God Speed the Plough,* 135-168
[165] Robert Sharrock, *The History of the Propagation and Improvement of Vegetables* (1660) Nehemiah Grew, *The Principles of Bodies* (1644)

Bacon whose work *Sylva Sylvarum* was consistently referred to and critiqued by the Puritan improvers.[166] Patronage was part of the story in inventing the propagator. What was also important was the authority of the sources they drew on to support their own 'learned' authorship.

At this point we need to return to the Latourian network because it is here we find the interaction between man and artefact as networks interlinked building cycles of accumulation. Gathering momentum, and building and accumulating, networks extended through a Republic of Letters, exchanges, plant hunting, trading, bartering, collecting and displaying as humanists crafted their identities. Their reference points were, according to Findlen, 'family, profession, social, and religious groups and the world of learning', and there was no better way to present ones credentials than through text.[167] This chapter will argue that, of course, authors of herbals, floras and husbandry and horticultural treatises used their connections; but more particularly they created their identity and their credibility through their investigation of plants and for the purposes of this work, seeds. Text, portraiture and art, fixed the identity of the collector and collections in a way the transient nature of private collections and botanical specimens could not. The social construction of the propagator was as important as the social construction of the literary landscape. To consider how some authors publicly present themselves, we journey into the literary landscape of plants beginning with Elizabethan John Gerard.

RENAISSANCE MAN

History has treated Gerard kindly. Generally conceived by historians as the author of his *Herbal,* he was, in fact, considered somewhat of a

[166] Francis Bacon, *Sylva Sylvarum: Or a Natural History in Ten Centuries* (1627). See Chapter 4
[167] Findlen, *Possessing Nature*, 296

plagiarist and transmitter of errors by his contemporaries L'Obel, Johnson and Goodyer. The *Herbal* Gerard claimed as his own was, in fact, a translation of Dodoen's *Stirpium historiae pemptades sex* (1583), and most probably carried many of the errors Gerard failed to notice, and for which he was criticized. He was a considerable collector, and fashioned himself as an exemplary Elizabethan 'virtuoso'. Coming from relatively humble beginnings, he worked his way up to become a barber surgeon before coming under the patronage of the Queen's adviser William Cecil. He supervised Cecil's garden 'by the space of twenty yeeres', and his authority in all matters botanical was stamped with Cecil's position and patronage.

Figure 7. John Gerard line engraving, artist John Payne, published 1633
National Portrait Gallery

The publication of Gerard's *Herball, or Generall Historie of Plantes* in 1597 provided a wide-ranging and eclectic selection of Mediterranean and exotic plants from overseas, intermingled with indigenous plants and herbs.[168] It was not unusual for botanical works to carry the image

[168] Gerard, John, *The herball or Generall historie of plantes. Gathered by Iohn Gerarde of London Master in Chirurgerie,* 1597 and amended version (1633)

of the author, and the front-piece to the *Herbal* is no exception, and shows an illustration of Gerard surrounded by a somewhat austere archway, free of plants or naturalistic adornments. He carries in his hand a potato, believed to be the first printed description of this plant, thereby adding to Gerard's own presentation of himself as a collector of the rare and exotic.[169] Gerard's less researched counterpart John Parkinson appeared to be well considered by his contemporaries with his private garden seemingly used for botanical study.[170] Parkinson also came from relatively humble beginnings, and as apothecary and herbalist to Charles l was also dependent on patronage. While also including a portrait on the front cover, Parkinson seemed less concerned with presenting himself as a Renaissance virtuoso, and more prosaically presented himself as an educator.

> And because our English Gardiners are all or the most of them vtterly ignorant in the ordering of these Outlandish flowers, as not being trained vp to know them, I haue here taken vpon mee the forme of a new Gardiner, to giue instructions to those that will take pleasure in them, that they may be the better enabled with these helpes I shall shew them, both to know how they should be ordered, and to direct their Gardiners that are ignorant thereof, rightly to dispose them according to their naturall qualities.[171]

Gerard was active during a specific period of intense collecting, and his *Herbal* is evidence of his strong sense of integration into scientific centres of activity, and the influence from Italy and other countries on the continent. However, his was one of the last herbals to be produced in England, as according to Arber, herbals gave way to medical

[169] Agnes Arber, *Herbals: Their Origin and Evolution* (Cambridge University Press 1912). For fuller account of patronage in Italy see Paula Findlen, "Patrons, Brokers, and Strategies" in *Possessing Nature*, 346-392
[170] See Anna Parkinson, *Nature's Alchemist* (Frances Lincoln Ltd. 2007) for an account of Parkinson's life and works.
[171] John Parkinson, *Paradisi in sole paradisus terrestris* (1629), 13

pharmacopoeia and botanical flora.[172] Parkinson's *Paradisi*, on the other hand, heralded a new means of transmitting knowledge, breaking from the herbal tradition with its eclectic mix of advice on methods of cultivation, botanical nomenclature, plant virtues and varieties.

PLAT'S JEWEL HOUSE

Unlike Gerard, Parkinson and indeed Bacon, no portrait of Plat, had there ever been one, survives. Plat has received recent interest from historians involved in researching scientific attitudes in England during the early modern period. The profundity of Francis Bacon's presence in English philosophical and scientific thought has historically overshadowed many other lesser-known candidates, who, according to Harkness, offer us an interesting narrative of scientific activities in the Elizabethan period.[173] Mukherjee describes Plat as a dearth scientist, and while he wrote a pamphlet on food preparation during famine,[174] his was not, as noted by Thick, a philanthropic stance. Plat was a man who was in the business of making money, and he wrote about a wide range of topics, with, according to Thick, the aim of selling his ideas.[175] Plat is now being recognized as a serious contender in the history of science, and perhaps the reason why he has failed until recently to be recognized in this guise rests with Harkness's assessment of Bacon's influence. 'Bacon did not want the study of nature to be left entirely in the hands of the Coles, Garrets, Russwurins, Clowses, and Drapers of his world, much less in the hands of gardeners, clockmakers, engineers, alchemists and women.'[176] The custodians of natural history and arbiters of natural knowledge should, in Bacon's literary world, be well-educated

[172] Arber, *Herbals: Their Origin and Evolution*, 264-270
[173] Harkness, *The Jewel House,* 214.
[174] Ayesha Mukherjee, "Manured with the Starres: Recovering an Early Modern Discourse of Sustainability" in *Literature Compass,* (11/9 2014), 602-614
[175] For a comprehensive assessment of Plat's writings and interests see Malcolm Thick, *Sir Hugh Plat.*
[176] Harkness, *The Jewel House,* 214

and well-born gentlemen. However, Plat's legacy is writ large in his manuscript notebooks and publications, in which he professes himself, and indeed crafts his identity, as a dedicated experimenter and inventor. He was, in the assessment of Thick, a collector of useful knowledge. Like Thomas Hill, Plat was a formulator of projects and in the *Jewel House* he claimed 'the trew end of all our priuat labors and studies, ought to bee the beginning of the publike and common good of our country'. Plat stamped his authority to the 'stvdiovs and well-affected Reader' in *Floraes Paradise*. 'Having out of mine owne particular experience' he continued, 'as also by long conference with diverse gentlemen of good skill and practice' referring to himself as well read and knowledgeable of continental treatises. It was learning through 'doing' that was central to Plat's work.

IN THE MARGINS – BACON'S SCIENTISTS

….the nature of things betrays itself more readily under the vexations of art than in its natural freedom – Francis Bacon[177]

Bacon served as Elizabeth's Lord Chancellor until his spectacular fall from favour when he was accused of and admitted to taking bribes. Bacon was an intellectual throughout his career, and following this ignominious end to his public career he drew himself as a man of scientific enquiry engaged in the 'propagation and Advancement of Knowledge'. The manner in which Bacon presented his exoteric and esoteric perspectives was a landmark in scholarly enterprise. He moved natural philosophy off library shelves, out of the herbals of apothecaries and the floras of enquiring gentlemen, and into a proto-scientific domain. Well researched by philosophers, historians of science and politics, and to some extent garden historians, Bacon was a controversial

[177] Francis Bacon, "The Great Instauration", in James Spedding, *The Works of Francis Bacon: Translations of the Philosophical Works* (1869), 48

figure in his lifetime and remains controversial today. Feminist historian Carolyn Merchant describes Bacon as a man who advocated the domination of nature for human benefit. Central to Merchant's critique is Bacon's use of language: 'He compared miners and smiths whose technologies extracted ores for the new commercial activities to scientists and technologists penetrating the earth and shaping "her" on the anvil.'[178] Bacon, Merchant contends, viewed nature as something that must be bound in service, where the "searchers and spies of nature" were to discover her plots and secrets. His search for natural knowledge, she claims, portrays a physically coercive relationship between male enquirer and female nature. In contrast, Pesic dismisses this stating Bacon had no wish to 'torture' nature through experimentation. An experienced judicial orator, queen's counsel, later solicitor general and attorney general, Bacon was versed in and evoked metaphors of legal examination.[179] Believing that an Aristotelian method of study merely touched nature by the fingertips, Bacon resolved to invoke a deeper, more inquisitorial approach wherein he envisaged a struggle that tested the nobility of the seeker and of nature.

Vickers assessed Bacon's contribution to science to be derivative, contradictory and in some cases dismissive of new scientific discoveries. 'If we can no longer estimate Bacon the scientist very highly,' Vickers concludes, 'justice has certainly yet to be done to him as a writer'.[180] Preaching to the converted is how Harkness describes Bacon's call to reform natural knowledge when in *The Jewell House* a decade earlier Plat had called on readers to study nature to improve the commonwealth. Harkness provides substantive evidence to support her

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[178] Carolyn Merchant, *Radical Ecology: The Search for a Livable World* (Psychology Press 1992), 45. Merchant, "The Death of Nature: Science and Worldviews" in *Radical Ecology: The Search for a Livable World,* 41-60: *Radical Ecology,* 1-25.

[179] Peter Pesic, "Wrestling with Proteus: Francis Bacon and the "Torture" of Nature" in *Isis* Vol.90, No.1 (March 1999)

[180] Brian Vickers, *Francis Bacon and Renaissance Prose* (Cambridge University Press 1968), 2

claim that Bacon was simply revising contemporaneously Elizabethan 'science' already in the public domain.[181] However, there are similarities and differences in the work of the two men that Harkness does not cover. According to Debus, both Plat's *The Jewel House* and Bacon's *Sylva Sylvarum* are reminiscent of the Renaissance "book of secrets" in the natural-magic tradition.[182] Both men were proponents of alchemy and natural magic rooted in Paracelsian philosophy, and each of them veiled their interest, Plat with alchemical signatures and Bacon with esoteric and cabalistic rhetoric. But, the writings of the two men differ significantly when it comes to plants and seeds.

Daston and Park discuss the contribution of Bacon within a chronological and historical framework of philosophical attitudes to wonders and marvels in nature. Bacon rejected the Aristotelian belief that monsters and aberrations interrupted the natural order. For Bacon, they created and inspired new ordering as nature and art converged in marvels. It was this new ordering that Bacon sought to define, for he believed nature's wanderings provided hints for the mechanical arts. He was a recondite author, able to present exoteric works in the manner of an enquiring natural philosopher to a large and heterogeneous audience.[183] But he also presented a complicated and somewhat impenetrable esoteric world-view, one often ignored by historians of science. This was a world of religion, alchemy and the occult, cosmology and natural magic.

Bacon was certainly an erudite author, fashioning himself as a propagator of knowledge, but he was also inventing and fashioning the 'scientist'. In the emboldened fictional world of *New Atlantis* Bacon, like the young and aspiring virtuoso, associoates travel with a gentleman's

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[181] Harkness, *The Jewel House,* 142

[182] Allen G. Debus, *Man and Nature in the Renaissance.* (Cambridge University Press 1978), 104

[183] Lorraine Daston & Katherine Park, *Wonders and the Order of Nature.* (Zone Books 1998), Ch.7

education, a means of enriching the mind and methodically amassing knowledge. Learning to be a virtuoso and learning to be a scientist seemed in Bacon's mind to hold similar practical elements. Upon his utopian island was set a research center, a Latourian center of calculation. *Solomon's House* was a place where Bacon's scientists collaborated in a rational and impersonal way for the material benefit of mankind. In his imaginary research facility, nature was to be reconstructed within a microcosm, creating an artificial world of knowledge in which the scholar experimented with nature in order to conquest 'the Works of Nature.'[184] In a short but particularly important section entitled the history of the mistakes of nature *[historia naturae errantis],* Bacon introduces the reader to the rationale behind his drive to both understand and 'vex' nature. Nature, he explained, exists in three states and is subject to three kinds of regime.

> 'Either she is free and develops in her own ordinary course (history of creatures) or she is forced out of her proper state by the perverseness and insubordination of matter and violence of impediment (history of marvels), or she is constrained and molded by art and human ministry (history of arts).'[185]

Bacon's essay *Of Gardens* reflected his own experience as one who owned a substantial garden, so there are practical elements held within the literary descriptions.[186] But this was also an allegorical garden. God Almighty first planted a garden, and Bacon's romantic and imaginary creation was as close a replica as humanly permissible. This was a princely garden, where knowledge was neither wasted nor uncultivated. Enclosed within socially constructed, culturally defined boundaries, this

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[184] Francis Bacon, "Solomon's House", in *New Atlantis* (1627)

[185] Francis Bacon, *Preparative toward natural and experimental history. I Aphorisms on the composition of the primary history (*1620). See also *Of the Advancement of Learning: Book II*

[186] Francis Bacon, "Of Gardens" in *The Essayes or Covnsels, Civill and Morall* (Essay 46, 1625)

garden would bloom all the year and be fruitful like the original Garden of Eden. But, in the margins, the periphery, at the edge of imagination, among the great works of nature *[inter magnalia naturae],* was to be found the impossible. Although preternatural phenomenon was central to his study of nature, Bacon broke with tradition. He did not believe in supernatural aberrations, thinking atypical or anomalous phenomena could, and should, be rationally explained.

So the scientist in Bacon's new world laboratory was there to 'vex' those parts of nature in the margins where patterns turned to problems and problems vexed the mind. The Baconian influence on scientific enquiry is evident in the horticultural and husbandry works of the improvers. Authors presented many different and varied experimental processes as they sought to understand how plants and seeds actually worked. It is difficult to gauge the level of practical application from many of these authors, and how much was actually drawn from the many cycles of accumulation. The shadow of herbals and floras can be found woven in the text, along with influences from classical and contemporary figures, and there was a good deal of plagiarism. However, some of the authors developed commercial ventures, which would not have happened without significant theoretical and practical knowledge.[187]

The Renaissance virtuoso, a young man of travels, an educated collector, fashioned by wealth and privilege, was a recognizable figure in Bacon's social construct. But, fashioning was taking place in other social spaces, most particularly within the landscape of the horticulturalist. Here self-fashioning was also towards authenticity and credibility of knowledge and experience, but was occurring within less evident sections of the community. As the landscapes of the horticulturalist became more defined, so did the collections, and in a turn from the polymath virtuoso,

[187] See Chapter 11 of this thesis.

we find the emergence of the 'specialist'.

BECOMING SPECIALIST

As Webster articulated, man was to be the 'helper and interpreter of nature,'[188] and titles of sixteenth-century books certainly conjured up imaginary puzzles the author set to solve. From labyrinth and mazes to the invocation of perfection in a paradise of flowers, a Garden of Eden, an earthly paradise, literature was full of the mystical. Professors of secrets in this scenario were natural magicians, alchemists, astrologers and diviners. In the husbandry manuals the power of knowledge rested with the master as he imparted instructions to stewards and servants. Surveying his lands, Rigo conjured a picture of fertile prosperity with the best dung for the field the Master's foot, and the best provider for the house the Master's eye.[189] The required collective activity of all those managing and working the estate was to maintain the status quo. Authors populated their landscapes with masters, managers, stewards and servants, and in Parkinson's case himself: 'where I doe as well play the Gardiner, to shew you (in briefe, but not at large) the times and manner of sowing, setting, planting, replanting.'[190]

Renaissance literature of the seventeenth-century was a continuation of two different outlooks. One emanated from theoretical science, theology or philosophy, and emphasized the role of man in changing or controlling nature, with proponents of this view including, Paracelsus, Bacon and Palissy. The other was everyday observation, without philosophy or moralizing, as discussions of techniques in mining, forestry, irrigation or engineering address the practical needs of statecraft. Glacken argues a growing attitude and self-confidence

[188] Webster, *The Great Instauration, Science, Medicine and Reform, 1626-1660*. Duckworth (1975), 329
[189] Googe/Heresbach *The Foure books of husbandrie* (1577), 2
[190] Parkinson, *Paradisi*, Letter to Covrteovs Reader

towards artisanship, invention and technology, rekindled Paracelsian alchemical principles, 'Man is not a creator of raw materials – God is; but man is a powerful transformer'. [191] Man as transformer, however, required particular expertise. Books of secrets gave way to the landscapes of husbandry and horticultural as specialist books reached the market. The mapping of territory in this new style has been discussed in Chapter 2 and this section will concentrate on the treatises written on specialist subjects.

The notion of what constituted expertise could be rather fluid. In sixteenth-century England the concept of being an expert or artisan encompassed experience and skill, which involved a combination of hands on experience and extensive book learning. As Ash contends, an unlearned craftsman might be highly experienced in his field, but still lack a deeper understanding of his craft, and as such, could not be defined as fully expert. [192] Horticultural and husbandry publications became important transmitters of scientific investigation, with a rise in specialist subjects covering forestry, orchards, vegetables and flowers. Authors became purveyors of improved knowledge, turning a mystical landscape of secrets into a style and content more akin to Bacon's *Solomon's House*. As metaphorical landscapes were scoped and defined, so the role of the propagator was fashioned, and certainly by the 1620s improvement was central to his activity. Warde argues the concept of improvement was initially associated with the means and ways of improving rental value. The improvement agenda grew to include a plethora of activities. From self-improvement to improving the lot of the poor the improver with his requisite qualities and virtues surveyed the

[191] Clarence Glacken, *Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth-Century* (University of California Press 1967), 462-464
[192] Eric H Ash, *Power, Knowledge & Expertise in Elizabeth England* (The John Hopkins University Press 2004), 10-13

social and political landscapes.[193] Thus, the Puritan improvement agenda became embedded in the landscapes of the 'specialist'.

Timber

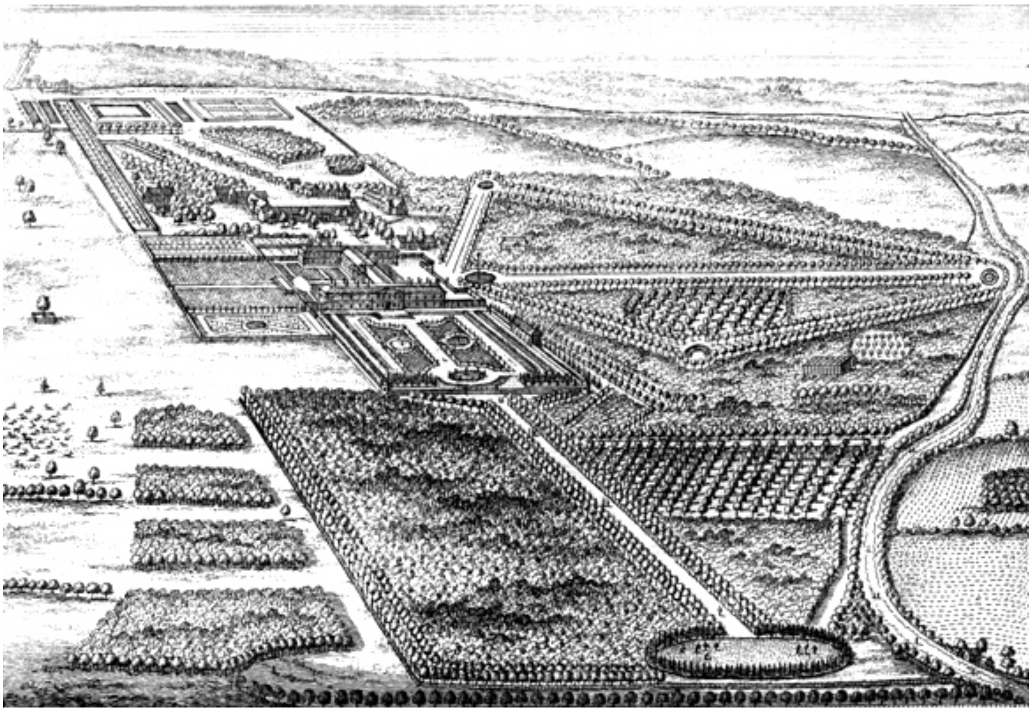

Figure 8. Cashionbury in Hertfordshire, Engraving by Johannes Kip after Leonard Koyff. From James Beeverell's *Les délices de la Grande Bretagne,* c.1707

When John Evelyn addressed the King in his second edition of *Sylva* (the first having sold more than a thousand copies), he estimated that two million timber trees, 'beside infinite Others', had been propagated as a direct result of his publication.[194] A member of the Royal Society and early associate of Samuel Hartlib, Evelyn was a prodigious author and diarist, and not above ennobling his own achievements. What prompted Evelyn to write his book *Sylva* was a growing concern in England of timber shortages. In order to obtain enough timber for its fleet England

[193] Paul Warde, "The idea of Improvement" in Richard W. Hoyle, (ed) *Custom, Improvement and the Landscape in Early Modern Britain* (Ashgate Publishing Ltd 2011), 127-149

[194] John Evelyn, "To the King" in *Sylva, or, A discourse of forest-trees, and the propagation of timber in His Majesties dominions* (1679)

started to import wood supplies, first from the Baltic region and Scandinavia, and later, for construction purposes, from the Colonies in North America. Warde's research on the 'fear' of wood shortage c.1450-1850 across areas of Europe, argues that the framework for regulation was set in the fifteenth and early sixteenth-century, with the widespread development of state oversight of woodlands. Warde questions whether wood shortage was real, in terms of exhausting a natural resource, or whether it was imagined. Early fears, he argues were generated by government intervention in resource management, urban growth and industry, and increasing and competing competition of woodland use. Using quantitative data, Warde concludes that, in fact, at a general level, there was no shortage of wood, although this may not have been reflected at a local level where wood was a crucial necessity.[195]

Nevertheless, Evelyn demonstrated that the 'fear' of wood shortage was very acute, and as a result there was a call for owners of estates to plant trees.[196] Nowhere was this more clearly demonstrated than by the endeavours of Arthur Capell, 1st Earl of Essex (1631-1683), who employed Moses Cook as head gardener at Cassiobury to fulfil an ambitious lifetime project to raise and plant a forest garden. Two books serve to illustrate a specialist response to a national 'fear', Evelyn's mighty *Sylva,* and the subject of this research, Cook's little known *The Manner of Raising, Ordering and Improving Forest and Fruit-Trees*.[197] Cook was clearly a specialist in his field, unlike Evelyn who compiled a selection of social and political evidence for his treatise. Cook's employer may well have been caught up in the political narrative, but Cook himself was a botanist with a deep understanding of plants and seeds. He had a

[195] Paul Warde, "Fear of Wood Shortage and the Reality of the Woodland in Europe, c.1450-1850" in *History Workshop Journal*, Vol 62, Issue, 1 (2006), 62

[196] John Evelyn was commissioned to produce a discourse concerning forest trees, which he presented verbally to the Society. The response was positive and the text was eventually published in *Sylva: A Discourse of Forest Trees and the Propagation of Timber in his Majesties Dominions* (1664). Four editions were produced in Evelyn's lifetime with seven posthumous editions.

[197] Moses Cook, *The manner of raising, ordering, and improving forrest-trees* (1669)

practical, down-to-earth style of writing combining oral traditions, 'do as our Farmers do', with the influence of Roman agronomists and Paracelsian alchemical principles. John Evelyn is believed to have described Cook as 'somewhat adept in Astrology'.[198] From his book we learn that he was well read, quoting and referencing the works, among others, of Paracelsus, Francis Bacon, John Gerard, John Parkinson and John Evelyn. He had a keen interest in natural philosophy and cosmology, and the rules of 'Arithmetick or Geometry', which, he used for planning and planting. It is almost certain he had access to his employer's extensive library using the books to enhance and compliment his practical skills and knowledge.[199]

At the end of his book Cook includes mathematically formulated diagrams. His use of mathematics was not unusual, but that he applied it to gardening reflects a growing use of mathematical techniques for planning. Acheson argues that this style of diagrammatic representation stemmed from military strategy and the need to visually present the military landscape. The method of measuring aspects of three-dimensional space and objects was then utilized in garden design.[200] Daniel Loris's *Le thresor des parterres de l'uniuers* (1629) translated into English and German, instructs readers in how and what to measure, how to draw the plot's outlines on paper after measuring, and then work out the design. Thomas Barker's *The country-mans recreation, or The art of planting, graffing, and gardening* (1654) includes instructions and diagrams of how to measure out garden plots using basic trigonometry,

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[198] George W. Johnson, *A history of English gardening* (1892), 115-6. I am grateful to Malcolm Thick for this reference.

[199] On Thursday 8th June 1922 by the direction of the Countess Dowager of Essex, Cassiobury estate in Hertfordshire was auctioned in London. The contents of the house, art, furniture and four separate libraries were spread far and wide. The estate, which comprised approximately 870 acres at the point of sale, has now sunk under urban sprawl. As the land was developed so a unique legacy was slowly erased.

[200] Katherine Acheson, *Visual Rhetoric and Early Modern English Literature* (Ashgate 2013)

a stake, and a piece of string.[201] Cook not only designed his employer's garden, he also planned and planted a vast area with forest trees. Left in a 'wild', unmanaged environment, trees, he argued, competed for space and light, leading to spindly top-heavy specimens. So Cook optimized the use of space by formalizing the forest floor, using geometry and arithmetic to plan and design his forest garden.

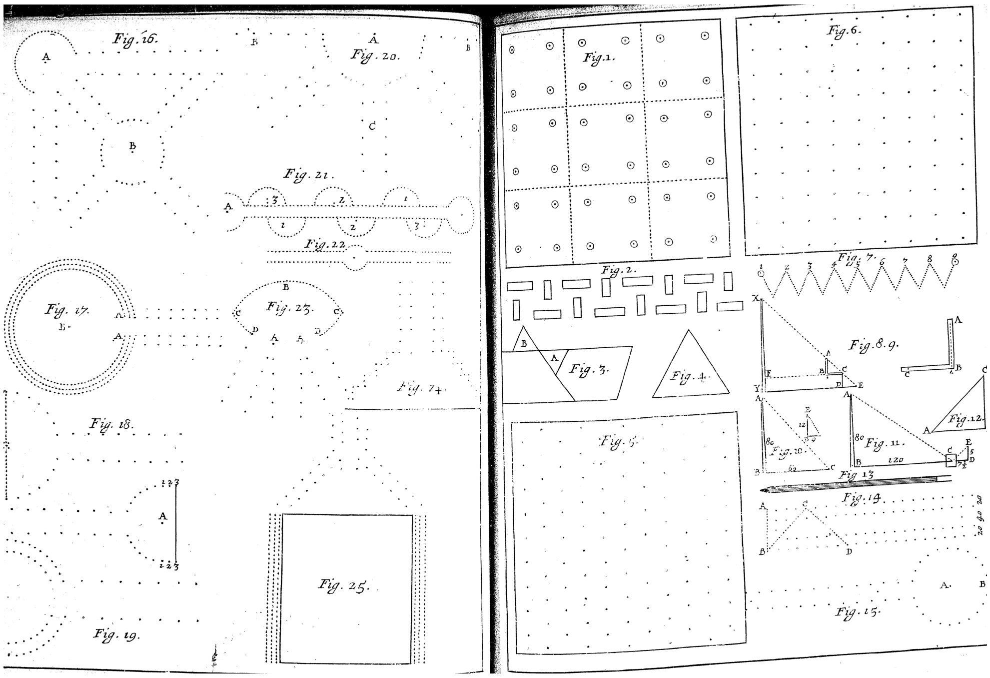

Figure 9. Cook, *The Manner of Raising, Ordering and Improving Forest and Fruit-Tree*[202].

Orchards

In 1731 Stephen Switzer (bap.1682-1745) had published a book entitled *The Practical Fruit Gardeyner,* in which he set out in careful detail 'the newest and best method of raising, planting and pruning all sorts of fruit-trees'.[203] A garden designer of distinction and writer on garden subjects, he joined the Brompton Nurseries in 1699 where he undoubtedly worked alongside Moses Cook. Switzer's treatise is a

[201] Thomas Barker, *The country-mans recreation, or The art of planting, graffing, and gardening in three books* (1654), 35-47

[202] Cook, *the Manner of Raising, Ordering and Improving Forest and Fruit-Trees,* image 116

[203] Stephen Switzer, Title page, *The Practical Fruit-Gardeyner* (1731)

compilation of classical and contemporary experience and knowledge relating to fruit trees. It is difficult to find a recognisable historiography associated with orchards specifically, although fruits have been research by food and gardening historian.[204] Early written examples are few, although, Pietro de'Crescenzi (1230-1320) describes nuts, apples, pears and other fruits being planted and grown in rows sixteen to twenty feet apart.[205]

Switzer represents a turning point in the establishment of a historiography, balanced as he is between the late seventeenth-century, and the burgeoning growth in gardening and market gardens in the eighteenth. References from antiquity from agricultural writers such as Palladius, through to exploration of the cultivated fruit grown in medieval England provides some background. The popularity of growing fruit trees becomes easier to trace through writers in the 1600s. Estate owners, including Fitzherbert, wrote fleetingly about fruit growing in *The boke of husbandrye* in 1530?/1598, as did Plat in *Floraes Paradise,* and Lawson in *A New Orchard and Garden with the Country Housewifes Garden*. Gerard and Parkinson both mention apples in their herbals, with Gerard's Winter Pearmain variety still available, while Fitzherbert writes of growing 'newly grafted fruit trees, laden with fruit'. Several estate owners planted orchards during the Tudor period, most notably Thomas Tresham (1534-1605) who planted an orchard, designed in a series of circular rings at Lyveden in 1597.[206] Tresham planted varieties of apples, pears, plums, damsons, cherries and gages, and his orchard gained

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[204] Christopher Stocks, *Forgotten Fruits: A guide to Britain's traditional fruit and vegetables.* (Random House Books 2008). Thirsk, *Food in Early Modern England.* (Hambledon Press 2006)

[205] Sylvia Landsberg, *The Medieval Garden* (British Museum Press 1996), 16. Pietro de'Crescenzi, a Bolognese lawyer, was the author of *Ruralium Commodorum Liber* published in 1305.

[206] It is thought that the orchard was lifted and some trees sold to Robert Cecil for his new house at Hatfield. Remains of this Elizabeth garden were discovered during examination of photographs taken by the Luftwaffe during the Second World War. National Trust experts believe the photograph shows the remains of an Elizabethan fruit garden.

repute amongst the elite, with Cecil describing it as 'one of the fairest orchards that is in England.'[207] Tradescant the Elder introduced many new varieties of fruit, while Plat noted in a Twickenham fruit garden belonging to a Mr. Vincent Corbet (1582-1635) were to be found the greatest variety of plums in England.[208] Corbet ran one of the first nursery businesses at Ewell before he finally moved to Twickenham in about 1590. Evidence of the interest in collecting and growing different varieties of fruit is found in a collection of coloured drawings of fruit-trees, popularly known as '*Tradescant's Orchard*', now in the Bodleian Library (MS. Ashmole 1461). The pictures were probably painted as a guidebook for the use of visitors to the garden.

Estate owners tended to grow their fruit trees in an organised arrangement, creating visual pleasure for the connoisseur as he strolled the walkways. More generally householders with gardens and smaller plots might have grown one or two apple trees, and of course fruit would be foraged in the countryside. By the turn of the century authors like Markham recommended fruit and nut trees be grown in square blocks. In a move away from fanciful designs, Markham, who absorbs most of Lawson's text into his own books, reflects a growing interest in fruit as a commercial enterprise.[209] The literature on orchards, both practical and spiritual, only begins to appear as a specialist subject from the 1600s. This is when the development of orchards as enclosed and designated areas within a garden or field began to be formulated. Within the narrative appeared two divergent themes found in the correspondence and literature of the time. One was the commercial

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[207] For a fuller account of Tresham's orchard see Margaret Willes, *The Making of the English Gardener,* 25, 40-1, 42, 49 and Andrew Eburne, "The Passion of Sir Thomas Tresham: New Light on the Gardens and Lodge at Lyveden" in *Garden History*, Vol.36, No.1 (Spring 2008)

[208] Hugh Plat, *Floraes Paradise*, 17-18. See Gunther, *Early British Botanists and their Gardens based on unpublished writings of Goodyer, Tradescant and others.* (Oxford 1922)

[209] Gervase Markham, "A New Orchard and Garden" (1623) in *A Way To Get Wealth,* (1625)

development of growing fruit, the other was fruit growing as a means to combat dearth and feed the poor.

Acheson contends that carefully constructed design and planting served more than a pleasant vista, or in order to optimize yield, although these were important aspects. In Markham's planting plan for an orchard contained in his treatise *The English Husbandman* (1635), 'the image is of an organized display of dots, large and small the illustration is about geometry as an instrument, by which we occupy space and turn territory into land, land into estate, and estate into sustenance and wealth. The diagram is not about *seeing* the orchards so much as is about *being* the gentleman whose mastery of the agricultural and horticultural versions of applied mathematics organizes dirt, water, and sunshine into power, money, and social identity.'[210]

[210] Acheson, *Visual Rhetoric and Early Modern English Literature* (Ashgate 2013), 1-10

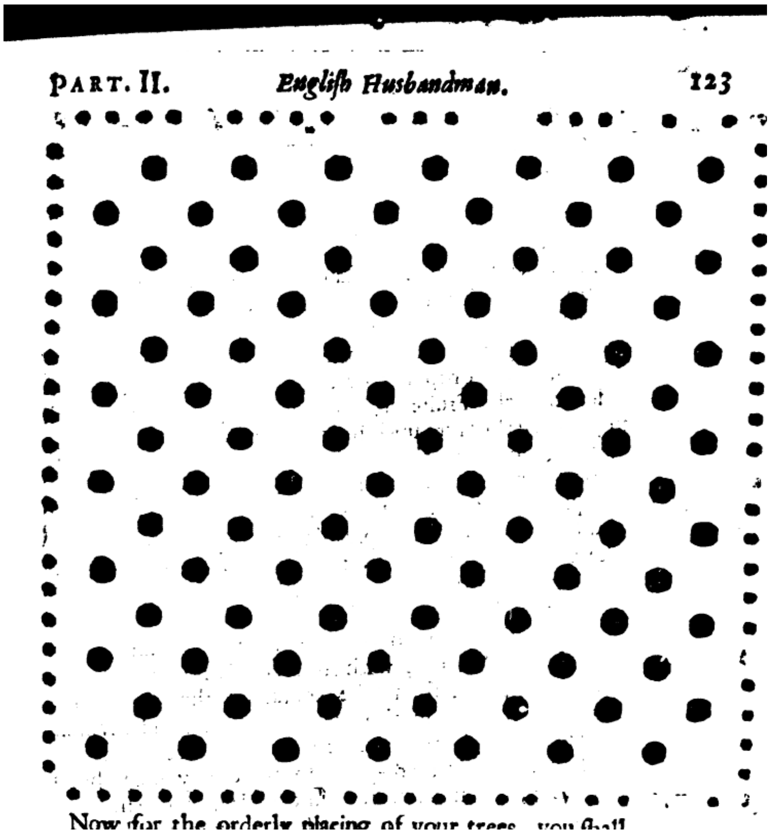

Figure 10. Markham, *The English Husbandman* (1635)

Austen recommended planting fruit trees as a means to improving and adding value to estate land. He commended the essential quality of fruit trees as requiring less attention than corn where men 'must of necessity bestow much money, time and paines about them every yeare.'[211]

The religious and metaphorical association with fruit is, of course, found in the fall of Adam and Eve in the Garden of Eden, and as exemplified by Austen, the similitude between fruit and the spiritual nature of man was ripe for propagation. Expounding his religious similitudes, Austen, an associate of Samuel Hartlib, was a practicing nurseryman who kept a small nursery in Oxford.[212] Growing fruit became a topic of correspondence between associates of Samuel Hartlib with the likes of Gabriel Plattes (1600-1644) suggesting landowners should plant fruit-

[211] Ralph Austen, *A treatise of fruit-trees* (1657), 3
[212] See Chapter 11 of this thesis.

trees in hedgerows, and amongst field crops, while others recommended planting commons and wastelands with fruit-trees as a means of feeding the poor.[213] Two books serve to illustrate the developing interest in, and study of, fruit growing, William Lawson's *A new orchard and garden*, and Ralph Austen's *The Spirituall Use of an Orchard; or Garden of Frvit-Trees.* The work of Arthur Standish, *Nevv Directions of Experience by the Author for the Planting of Timber and Firevvood,* is also recognised as contributing to the discourse of the period.[214] Standish recommended regular planting of hedgerows with trees in them to provide fuel, fruit and timber in the 1610s.

Vegetables

The history of the kitchen garden illustrates the tendency of food and garden historians to focus on the wealthier and elite country houses.[215] While little is known about the smaller households, we can consider the content of a plot to contain vegetables and herbs for cooking and medicinal use. Fruit and firewood could be foraged from hedgerows, as could many other herbal and edible plants. Thirsk describes the interest in fruit and vegetables among the elite encouraged tenants and villagers to increase production in order to sell to the estates.[216] Many purchases of this nature are noted in the household records of the LeStrange family in Norfolk.[217] We hear from Thomas Hill that vegetable growing was a commercial activity among 'the meaner sort'.[218] It is therefore possible to surmise, that the information contained within the pages of the many

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[213] Webster, *The Great Instauration*, 477–8; Thirsk, "Agricultural Innovations and their Diffusion", in Joan Thirsk (ed.), *The Agrarian History of England and Wales, Volume V, 1640–1750, Part II: Agrarian Change* (Cambridge, 1985), 533–89; Blanche Henrey, *British Botanical and Horticultural Literature Before 1800* Vol. 1, 169. Hartlib Papers, 28/2/49B, 41/1/2A–17B. See also Walter Blith, *The English Improver* (1652), 126

[214] Arthur Standish, *Nevv directions of experience by the author for the planting of timber and firevvood* (1613)

[215] C. Anne Wilson (ed) *The Country House Kitchen Garden 1600-1950* (National Trust, The History Press 2010)

[216] Thirsk, *Food in Early Modern England,* (Hambledon Press 2006)

[217] Jane Whittle & Elizabeth Griffiths, *Consumption and Gender in the Early Seventeenth-Century* (OUP Oxford 2012)

[218] Thomas Hill, *The Gardeners Labyrinth*

books of the period, was a mixture of oral tradition and local practices, wrapped around by the classics.

According to Thirsk, vegetables are closely allied with the history of medicine as well as husbandry, field crops and the production of food.[219] Gardens, particularly botanical gardens, were the sites of scientific interest long before early modern authors created their own theoretical models. From the medieval to the early modern period, the role of gardens has been described by Rawcliffe as, ‘a frontline defence in the battle against disease’. Certainly the herbals of the period reinforced the importance of plants in medicinal care, but the relationship between health and the environment was complex. The balance of health lay within the harmony of humours in the body, good and evil smells and the physiological and psychological impact of senses such as sight and smell. The smells of the garden coupled with wholesome country air were thought to prolonging life, and enhance the general health and wellbeing of the individual. As noted by Rawcliffe, from the monastic and botanical gardens to the care of the poor, vegetables were grown in a range of establishments, including leper hospitals where growing vegetables was part of the general routine.[220]

As well as servicing the medical needs of the household, the main purpose of the garden for most householders was for the production of food. On the small peasant plot to the large estates, fruit and vegetables would be grown along with the raising of livestock, and for the wealthy additional rabbits, fish and venison. Innovation in alternative agriculture was regionally variable, but one example from Bailey indicates that Suffolk was one of the richest and most industrialized regions in England in the 1500s. Notably peasants dominated dairy farming and stock

[219] See Thirsk, *Food in Early Modern England,* 284-294
[220] Carol Rawcliffe, “Delectable Sightes and Fragrant Smelles” in *Garden History*, Vol.36, No.1 (Spring, 2008), 3-21

rearing, while specialized commercial production of poultry and eggs, fruit and vegetables, wax and honey utilized household labour. Statutes in Ipswich indicate that gardens and orchards were rented in East Bergholt and although unable to quantify or even identify the produce, he speculates the produce held a substantial value for household consumption and market returns.[221]

Authors of the period presented their own perception of vegetables. Indigenous vegetables and herbs had long been foraged in the wild for consumption. The association of indigenous and local nature with peasant communities was evident in the narratives of Gerard and Parkinson. For Gerard the 'wild' could be bred out of a plant by transplanting and husbanding it in a controlled environment.[222] Parkinson had an alternative view. In his section *The Ordering of the Kitchen Garden* in *Paradisi,* he discussed 'Herbes and Rootes, fit to be eaten of the rich and poor as nourishment and food, as sallet or refreshing, for pleasure or profit; where I doe as well play the Gardiner'.[223] Gathering herbs from the garden, the 'wilde', or even as 'weedes', were all acceptable for Parkinson, and indeed he commented being 'wild' (not husbanded) could enhance the taste.

The prospect of crop failure, dearth and famine was a constant theme and one addressed by Richard Gardiner in his *Profitable Instrvctions or the Manuring, Sowing and Planting of Kitchin Gardens* published in 1599. With a direct commentary on famine, Gardiner claimed he fed the poor of his parish for twenty days on life saving food 'closed cabbedges' and 'carrets', all of which he grew from seeds he collected himself. Plat addressed his concerns in his *Remedies against Famine* in 1596, and

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[221] Mark Bailey, *Medieval Suffolk: An Economic and Social History* (Boydell Press 2007)
[222] 'Husbanding' as opposed to husbandry was a word used in sixteenth-century horticultural literature and refers to controlling and managing a resource. See also Bailey, *Medieval Suffolk.*
[223] John Parkinson, *Paradisi*, 465

warned against 'daies of sword and famine' where 'our harvest is smitten and daunted already.'

Although this section is concerned with specialist topics, with the exception of Gardiner's treatise, vegetables did not warrant any specialist attention. Timber and fruit were capitalized for the common wealth, flowers engendered passion and power; but vegetables, perceived as humble food for peasants, did not accord such importance. The production of vegetables was included in husbandry and horticultural literature, but was often placed in the section concerning women's work such as dairy and poultry produce. Lawson wrote what is considered the first horticultural book for women qualifying his decision as a treatise for 'my country housewife, not skillful artists'. *A New Orchard & Garden with the Country-Housewifes Garden for Herbs*[224] was later absorbed by Markham into his collection on cookery, agriculture and gardening and entitled *A Way to Get Wealth*.[225] This was not a treatise for 'working women' but a publication directed at a literary readership of women who could 'delight and direct'. Lawson was concerned that women should know and understand how to direct the worker. It was difficult, if not impossible in the literary world, for a man to fashion his identity solely on vegetables.

Lawson left the important business of directing and growing vegetables in plots and gardens to women. Notable vegetables were artichokes, cabbages, turnips, parsnips, onions and carrots all vegetables along with potatoes, all described by Muldrew as containing essential calorific components.[226] It is difficult to ascertain the true level of women's

[224] William Lawson, *A New Orchard & Garden with the Country-Housewifes Garden for Herbs* was first published in 1618 and then in 1623 and 1626.
[225] See Malcolm Thick, *A New Orchard and Garden with the Country Housewifes Garden, William Lawson* (Prospect Books, 2003)
[226] Craig Muldrew, *Food Energy and the Creation of Industriousness* (Cambridge University Press 2011), 109. Muldrew uses examples from the eighteenth-century, but argues the Agricultural Revolution was not driven solely by mechanization and new

involvement in food production, but an alternative horticulture, as described by Thirsk, found favour for reasons of fashion, and also to demonstrate the owner's social standing in the community through his or her abundant gifts and hospitality. Agricultural diversification was also important for small-scale farmers, with vegetables grown on small plots and fields yielding good profits when cereal prices slumped. The status of vegetables as an important alternative agricultural product was reinforced by the fact that many of them were tithed.[227] But, as discussed in Chapter 11, the production of vegetables became increasingly commercialized as the population in London increased, and the growth in market gardens led to a new specialism.

Sharrock produced his book *The History of the Propagation and Improvement of Vegetables* in 1660 in response to Bacon's discourse on the advancement of learning and his view concerning the 'Deficients of Natural History.'

> Having indeed some quarrel at the fashion of ordinary Writers, who study in nothing to benefit Learning, but by giving new words to old matter. To improving knowledge (and) to give some account of the particular effects of Man, co-operating with nature, in the matter of our English Vegetables, as they are improved by Husbandmen and Gardiners.[228]

As was so often the case in early modern treatises, the title is somewhat misleading as the term 'vegetables' actually covered edible plants,

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practices of husbandry; it was spurred quite as much by renovation of the labourer himself as by actions of the improver. The culture of eating and calorific intake energized workers and increased their productivity.

[227] Thirsk, *Alternative Agriculture*, 23-42. A tenth part of agricultural or other produce, personal income, or profits, contributed either voluntarily or as a tax for the support of the church or clergy or for charitable purposes. The development of market gardening in England is discussed in Chapter 11 of this thesis.

[228] Sharrock, *The History of the Propagation and Improvement of Vegetables,* 1660 or 1659, image 4

herbs, flowers and trees, but our interest lies in the title and the use of the word 'improvement'. Sharrock was a clergyman, but his title echoed the millennial calling of the Puritans and the Hartlib circle. Sharrock fashioned himself in his treatise as 'Artist', propagator and improver. He was a fellow of New-College and active in the Oxford botanical garden where he circulated with others interested in science, including Robert Boyle. He dedicated his treatise to Boyle who, not only encouraged Sharrock to write and publish his book, but probably financed it as well.[229] On the title page Sharrock authenticates his work as, 'Written according to observations made from Experience and Practice'. A treatise, he claimed intended as a practical text for husbandmen and gardeners.

Flowers

The historiography of flowers is also a narrative of specialization at particular periods in the history of flora. One cannot discuss flowers without starting with the rose, for there is no greater iconic emblem of Tudor supremacy. As Potter narrates, the transformation of a wild briar in the northern hemisphere to the garden rose of the Tudors saw the rose transformed from 'a venal rose of Roman pagans to the Marian rose of Christian iconography.'[230] Of course the rose can be traced back to Pliny's garden, while one of the earliest surviving manuscripts (AD1083) depicting a rose with three kinds of flowers, comes from northern Islam. Locations of wild roses stretched across continents, from Asia to India and North America. The story of the rose certainly attests to a narrative of travel and trade, as plant hunters tracked vast swathes of landmass to collect specimens, not to mention immigrants, pilgrims and soldiers, any of whom may have collected and transported seeds and root cuttings. The pockets and packs of human and animal transport spread the propagating material of the rose across the world.

[229] Oxford Dictionary of National Biography
[230] Jennifer Potter, *The Rose*. Atlantic Books (2012), 3-17

Emblematic in the Tudor dynasty, varieties of roses were catalogued in the private botanical gardens with, for example, Gerard naming sixteen different varieties in his *Herbal*.

The other example of a flower of immense value was the tulip. Goldgar traces the rippling effect of what has been termed tulipmania in the Netherlands during the 1630s where a community of *liefhebbers* in Middleburgh (the modern capital of Zeeland) engaged in the pursuit of cultivating rare flowers.[231] According to Goldgar, it appears that the 'mania', as it has been described historically, was located within this small community where vast amounts of money changed hands (or led to bankruptcy). However, collecting was a phenomenon experienced across Europe and between communities of naturalists and botanists. Many exotics, violets, auricula, narcissi, crocuses and, of course tulips, arrived from all parts of the world. In England, with new and various plants arriving on its shores, Parkinson not only appreciated the beauty and challenge of these plants, he also recognised their commercial value. Consumer culture, he wrote, had already begun to take a hold in England's urban centres, and certainly in the gardening world. But the emphasis in England was not so much on one specific plant or bulb, but rather a widening interest in plant cultivation among a group of individuals calling themselves florists. Duthie explores the growth of florist societies, and their feasts, in the seventeenth and eighteenth centuries.[232] This fascination in, and cultivation of flowers, was at its height in the 1630s, a period in which the tulip was reaching its zenith in the Netherlands. Duthie suggests incomers, particularly from the Netherlands, contributed to the introduction of florists' societies and feasts with one the earliest known events held in Norwich probably between 1632 and 1635. These feasts were important events where

[231] Anne Goldgar, *Tulipmania Money, Honor, and Knowledge in the Dutch Golden Age*. (The University of Chicago Press 2007)

[232] Ruth E Duthie, "English Florists' Societies and Feasts in the Seventeenth and First Half of the Eighteenth Centuries", *Garden History* Vol.12, No.1 (Spring 1981), 8-30

growers had the opportunity to display their flowers. This was a floral curiosity cabinet where petal colour, variegation particularly stripes and speckles, double flowers, any feature that was unusual, were admired, discussed and celebrated. The only way growers could achieve these diverse results was by propagating seeds as Gerard, when writing about Beta vulgaris cicla (chard) succinctly reminded his readers:

> 'It grew with me in 1596 . . . which plant nature doth seeme to play and sport herselfe: for the seeds taken from the plant, which was altogether of one colour and sowne, doth bring forth plants of many and variable colours.' [233]

The observation of nature's unpredictable and often-pleasurable outcomes became a quest for diversity as growers began selectively breeding and cloning plants. Thomas Hill's treatise on gardening includes lists of many flowers, but mirroring the herbal he does little more than identify the medicinal qualities or virtues of plants.[234] Both Gerard and Parkinson enjoyed flowering plants purely for pleasure, while Plat covered his house and garden in flowers in his *Floraes Paradise*, and in the seventeenth-century Samuel Gilbert began selective breeding.[235] From observation and comment to experimentation and breeding, there was a steady incremental growth of knowledge.

The English cleric Gilbert fashioned himself as a gentleman engaged in floriculture. He seems to have lived with his father-in-law the gardener John Rae, and when he died in 1681 Gilbert took over and added to Rae's extensive plant collection. *Florist's vademecum* was designed for both the 'curious' and the experienced horticulturalist, and within it we learn of a network of gentlemen engaged in floriculture. Laced with detailed descriptions of plants and instructions for planting and

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[233] John Gerard, *Herbal* (1636)
[234] Thomas Hill, *The Gardeners Labyrinth,* (1577)
[235] Samuel Gilbert, *Florist's vademecum and Gardener's Almanack*

propagating, it was laid out to a month-by-month schedule of activities.[236] Here we find Gilbert, with his shrewd collector's eye, scanning the ever-expanding national and overseas market for new species and specimens. As previously noted, Plat was in the business of making money from 'knowledge' and his inventions, and Parkinson commented on changes in the way plants and seeds were being exchanged in a growing commercial market. The significance of Gilbert's book lies in the period it was produced representing, as it does, a cementing of the commercial value of collections. Knowledge, skills and access to a growing market meant that men like Gilbert were able to fashion themselves as plant breeders without losing the 'gentlemanly' aspect.

The final example in this short selection is Nehemiah Grew, a doctor by occupation, who fashioned himself as a godly man, who believed God had created both animals and plants. Grew has not drawn the interest of historians, and has to some extent been overshadowed by intellectual heavyweights like Robert Boyle. He was, nevertheless, one of a growing number of natural philosophers developing specialized knowledge in the botanical structure and function of plants. In Europe, a wealthy Italian physician, Marcello Malpighi was also studying structures and systems in humans, animals, insects and plants. Both men had access to the microscope, a research tool opening up the microcosmic world of plants hitherto unseen. Grew's investigations were meticulously recorded and presented as a series of lectures to the Royal Society. The lectures were eventually gathered together and published in *The Anatomy of Plants with an Idea of a Philosophical History of Plants* in 1682. This was a particularly important change in the way information was produced and presented, a new kind of systematic study, where the illustrations in particular were presented as a form of scientific proof. After many years

[236] Oxford Dictionary of National Biography

of observation and study, Malpighi submitted a paper to the Royal Society, followed by a comparative study of plants published in *Anatomia Plantarum* 1675 and 1679. The compatibility and similarity in findings between Grew and Malpighi indicates the two men did not work in isolation, and very probably drew on each other's research.[237] Grew and Malphigi were regular contributors to the Royal Society at a time when botanical research became associated with the microscope and microanatomy in Italian medical schools. Interest in the mapping if the internal physiology of plants was, according to Wilson, due to a 'strongly positive reception of the microscope by those enthusiastic philosophers who were enchanted by images of an infinite complexity, regularity, and variety of animate and inanimate forms of nature.'[238] In other words, there was more interest in Latour's tools of inscription than in any botanical advancement. According to Bachelard, the microscope impeded knowledge in the seventeenth and eighteenth centuries because it revealed things that were beautiful rather than contributing to new theories.[239] Interest in Grew's work for this study rests less on his microscopic work and more on his revival of atomism as an explanation on the working of plants.[240]

Bacon's notion of the virtuosi, as educated collectors of artefacts and knowledge, remained contingent within members of the Royal Society, who took on the mantle in the 1660s. But there was another group of collectors of nature, no less erudite, who were refining their knowledge into specialisms. As noted above, the engagement of the elite in projects like Capell's forest garden, vegetables, fruits and flowers, alongside the commercial diversification of agriculture, facilitated a programme of specialisation and improvement.

[237] Grew notes that Malphigi obtained a copy of his publication and had it translated into Latin for his use. See Preface *The Anatomy of Plants.*
[238] Catherine Wilson, *The Invisible World* (Princeton University Press 1995), 520-256
[239] Bachelard, *La formation de l'esprit scientique* cited in Catherine Wilson, *The Invisible World,* 251
[240] See Chapter 5 of this thesis.

Chapter 4

Patterns & Problems

Within Latour's actor network model, the interaction between human and artefact results in what he describes as an *inscription*, or the translation of an interest into material form. Inscriptions are an element in establishing a social order and management, which, in this context, seeks the ordering of nature. Earlier chapters discussed Latour's network model as it connected to collecting and collections. This was followed by discussion of the textual materials used for *inscriptions* and the manner in which knowledge was set out in herbals, floras, catalogues, husbandry and specialist treatises. Finally, consideration was given to the authors of treatises and how they presented and fashioned themselves in the literary world and of specialization in the landscapes of woodlands, vegetable and kitchen gardens, orchards and flowers.

We now turn to two further themes to consider what was inscribed and in following chapters, how this might have translated into technology. According to Latour, scientific knowledge is embedded in procedures of inscription and this process of inscriptions, like the drawing and redrawing of maps and text, is cumulative, a process of superimposition and reinforcement.[241] According to Ginzburg, no text can be understood without a reference to extra-textual realities.[242] For Harkness, textual representation from the Elizabethan period attests to an interest in natural history, even while she suggests that a burgeoning scientific community was muted by Baconian science.[243] This is not the view of Webster, who argues that the Puritans, a dominant element in English society between 1626 and 1660, continued and indeed built on Bacon, but also others like Plat, in their investigations of natural history and the

[241] Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society.*
[242] Carlo Ginzburg, "Checking the Evidence: The Judge and the Historian" in Chandler, Davidson, Hoarootunian (eds) *Questions of Evidence, Proof, Practice, and Persuasion across the Disciplines,* (University of Chicago Press 1994), 290-303
[243] Harkness, *The Jewel House*

natural world. Against a backdrop of the catastrophic events of the Thirty Years War, the 1641 Irish Rebellion and turmoil in the colonies, 'there emerged a growing conviction, particularly among the Puritans, that Christian civilization was approaching its final age.'[244] This led to what Webster describes as two interconnected themes, a millenarian eschatology, and a belief in the revival of learning. It is this revival in learning that forms the backdrop of the horticultural and husbandry treatises written during the period prior to the formation of the Royal Society in 1660.

Dear claims the term 'natural philosophy', of common usage in the sixteenth and seventeenth centuries, fell into disuse by the nineteenth century becoming absorbed by 'science'. Collectors, naturalists, botanists, horticulturalists and the dawning of Bacon's scientists, all used natural philosophy as a means of explaining and understanding the world. There was no progressive single picture of what the world was like, of what it contained or the ways it interacted. The picture changed constantly as natural philosophers moved intellectually backwards and forwards, drawing on the past, the contemporary, and an imaginary future, in an attempt to answer fundamental questions about the 'underlying nature of physical phenomena.'[245]

In her interpretation of the rise of English experimental philosophy in the seventeenth-century, Shapiro examines what she perceives as the gradual construction of a culture of fact. Tracing the use of the word 'fact' in law courts and historical writing, where primarily it had been associated with human acts, Shapiro argues that the law was the earliest and most influential factor in determining a 'fact', and once established in law began to influence other areas of English life such as historical

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[244] Webster, *The Great Instauration,* xiv

[245] Peter Dear, *The Intelligibility of Nature, How Science makes sense of the World,* (The University of Chicago Press 2006), 2

writing, chorography and travel writing. These, and other works, presented 'both human affairs and natural phenomena as facts, thus fostering the shift of 'fact' from the older legal and historical meaning of human deeds to a newer, more encompassing meaning.'[246] In her distinction, Shapiro argued that common law clearly distinguished between 'matters of fact', the province of jurors, and 'matters of law', the province of judges. For Latour 'facts' are not uncovered in a laboratory or a court of law as Shapiro explores, but are rather produced or socially *constructed*. The experimental process is, for Latour, an elaborate mechanism for *constructing* facts rather than uncovering them.

Applying Shapiro's argument for the forming of facts to natural history and the natural world is problematic. Early modern authors did not generally use the word 'fact' to describe their findings, rather they used *observations* and *experimenta* to demonstrate and authenticate their findings. Medieval observational science, as discussed by Park, had its roots in classical traditions, and involved the study of long-term cyclical phenomena related to the heavens and the weather, or to particular therapeutic interventions. She cites how Cicero's *On Divination* emphasized the predictive nature of observations, while Pliny in *Natural History* identified observation with medicine, navigation and farming and the planting of crops. By the late fifteenth century, observational science not only involved long-term cyclical phenomena but, according to Park, incorporated properties of natural substances and species 'especially those that were unique, variable, or contingent and therefore not amenable to deductive explanation.'[247]

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[246] Barbara J. Shapiro, *A Culture of Fact in England, 1550-1720* (Cornell University Press 2000), 104

[247] Katherine Park, "Observation in the Margins" in Lorraine Daston & Elizabeth Lunbeck (eds) *Histories of Scientific Observation* (University of Chicago Press 2011), 35

Many observations of plant life in the sixteenth-century were recorded in lists or categories as collectors and botanizers sought to classify and categorize different plants and seeds. As more information circulated, building and accumulating, so the manner in which observations were inscribed began to change as practitioners sought to authoritatively present their science and scientific findings. Using the example of medicine, Pomata points to a change in the way medical efficacy was observed and recorded in the late sixteenth-century. Previously the province of scholastic medicine, late Renaissance observations increasingly came from practitioners in the form of town and court doctors who recorded their observations in the form of case histories. This new form of medical writing 'combined emphasis on practice with scholarly credentials, giving new visibility, significance, and circulation to the expertise of practitioners.'[248] Case histories recorded observations of patients and the effects of interventions, rather than lists of diseases and treatments. Previous chapters in this research has noted similar changes in botanical and horticultural writing, as herbals and floras made way for a case history approach in the specialist horticultural literature.

According to Daston, by the 1600s, observation had become an epistemic genre among astronomers and physicians with an increasing emergence of books accounting observations. Observational science changed direction during this period. In a move away from anonymous collections of data emphasis was placed on single witnessed events; a deliberate move to separate observation from conjecture, and, the creation of 'virtual communities of observers dispersed over time and space, who communicated and pooled their observations in letters and

[248] Gianna Pomata, "Observation Rising: Birth of an Epistemic Genre" in Daston & Lunbeck (eds) *Histories of Scientific Observation,* 54-60

publications.'[249] In addition, there was increasing emphasis on the inclusion of experimentation within observation, such that theory and practice of natural knowledge were essentially intertwined. Bacon's usage of *experimentum* in *Novum Organum* (1620) refers to artificial or man-made experiments of the natural world, as opposed to nature's own ability for 'sports and wantonings'. In collecting his useful knowledge, Plat was collating observations, while Johnson observed and recorded plants growing in their natural environments, and Bacon conceived a centralized, state funded, 'Multitude of Observers'.

In terms of plants and seeds, what was being observed and collected chimed with the cultural and political landscape. For Drayton, the collection of exotic plants was symbolic of a national power, order and riches.[250] The metaphorical connection between plant knowledge and political authority was visualized and realized, he argues, in collections and botanical gardens. Drayton's focus on the elite, princes, patrons and holders of power, does not, of course, address the more politically prosaic matter of feeding a population for when crops failed, power waivered. In Harkness's Elizabethan London, among the less profligate collectors of the period, the likes of Plat, L'Obel and Francis Bacon were recording observations of plants and seeds in increasing detail.[251] The economic importance of plants was not just symbolic and searching for reproductive potential became central to the scientific enterprise in the early modern period.

Vegetative methods of propagation were well established by the sixteenth-century. Bulbs, corms, offsets, rhizomes, runners, suckers, and tubers were all recognized methods of vegetative propagation, and

[249] Lorraine Daston, "The Empire of Observation, 1600-1800" in Daston & Lunbeck (eds) *Histories of Scientific Observation,* 81
[250] Richard Drayton, *Nature's Government*
[251] Deborah Harkness, "Living on Lime Street", in *The Jewel House,* 15-56 and "From the Jewel House to Salomon's House" in *The Jewel House,* 211-253

produced plants that were genetically identical to the parent plant. Grafting was one method used for improving fruits, vines and roses in particular, but the experience of propagating plants from seeds of grafted stock were apt to produce what Austen described as 'mongrell' plants. [252] Efforts to improve plants, more generally, involved complicated environmental management resting as much on the skills and knowledge of the horticulturalist or husbandman as it did on the conditions. It was long observed that plants produced seeds, except, as noted in classical and contemporary texts, some plants did not conform to the predicted pattern. Mosses and ferns failed to produce observable seeds, as did some plants that had been grafted. So past observation did not stand up to scrutiny. Herbals provided external representation and illustration of seeds, while floras demonstrated the same type of plant could flourish in a range of habitats. But this did not explain how seeds came into being, or why they did not always follow the Aristotelian deduced formula of growth. So in the literary landscape of early modern authors, Aristotle was mixed with classical text and continental writers with contemporary authors, as each author prepared to justify and present his own observations and experiments within the laboratory of his literary landscape.

This chapter will present three examples ranging from the 1580s, the 1620s to the 1660s and the formation of the Royal Society. Examples include Plat's philosophical garden; a Puritan response to Bacon's experimental approach to species change, and Nehemiah Grew's atomistic theory on the forming of a plant. These examples will consider a convergence of philosophical themes that unfolded, like the seed, during the early modern period, when observations and experiments became inscribed in husbandry and horticultural literature.

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[252] Jules Janick, (ed) "A History of Grafting" in *Horticultural Review*, Vol.35 (2009), 437-493

Provoking Nature to Play

In an Aristotelian landscape of nature, whatever comes to be is always complex. On the one hand there is something which comes to be, and on the other hand, something which becomes that new thing. In an Aristotelian teleological framework, 'coming into being' for a seed can best be associated with the point of germination, a phenomenon that was only just beginning to be observed and recorded in detail by Renaissance botanists. Did the seed hold any matter, and if it did what was it? For whatever was inside the seed in some way transformed and transmuted it into a new and entirely different material form. Authors of husbandry manuals made observations, but writers of horticultural literature, like Plat, began to apply Renaissance alchemy and Aristotelian elemental theory to their observations and knowledge of germination. Observations of the external features of seeds were illustrated in herbals and described in sixteenth-century horticultural and husbandry manuals. Portrayed as inert, dry and lifeless, it was difficult to reconcile this description of a seed with the apparently purposeful growth of a new entity in the form of a plant. How the seed appeared on the inside remained a mystery and in order to theorize observations authors, like Plat, utilized what Arber describes as astrological botany, a drawing on cosmological principles and the connections between plants and stars, planets and moons.[253] In a complex interrelationship between the heavens and the earth, cosmic forces were drawn downwards to fertilize and enrich the earthly domain. Only through a cosmological process could an alchemical process begin, enabling the seed to transform into a plant. But before this could happen the seed in its inert form needed to be brought to life.

[253] Arber, *Herbals Their Origins and Evolution, 1470-1670,* 247-263

The philosophical garden of Hugh Plat

Plat was a collector of plants and seeds, but importantly a collector of knowledge. In *Floraes Paradise* published at the end of his life in 1608, he sets out what he described as 'a prety volume of experimental observations'. [254] Plat was a gardener, who reinforced his own observations by collecting information from contemporaries, as well as utilizing the writings of alchemists and occult philosophers. In his work he makes reference to, and according to Thick relies heavily on, continental writings and, in particular, the alchemical works of Paracelsus and Paracelsians, the ceramics expert Palissy, and, the chemical philosophy of van Helmont.[255] He essentially worked on his own, but his writing is representative of how the study of natural history amalgamated alchemical and transformational theories in the period. Plat presented an account of seed transmutation, which while manifestly esoteric, provides an illustration of the alchemical rationale of the period. Using theoretical chemistry, he described the preparation of a material or manure for his philosophical garden. Consisting of well-composted vegetable matter made from the alchemical elements Saturn (lead) and Mercury (quicksilver), and imbibed from the heavens with *aqua coelestis*, this combination caused a fermentation likened by Plat to the digestive tract of the stomach of an ostrich.[256] The seed, once planted, slowly fermented until it released the fifth element *quintessence* or *quantum esse*, the nucleus of the essences and properties of all things in the universal world. As it degenerated, so a celestial 'mysterium' was extracted, and the seed underwent transmutation in order that it might grow and pass into a plant. The

[254] Hugh Plat, "To the Stvdiovs and well-affected Reader" in *Floraes paradise* (1608)

[255] Thick, *Sir Hugh Plat,* see chapters on gardening, agriculture and alchemy. For van Helmont see Debus, *The Chemical Philosophers: Chemical Medicine from Paracelsus to van Helmont* (Dover Publications 2003), 242. Paracelsians included the theories of the occultist and astrologer Cornelius Agrippa (1486-1534 or 1535), the Italian scholar Neapolitan Giambattista della Porta (1535?-1615) and to the physician Dr. Quercitanus, (c.1544-1609) a follower of hermetic alchemy and theorists in nature and saltpeter.

[256] Plat believed this mixture would remain fertile for up to two years and required no further additional fertilizing agent.

proposition inherent in Plat's theory was the need for an external force to activate the seed 'that this heavenly earth so manured with the stares…yea, I am persvvaded, that it will receive an *Indian* plant, and make all vegetables to prosper in the highest degree, and to bear their fruits in *England,* as naturally as they do in *Spain, Italy,* or elsewhere.' [257]

In Plat's literary landscape, for a seed to alchemically transmute it required vitalizing externally by a cosmic force, which delivered all the essences required for the seed to grow. Following the Aristotelian model, in which the male (father sky) was the active (vital) principal and the female (mother earth) was the passive recipient or transmitter of male activity, the seed needed to be activated before it could germinate. Plat's theoretical framework might well fall into the realm of vitalism but, the central theme in his work, and one followed through in the writing of the improvers, is the concept that the seed needed to have been fertilized by a male entity before it could germinate. Plat collected plants, furnishing his house and garden with pleasing sights, smells and sounds and the interaction between human and plant was one of emotional pleasure. Not so for Francis Bacon, who was concertedly chasing monsters.

Francis Bacon: As caterpillars change into flies

> A compilation, or particular natural history, must be made of all monsters and prodigious births of nature; of every thing, in short, which is new, rare, and unusual in nature. This should be done with a rigorous selection, so as to be worthy of credit.[258]

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[257] Hugh Plat, *The Garden of Eden,* 168

[258] Francis Bacon, *Lord Bacon's Works. Volume the Fourteenth, containing Translation of the Novum Organum and of Thoughts on the Nature of Things.* (Printed in London MDCCCXXXI), 138. The first edition was published in folio in 1620.

So wrote Francis Bacon in his advise to a natural philosopher. According to Park and Daston, Bacon's idea of collecting monsters was greeted with enthusiasm by his contemporaries. The notion of monsters, they argue, evolved in the sixteenth and seventeenth centuries, becoming associated with 'earthquakes, floods, volcanic eruptions, celestial apparitions, and rains of blood, stones and other miscellanea.'[259] We can also add to this list the mysterious power of degeneration, most notable in plants grown from seed where colour, taste and fashion resemble another kind of plant altogether. The belief that plant species were inherently unstable can be traced back to classical texts. Theophrastus reported insects and plants could change from one species to another through an alchemical process: 'those things which do change in this manner do so spontaneously, and the alteration is due to a change of position…and not any particular method of cultivation.'[260] It was a theme repeated in husbandry manuals and integrated into horticultural literature where authors were apt to repeat examples of curious and unexplained phenomena. Hill, quoting almost verbatim from Googe's translation of Heresbach wrote:

> Haue good regarde, that the seeds be not too old, for these then bring forth plants out of kinde, of whiche the reporte goeth, that seedes sowen become Rapes, or Nauews. Such seeds as you would to indure for sixe yeres, ought to be carefullie preserued.[261]

Coleworts changed into rape, it was claimed, and rape into coleworts while basil-royal degenerated into 'wilde betony'. The kernels of the natural olive trees reverted to wild, while the male Cypress tree, wrote della Porta, degenerated into a female and over time 'agreeth in nothing with the natural Olive, but is so stark wilde, that sometimes it cannot

[259] Katherine Park & Lorraine Daston, "Unnatural Conceptions: The Study of Monsters in Sixteenth and Seventeenth England" in *Past & Present* (No.92 Aug.1981), 20-54
[260] Quote from Theophrastus, *Enquiry into Plants,* cited in Anna Pavord, *The Naming of Names* (Bloomsbury Publishing 2005), 40.
[261] Thomas Hill, *The Profitable Arte of Gardening* (1577)

bring forth fruit to any perfection.'[262] According to Park and Daston, belief in the sixteenth-century that monsters were the result of portents of God's wrath, shifted in emphasis to evidence of natural wonder and a sign of nature's fertility. Bacon had a particular interest in 'vexing' nature in the margins of nature and collecting histories of those phenomena that did not conform to expectations. He did not believe that oddities and monsters were signs and portents, but rather a process of nature that, if understood, might lead to greater knowledge and technological innovation.

In *Sylva Sylvarum* Bacon set forth experiments regarding the 'Degeneration of plants, and of the transmutation of them into one another'.[263] Bacon believed that plants degenerated through lack of culture, and claimed that environmental manipulation, or poor environmental management, could fundamentally alter a plant changing it from one species to another. Exposure to the sun, he wrote, turned basil into wild thyme and sterile years turned corn 'into another species'. Bacon begins his section on transmutation with his review of the natural history of creatures. He wondered at those creatures created without a seed and observed they transmuted from one living organism to another in an apparent species change just as 'caterpillars turn into flies.' Equally, he continued, soil not previously seeded produced plants, which to Bacon's mind, proved 'that seeing the earth of itself doth put forth plants without seed, therefore plants may well have a transmigration of species.'[264] If a grafted plant could produce a seed that formed a plant unlike its own, was it then possible to alter seeds by artificial means? This work of transmutation of plants one into another is, wrote Bacon:

[262] Giambattista della Porta, *Natural Magic,* Book 3 (1659), 63
[263] Francis Bacon, "Experiments in consort touching the degenerating of plants, and of the transmutation of them into one another", *Sylva Sylvarum: Or a Natural History in Ten Centuries*, Century 5, Experiments 518-531.
[264] Francis Bacon, "Experiments in consort touching the degenerating of plants, and of the transmutation of them into one another", *Sylva Sylvarum: Or a Natural History in Ten Centuries*, Century 6, Experiment 525.

'*inter magnalia naturae* (among the marvels of nature), for the transmutation of species is, in the vulgar philosophy, pronounced impossible, and certainly it is a thing of difficulty, and requireth a deep search into nature; but seeing there appear some manifest instances of it, the opinion of impossibility is to be rejected, and the means thereof to be found out.'[265]

Bacon's proposed experiment was a simple one. He advocated mixing together seeds from different plants, mainly herbs and vegetables, and sowing them in a range of unfamiliar soil types. The main purpose was to 'overrule' the nourishment or 'juice' received by seeds by subjecting them to unaccustomed levels and strengths. It was the 'juice', according to Bacon, 'which perhaps will alter the seed, and yet not to the kind of the former herb.' In his writing Bacon appears to be promoting the notion that the seed held within it material matter. This was a philosophical concept found in continental writings where Latin translations were incorporated into medieval scholastic doctrine. In particular, classical thought on the origin of seeds was proposed in Varro's *On Agriculture,* where he refers to other classical writers like Anaxagoras (ca.500-480). Varro conceptualized a *sperma* (seed, semen) as holding a *seminal principle*, a creative force believed to be the beginning of natural things. Hirai considers the notion of the *seminal principle* to be rooted in the Greek philosophy of the Stoics and Plotinus where *logio spermatikoi* (seminal reasons) was a doctrine that unified the role of creative power with the origin of being.[266] According to Shackelford, Paracelsus claimed this *scientia*, or knowledge, was predestined and ordained, while Severinus (1542-1602) regarded *semina* as containing the material or spiritual principles for both generation and corruptions.[267] The sixteenth-century revival of Aristotle's elemental

[265] Bacon, *Sylva Sylvarum*, Century VI, Experiments 521 & 525

[266] Hiro Hirai, "Logoi Spermatikoi and the Concept of Seeds in the Mineralogy and Cosmogony of Paracelsus*"* in *Revue d'Histoire des Science*, Vol.61 (2008), 245

[267] James Shackelford, "Seeds with a Mechanical Purpose: Severinus' Semina and

theory, cosmology and his notion of a prime mover, began to dominate Western philosophy and was certainly an intellectual force among authors of natural philosophy. Nevertheless, the concept of *sperma* and *seminal principles* remained and was conspicuously present in the long and esoteric tradition of alchemy and the work of Paracelsus. Sixteenth-century investigations in mineralogy, and the origins of disease from Paracelsus and his follower Severinus, in particular influenced thinking, and reinforced a belief that all organic and inorganic matter stemmed from seeds. That they were the very source of life was endorsed with a philosophical argument that the external appearance of seeds belied an internal life-promoting agency. For Paracelsus, this was the *archeus* an inner agent responsible for the process of growth. Severinus presented the generation of a body 'as a kind of Cusanian unfolding *(explication)* of the seed from potency and actuality, from generality into particularity.' [268] Van Helmont (1580-1644) believed *semina* was endowed with a 'spiritual type-plan' an image from which generation arose.

It is worth pausing briefly to summarize some of the cycles of accumulation that were unfolding in the horticultural and husbandry literary landscapes. Renaissance observations of seeds and plants were inscribed in herbals and catalogues drawn up from collections, botanical and private gardens and floras. As well as the classics, continental works were being translated and published in England, and by the 1650s Hartlib's collections of treatises and correspondence provides evidence that all of this was circulating. In Latourian terms, the cycle of accumulation, formed from a wealth of observational and philosophical inscriptions was increasingly rich. Hartlib was responsive to Bacon's experimental approach and to his call for the collection of observations

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Seventeenth-Century Matter Theory" in Debus & Walton, (eds) *Reading the Book of Nature. The Other Side of the Scientific Revolution*, (Sixteenth-Century Journal Publishers 1998), 21-36

[268] Shackelford, *Seeds with a Mechanical Purpose,* 22

of natural phenomena. Indeed, Hartlib's intelligentsia is reminiscent of Bacon's 'Multitude of Observers'. As noted by Sturchio, intellectual innovation in science came about as a result of complex negotiations among groups of actors in particular local contexts with competing interests'.[269] It was during this period that the seed was drawn into focus in the horticultural landscape as a life-giving force in agenda of Puritan improvement.

Monsters unmasked

Three authors, and inexorable promoters of the improvement agenda, were Ralph Austen, a religious radical closely associated with the Hartlib circle; Robert Sharrock who, although not a Puritan, circulated in the Hartlib circle, and Moses Cook who may have been a Puritan, but was active in the post-Hartlib period as the Royal Society was being formed. (In fact Cook's treatise was published well after Hartlib's death.) The key contention from these three authors was that it was not possible for man to fundamentally alter the make-up of a seed. However, described by Gerard as nature playing and sporting, and Bacon as nature's 'wantonings', Puritan improvers recognized from observation, and from readings in classical texts, seeds could throw out unexpected results. Art played a part in improving or denigrating nature, but they doubted whether the fundamental nature of the seed could be altered. As with earlier continental writers, Paracelsus, Severinus and van Helmont, the notion that a seed held some kind of *intelligibility* or *seminal principles* was permeating horticultural writing in this period. Austen rested his argument in theology, while Sharrock, although remaining swayed by nature as malleable was intellectually intrigued by the revival of atomism. Cook, through his observations, recognized change was

[269] Jeffrey L. Sturchio, "Artifacts & Experiment" in *Isis* Vol.79, No.3, A Special Issue on Artifact and Experiment The University of Chicago Press on behalf of The History of Science Society (1988), 368-372

possible, and was perhaps influenced by van Helmont's 'spiritual type-plan'.

Austen responded to Bacon's experiment with:

> It is true, that *Gilly-flowerseede* of one kind sowen, will bring up severall kinds some double some single…but I much doubt whether it be for that the seede meets with severall juyces in one bed of earth, for can it be imagined that two, or three very small seeds, that lye close together as can be, in the earth, should draw severall juyces, from the very selfe same mould so as to cause them to vary in the colour of the flowers? May it not rather be said, it is from a Law in Nature, which God…hath put into it…[270]

Sharrock used the insect kingdom as an example of transmutation, but contrary to Bacon's explanation, believed that the alchemical process of transmutation did not turn one into another, but rather released some latent essence as silkworms and caterpillars emerged after a long sleep when 'the reptile turne into volatile kind.'

> 'Yet I am perswaded that in many of their changes they are separate, and bring to apparence a latent minerall, than produce it by the transmutation of another into that nature.'[271]

Any change in a plant, stated Cook, came from the seed not art.

> I do verily believe, that to sow Seeds in way that can be devised by Man, will not in the least cause them to be quite another kind of Plant; for if you find any alteration, in any Plant that is, it is from the Conception and Nativity of the Seed; for there is no real alteration but by Seed.[272]

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[270] Ralph Austen, *Observations upon some part of Sr Francis Bacon's Natural history as it concernes fruit-trees, fruit, and flowers* (1658), Experiment 510, 30

[271] Robert Sharrock, *The History of the Propagation and Improvement of Vegetables* (1660), 30-31

[272] Moses Cook *The manner of raising, ordering, and improving forrest-trees* (1676), 59

Held within each of these explanations was a notion that the seed had a 'type-plan' or *blueprint* conceived, according to Cook, at its *Nativity*. This *blueprint* was immutable, much like Grew's atoms. However, the seed also held its own *intelligibility,* and it was this aspect of the seed that became central in early modern experimental and natural philosophy. Plat's transmuting, malleable matter, reliant on external forces, and the notion of a seed with *intelligibility* did not explain how a seed was formed. For this we turn to the observations of Nehemiah Grew and his interpretation of Lucretius and Epicurus. Grew's contribution to horticulture is recognized, but his works have to some extent been overshadowed by the writings of parson-naturalist John Ray (1627-1705) and intellectual thinkers like Robert Boyle. Grew is best acknowledged for his extensively recorded observations of the anatomy of plants, but according to Johnson, he is a 'forgotten mercantilist' a side of him rarely exposed. A strong advocate of economic self-sufficiency, he endorsed the efficacy of government interference in the economic sphere. Grew wrote on a wide range of subjects with most concentration on how to improve natural resources for economic advancement. One can deduce from his writing, that his extensive focus on plants was part of a larger plan wherein 'all natural and mental resources were to be combined with the maximum labor power that the nation could muster.'[273]

Grew's investigations were meticulously recorded and presented as a series of lectures to the Royal Society, which were eventually gathered together and published in *The Anatomy of Plants with an Idea of a Philosophical History of Plants* in 1682. Less well known, or researched, is the discourse he read to the Royal Society on the 10th December 1674 entitled *Concerning the Nature, Causes, and Power of Mixture* in which he considered classical texts as they pertained to the late seventeenth--

[273] Edgar Johnson, "Nehemiah Grew: A Forgotten Mercantilist" in *The American Economic Review*, Vol.21, No.3 (1931), 463-480.

century and contemporary thinking. Grew considered atoms to be the source of all life, and in the beginning of his lecture he summed up Aristotle's claim that *miscibilium alteratorum union* (in the union of mixable substances or bodies (atoms) are or have been changed). He categorically refuted that atoms had the potential to change, and was clearly influenced by the seventeenth-century revival of the atomism of Epicurus and Lucretius expounded particularly by Pierre Gassendi (1592-1655). For Gassendi the world was made up of two principles, atoms and the void.[274] In the *Principles of Bodies,* Grew stated that atoms were the foundation of all life. 'For as the *World*, taken together, is *Natures Shop*; so the *Principles* (atoms) of Things are her *Tools,* and her *Materials*.' Atoms were indivisible, *'physically*; and so, what is but *one*, cannot be made *two*' and, immutable, 'for that which cannot be divided, cannot be chang'd and therefore cannot mutate.'[275] Grew appears to subscribe to the Lucretian view that atoms were infinite in number and diversity leading to his description of atoms as bodies;

> 'like that of *Letters*, in *Words*…whereby, we have many thousands of *differing Words,* without any *alteration* at all, in the *Letters themselves*..in the same analogous way, as the *Letters* of the *Alphabet*, are the *Principles* of *Words*; so *Principles*, are the *Alphabet* of *Things.*'[276]

Binding together, or mixing atoms formed complex or simple bodies. The universe was comprised of void and *principles* and thus, 'the whole *Business* of the *Material World*, is nothing else, but *Mixture.*' In his explanation the seed comprised a mixing of atoms, and held the 'alphabet' or building blocks that made up the entire plant. All matter, in Grew's philosophical discourse, was a mixing of atoms, which, 'are

[274] Nehemiah Grew, *Concerning the Nature, Causes, and Power of Mixture,* Ch.II *Of the Principles of Bodies*, (1644), 223 §5
[275] Grew, *Concerning the Nature, Causes, and Power of Mixture*, 223 §3
[276] Grew, *Concerning the Nature, Causes, and Power of Mixture,* 226 §10

translated from one Body to another, as from a Vegetable to an Animal, are not in the least alter'd in themselves; but only their Mixture.'

The ability of atoms to be able to move, connect and then rearrange, is in many ways akin to the notion of matter as malleable and transmuting. Alchemical processes were perceived as fluid and liquid, running into each other, whereas atoms were interconnecting and indestructible. Either way, the motion and exchange in each philosophical example produced a new form, and were used to explain the reformation of matter from seed to plant. Bacon's argument for species change, disputed by some authors of horticultural literature, nevertheless left unresolved the question of mutations in plants. If, as was conjectured, the potential for alteration or mutation of a plant was held within the seed, the question then became one of creation. At what point in a creationist explanation was the seed conceived and how did this explain mutations? Paracelsians held the view that chaotic matter existed prior to God's creation and the very use of this pre-existing chaotic matter precipitated the potential for unfavourable as well as favourable end results. The argument was essentially whether the *blueprint* of the seed was formed from pre-existing chaotic matter or from God's chaotic matter. Austen referred to the Law of Nature or God's creation, while Sharrock, in a slight twist, considered the seed either 'already made' or in Paracelsian style 'as it is under the hands of Nature imperfect.' Cook was clear that the seed had its *genesis* in:

> The Chaos or first Matter was made a World, and of this World, was made Man: so a Tree grown from the Seed, the Seed is the beginning of the Tree, and in every grain or seed of a Tree there lies hid another tree.[277]

[277] Moses Cook, *The Manner of Raising, Ordering and Improving Forest and Fruit-Trees*, 6

However, not all seeds produced mutated plants, and this led to notion that some seeds conceived mutating information at their conception, for, as Cook wrote.' This I know, that Nature doth delight very much in Imitation, and in Plants and Trees like doth endeavour to produce its like.[278]

Authors illuminated their literary landscapes with observations and experimental philosophy. The economic and political landscapes absorbed into their writing were tinged with famine, war and poverty, yet juxtaposed with narratives of wealth, grandiose gardens and collections. An unpredictable and uncertain nation state was reflected in the Puritan discourse on seeds and plants. In their drive to restore dominion over nature, the improvement agenda of the 1640s and 1650s was imbued with the religious radicalism of the Puritan movement. The original seed was of God's creation, but after the Fall, the seed became susceptible to imperfections, the very imperfections Bacon sought to economically exploit. As noted by Webster, writers were concerned to give accounts of the powers lost at the Fall, citing John Beale's letters to Hartlib in which he recalled 'the devine Wisdome exemplified & executed by Moses' which could 'effect strange alterations in the World.'[279] However, the Fall of man was not, according to Webster, conceived as irreversible, indeed 'spiritual salvation would be accompanied by the renewal of his dominion over nature.' In their textual laboratories, authors reviewed and considered the observations from classical and contemporary texts noting unpredictable phenomenon. Findlen demonstrates how collections led to recognition of global diversity, which not only led to interrogation of universal categorization and classification methods, but also engaged early modern natural philosophers in conceptualizing difference. As illustrated

[278] Moses Cook, *The Manner of Raising, Ordering and Improving Forest and Fruit-Trees,* Ch.4
[279] Webster, *The Great Instauration*, 328

by Cooper, botanists compiled and inscribed local and geographical knowledge into floras, observing the range of environments in which plants survived and indeed thrived.[280] The botanist Goodyer is recorded by Gunther to have observed and recorded several species of non-native elm that seemed to have naturalized.[281] But most difficult to explain, was the reason why seeds failed to germinate, or once having germinated, why plants failed to thrive. All of these phenomena were inscribed onto the leaves of horticultural and husbandry texts during the early modern period. Explanations were influenced by the natural philosophical arguments of the period under consideration, from alchemical transmutation to mechanical atomism. Bacon's 'deep search of nature' was reflected in Puritan enterprise, as religious and economic forces contrived to drive their improvement agenda. The seed was reassembled from a 'wantoning' sporting entity into a controlled mechanism where its *intelligibility* was seen as holding the answers to problems and unpredictability in nature. Drawing on the cycles of accumulation from classical text, continental influences and contemporary texts and correspondence, Hartlib's circle and improvers like Cook used their literary landscape as a textual laboratory in which was constructed a 'model' seed.

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[280] Paula Findlen, *Possessing Nature.* Alix Cooper, *Inventing the Indigenous*, 83
[281] Gunter R.T., *Early British Botanists and their Gardens [based on unpublished writings of Goodyer, Tradescant and others*, 337

PART II

Trials of Nature

The best time to plant a tree was 20 years ago.

The second best time is now.

Chinese Proverb

Chapter 5

In the beginning

The search for a model seed remains a quest that continues today in our modern world of genetically modified organisms. But in the utopian world of Puritan improvement the model seed would produce trees and timber fit to construct naval ships, houses and furniture, as well as charcoal for industry. It would fill the orchards of the nation with diverse fruit trees, and improve cider making, with fruit to feed the poor. It would provide strong and nutritious vegetables to feed a growing urban population and support the hungry in times of famine. The seed would help end poverty, provide employment to the poor in growing newly introduced industrial crops like flax and hemp. It would produce crops resistant to disease, and the vagaries of the climate. And for the industrious horticulturalist, fine flowers with scent and colour to deck and adorn the nations gardens and homes. The model seed could quite literally, in Plat's word, turn 'penury into plenty.'

The heightened period of collecting during the early modern period, afforded sixteenth and seventeenth-century naturalists a vision of the sheer diversity of nature in the world as they discovered it. The naturalist sharpened his observational and literary skills, and inscribed his ideas into text. In this visible world all the senses were used to understand and philosophize. But it was the invisible world that remained a mystery. In classical text, Plato's invisible world was an *intelligible* world consisting of Forms that were unchanging and eternal.[282] According to Dear, Aristotle's idea of *intelligibility* included mechanical explanations of natural processes that involved tiny particles or atoms, or mathematical formalisms. This *intelligible* realm could not

[282] See also Stephen Gaukroger, "Aristotle on Intelligible Matter" in *Phronesis*, Vol,25, No.2., (1980), 187-197. His paper considers Aristotle's discussion of mathematical objects having matter. M.C. Lemon, *The Discipline of History and the History of Thought* (Routledge 1995), 157

be sensed, but only grasped with the intellect and only the *intelligible* realm could be the object of knowledge. Building on observations of the external, visible world of the seed, authors during this period used experimental philosophy to explore and define the invisible world of the seed.

The previous chapter considered how contemporaries in the 1620s to the 1660s reconciled the notion of God's design with their desire to uncover nature's secrets. They did this by conceptualizing the invisible world of the seed as an immutable blueprint that was species specific. At the same time they intellectualized that the seed held some essence of its own, intelligibility that, in Latourian terms, was a power to be harnessed. In a method more akin to Aristotle, the concept was to start from the things, which were observable, and knowable, before proceeding towards those, which were clearer and more knowable by nature. Dear summarized the hallmark of natural philosophy in its 'stress on *intelligibility'* in that 'it takes natural phenomena and tries to account for them in ways that not only hold together logically, but also rest on ideas and assumptions that seem right, that make sense; ideas that seem natural.' [283] Thus, the direction taken by early modern horticulturalists in particular, turned to an experimental investigation of what nature could be made to do, rather than what it usually did by itself. In Aristotelian terms, *epistēmē,* which translated in Medieval Latin as *scientia* (science), meant the demonstration of knowledge, while, *technē* or *ars,* was the artificial technology utilized to manipulate material things. Dear accords an Aristotelian hierarchy to this interpretation, one where freemen and citizens held the knowledge, and slaves and servants undertook manual work. A similar role appropriation was followed in the husbandry manuals, particularly Surflet and Googe's continental translations of Heresbach and Estienne, both of which had

[283] Peter Dear, *Revolutionizing the Sciences: European Knowledge and its Ambitions, 1500-1700,* (Palgrave Macmillan 2001), 173

their roots firmly embedded in the soil of classical agrarian text. However, by the seventeenth-century, the primary goal of experimental philosophy was to combine knowledge with *instrumentality* as a means of providing support for natural philosophical speculations. A standard definition of *instrumentality* implies the agent of action to be human. However, within the actor network theory, the interaction between the artefact and human, while rarely of equal compatibility, nevertheless involved the agency of both.

This chapter will begin to unveil the hidden invisible world of the seed as early modern naturalists and horticulturalists applied experimental natural philosophy and constructed their model seed. Dear divides theories of matter into two distinct categories, the sixteenth-century embraced alchemical and iatrochemistry, while the seventeenth-century was distinctly involved with mechanistic atomism. In support, he uses examples from the grandees of intellectual thought in the period, including Robert Boyle, John Locke, Robert Hooke and Isaac Newton. However, a clear division between sixteenth-century alchemy and seventeenth-century mechanistic philosophy is not apparent in the literary landscape of horticultural authors. These men may have had connections to the likes of Robert Boyle through the Royal Society, or secured wealthy patronage, but they were essentially, as argued in Chapter 3, citizens with a burgeoning interest in releasing science from the rarity of medical and university environments. What is evident in their narratives, is that authors of horticultural and husbandry literature have oscillated between classical and contemporary natural philosophy. So, for example, as will be discussed below, heat was a common theme in the developing theories of germination. According to Dear, seventeenth-century experimental philosophers adhered to a theory of heat as an effect of particles of matter in rapid agitation. In the eighteenth century the idea was replaced with the view that heat was a kind of fluid called caloric that pervaded bodies like water in a sponge.

The nineteenth century witnessed the revival and reassessment of the seventeenth-century kinetic theory of heat. Cycles of accumulation layered knowledge as contemporaries revived and reviewed in light of the intellectual ideas of the period. Knowledge was assimilated, refuted, plagiarized or uncritically recycled.

There was much to be discovered in nature, but what did become embedded into the agenda of the Puritan improvers was the notion of a blueprint. In other words, if a particular species was planted, be it tree, vegetable or flower, you should get the same species from its seed. The forming of this notion is complex, and certainly involved invoking religious doctrine and God's grand design. However, it can as well be argued that collections both private and, increasingly, those offering public access, were formative as centres of enquiry. The introduction of seeds and plants collected from plant hunting exhibitions, through colonization and voyages of discovery, provided the horticulturalist with very specific problems, not least recognition. 'My Lord had thirteen sorts of strange seeds sent to him, as I remember from *Goa*: I never say the like, nor none that saw them here" wrote Cook.[284] That an unknown seed produced a sapling, or a vegetable plant, and then propagated and reproduced its 'image' helped to confirm the notion that the seed knew what it wanted to be regardless of the environment in which it found itself.

However, while patterns of plant behaviour were observed and recorded, problems remained. Bacon's species change as discussed in the previous chapter was refuted, but this left problematic observations concerning plants that degenerated, mutated, failed to germinate and more. Could a Baconian style investigation of problems, a 'vexing' of nature in the margins, actually provide a basis on which to construct a

[284] Moses Cook, *The manner of raising, ordering, and improving forrest-trees,* 5

model seed? Could the problems and differences be part of the solution to creating a perfect seed? Before exploring the literary landscape of experimental philosophy, this chapter will consider the narrative of the observable and considered known.

Included in the classical texts of Pliny and others, and documented by early modern naturalists, were three features of plant behaviour that appeared to be common to all species, except mosses and ferns. The first was that seeds required fertilization, the second that plants grew out of germinating seeds, but of particular interest, was the ability of seeds to appear unmoving and 'dead'.

Fertilization

From around 1540 into the early 1600s, European botanists were investigating ideas of self-pollination, or cross-pollination. Sachs, (1832 – 1897) an early commentator on botanical matters, credited Joachim Camerarius (1665-1721) with the discovery of sex in plants, a view that has generally remained unchallenged.[285] Camerarius, a German botanist and physician, described his findings in the form of a letter to a colleague, *De sexu plantarum* (On the sex of plants) in 1694, and in *Opuscula botanica* (Botanical Works) in 1697. Camerarius studied the mulberry and observed that without close proximity to male plants female plants produced fruit with no seeds. With maize he cut off the tassels and observed that when removed, no seeds formed. He concluded from his experiment that there was a sexual component in the propagation of plants. In many respects Camerarius was not saying anything new, but what he did demonstrate, through experimentation, was the need for male and female parts of the plant to *interact* in order for seeds to be formed. Fertilization, in other words, took place prior to the seed being formed, as opposed to a contrary view held well into

[285] Julius von Sachs, *Lehrbuch der Botanik* (Textbook of Botany) (1868)

1680s, that the seed was fertilized after it was formed by an external male force stimulating germination.

However, a theory of the biological sex of plants had been published well before Camerarius. Bohemian physician, apothecary, botanist and professor at the University of Prague, Adam Zaluzansky (d.1613) produced a seminal work entitled *Methodi herbariae libri tres* (Prague, 1592; Frankfurt 1604). According to Ogilvie, Zaluzansky, who was writing books for students, is credited as being one of the first botanists to attempt to differentiate and categorize plants by their botanical qualities rather than their medical and herbal qualities. Zaluzansky's radical alternative method of categorization was in response to the multitude of new plants flooding into Europe, and in so doing, he considered the structure of the plant and biological sex.[286] Funk also refers to Zaluzanky's *De sexu plantarum* (The sex of plants) and Zaluzansky's statement that plants had a male and female sex, 'sometimes separated ("divism"), mostly, however, combined ("confusus", "permistus") on one plant.'[287] Zaluzansky's theory was anything but commonly accepted at the time, and certainly departed from the received wisdom of Aristotle, who stated plants 'do not have real sexes' (*GA* 731a) and 'do not impregnate' (like testaceans, *HA* 538a).

Investigating the invisible world of the seed had to be combined with observations from its external world. The continental contribution from Zaluzansky may well have percolated into intellectual thinking in England, he was, for example, a contemporary of l'Obel whose connections in Europe were extensive. However, in England,

[286] Brian Ogilvie, *The Science of Describing* (University of Chicago Press 2006), 50, 66, 209, 221-223

[287] Holger Funk, "Adam Zaluzansky's "De sexu plantarum" (1592): an early pioneering chapter on plant sexuality" in *Archives of Natural History,* Vol.40, Issue 2 (2013), 244-256. *Divism* (sliced) means plants are either male or female; *permistus* (mingled) means male and female sexual parts are on the same plant. Plants may either self-pollinate or cross-pollinate.

Renaissance explanations of fertilization and germination remained consistently associated with Paracelsian alchemy, the cosmology of Aristotle, and, classical traditions, all of which continued to ripple through the 1600s. Schiebinger discusses what she describes as the *scientization* of botany, or, more precisely, the sexualizing of botany. She argues there were two levels in the sexual politics of early modern botany: 'the *implicit* use of gender to structure botanical taxonomy and the *explicit* use of human sexual metaphors to introduce notions of plant reproduction into botanical literature.'[288] Schiebinger touches on an important aspect of notions of fertilization, particularly in the early part of the seventeenth-century, where plants were described anthropomorphically. However, as will be discussed in Chapter 6, it was not the attribution of sexuality to plants that was of importance, but rather the socially constructed characteristics of maleness and femaleness. These were the attributes that would help define a model seed. While it was recognized, and to some extent assumed if not understood, that a seed required fertilization, how this happened was not generally discussed in detail. Writing in the 1660s, Cook succinctly summarized what many for a long time believed. 'As touching the several Kinds, some Authors will have two sorts, the Male and Female: but there is no such thing as Male and Female among Plants, though some Plants are so called; for what Act of either do any two Plants communicate to each other?'[289] So, despite European botanists early speculation and investigation into pollination of plants, no systematic investigations occurred in England until Grew described the stamen as the male part of the flower.

Grew conceived a vital force as an internal, invisible, incorporeal *intelligibility.* His ideas and concepts were scattered through his writing,

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[288] Londa L. Schiebinger, *Nature's Body: Gender in the Making of Modern Science,* (Rutgers University Press; 2nd Revised edition edition 2003), 13
[289] Moses Cook, *The manner of raising, ordering, and improving forrest-trees*, 54

but in *The Anatomy of Vegetables* and *Cosmologia Sacra,* he reconciled his religious beliefs with his experimental philosophy.[290] With a botanical eye and enquiring mind, he used nature's laboratory to observe and described the morphology of plants in great detail. Grew was able to use an eyeglass and rudimentary microscope in his botanical investigations, a technological advancement that Latour would define as an *inscription* device, in much the same way as mechanical advancement in map making, such as magnetic devices and the compass, increased the accuracy of reproductions and data. For Salmon, an *inscription* devise was 'apparatus used such that it provides some sort of symbolic output'.[291] Grew wrote one of the first detailed observations of pollen situated in the centre of flowers. All flowers, he claimed, had their '*powders* or *globules'* noting that some of the powders were yellow and some white. Recording vast numbers of little '*Animals* in the *Attires* of all *Flowers',* he described them as carrying some of the '*Parts,* as of the *Globulets, wholly away.'* [292] Grew did not consider these little *Animals* to play any part in the fertilization process, relying instead on his interpretation of his observations of the flower. He records a discussion with his contemporary Sir Thomas Millington I1628-1703), in which they agreed, that the 'Attire (of the flower) doth serve, as the *Male,* for the *Generation* of the *Seed.*' In other words, the flower held both male and female parts. [293] Grew hypothesized the seed carried within its *intelligibility* a fertilizing agent or essence (possibly his vital substance). This agent, released as the seed germinated, was carried in the sap, which, he likened to semen, and as the sap circulated the plant the fertilizing agent eventually reached the new seed(s) that formed in the

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[290] Nehemiah Grew, *The Anatomy of Vegetables Begun: with a General Account of Vegetation Founded Thereon,* (1672). *Cosmologia Sacra: Or a Discourse of the Universe as it is the Creature and Kingdom of God,* (London, 1701)
[291] Merrilee H. Salmon, *Introduction to the Philosophy of Science*, (Hackett Publishing 1992), 169
[292] Grew, *Anatomy of Plants*, 148
[293] Grew, *Anatomy of Plants*, 148

flower. From the development of the seed in one generation, to the formation of seed for subsequent generations, Grew consider this cyclical process was achieved through plant self-fertilization with each new generation of seeds carrying the blueprint and *intelligibility* of its species.

Fertilization provides an example of the complexity in building knowledge, and the desire of naturalists, botanists and horticulturalists to pursue purpose and reason in the propagating properties of the plant. The very invisibility of the topic led to a plethora of speculation harnessed by the intellectual mood of the period. This example also demonstrates that access to technology, combined with botanical observation, in some way transported the macro notion of a cosmological vitality to a micro notion of the *intelligibility* of the artefact under investigation. It is worth pausing at this point to consider the importance, or not, of notions of fertilization in the early modern period. According to Morton, the exact fertilization process was uncertain well into the eighteenth century.[294] Most of what has been written about the sexual differences between plants has concentrated on the biological classification developed by the Swedish botanist Carl Linnaeus (1707-1778), whose taxonomy system was based on the sexual parts of the plant already identified by Grew and Malpighi. What is different in the examples above is that horticulturalists and botanists were not attempting to classify, they wanted to find out *how* things worked. There was no doubt they were clear about the need for a seed to be fertilized, and they used anthropomorphic terms to describe the necessary elemental activity, whether it be from the cosmos, or within the plant itself. In trying to formulate an image of the model seed, it was clearly evident in their literary landscapes, that fertilization required an interaction of a vital force, most often described as male, on a less well

[294] A.G. Morton, *History of Botanical Science* (Academic Press 1981)

defined 'female' characteristic in the seed. As is discussed, this becomes important in selecting the most desirable characteristics carried by the seed.

Germination

Germination was a topic of significance throughout the period and was central in both the husbandry and horticultural literary landscape. As is discussed below authors in their literary laboratories applied experimental philosophy as a means of engaging with the *intelligibility* of the seed. This is where we return to the centres of calculation, the literary landscapes of fields, gardens, forests, orchards and vegetable plots. This is where the heavens were read and the earth was planted, where authors interacted with the *intelligibility* of the seed*,* and where the model was constructed.

Germination is a biological process whereby a seed puts forth shoots also described as sprouting or pullulating. Theophrastus wrote about the germination of seeds, as did Aristotle who viewed plants as having 'no other task to perform than the generation of seed.'[295] Theophrastus described the inside of the seed as containing a certain amount of food, and 'do not, like the seed (semen) of animals, perish directly on separation from the parent.'[296] Changes in the external appearance of a seed as it germinated were observed and noted in the horticultural literature of the early modern period. Put some seeds, wrote Plat, '…in a sawcer of faire water, set it a while upon a Chafingdish of Coales; and if they be good they will sprowt in a short time, else not.'[297] But it was the internal mechanism, the process of change that required explanation. In Plat's explanation, germination required the seed to be first fertilized by an active male agent, and with the external application of gentle heat,

[295] Aristotle, *On the Generation of Animals,* 1.23
[296] Cited in J. Derek Bewley, Michael Black, Peter Lalmer, (eds) *The Encyclopedia of Seeds: Science, Technology and Uses,* (CABI Publishing, Oct. 2006), 331
[297] Hugh Plat, *The Garden of Eden* (1654), 48

resulted in instigating a process of fermentation, an alchemical process, which stripped away the outer coating of the seed. Applying Renaissance alchemy to seed germination, Plat invoked an Aristotelian world of mirror imaging the heavens with the earth. Thus there was *Saturnus* (fire) in the heavens; and there was one on earth. As there is a Sol (water) on earth as there is one in the heavens. That which is above is like that which is below. According to Moran, alchemy provided a shared way of seeing, experiencing and exploring the world. He argues the evolving thinking and exploratory activities that drove alchemical practice during the sixteenth and seventeenth-century lead to analysis and increased understanding of various parts of the natural world.[298] In this sense the *intelligibility* of the seed drew on an experimental natural philosophy that incorporated nature as malleable and transmutable. The inside of the seed, as in the search for the Philosopher's Stone, became fluid in a transformational process, as matter moved from one form to another, from seed to juvenile plant.

Bacon's theory of matter is a complex combination of alchemy and atomism. According to Debus, Bacon abandoned his early intrigue in mechanical atomism replacing it with pneumatic theory, although Manzo claims he never rejected it completely. Bacon believed there existed tangible matter, which was dense, sluggish and passive, and pneumatic which was rarified, weightless and active and that both were imperceptible at their corpuscular level.[299] Manzo refers to Bacon's notion of the anatomy of nature where in alchemy 'anatomy means more than the mere dissection of living beings as it does in medical anatomy; it sometimes refers not only to a separation of physical parts

[298] Bruce Moran, *Distilling Knowledge,* (Cambridge, Mass.2005)
[299] Allen Debus, *Alchemy and Early Modern Chemistry, Papers from Ambix*. (Jeremy Mills Publishing 2004). Silvia A. Manzo, "Francis Bacon and Atomism: a Reappraisal" in Christoph Herbert Lüthy, John Emery Murdoch, William Royall Newman (eds) *Late Medieval and Early Modern Corpuscular Matter Theories* (Brill 2001), 209-244. See also Doina-Cristina Rusu, *Francis Bacon: Constructing Natural Histories of the Invisible*, (Academia, Early Science and Medicine 17 2012), 112-133

of chemical substances, but also to the theoretical knowledge of the invisible forces involved.'[300] For Bacon, tangible matter imprisoned what he referred to as 'spirits', although according to Shackelford, he stopped short of equating spirit with seminal forms or reasons, referring rather to spirit as 'pneumatic matter'. Bacon's explanation of germination involved a strong and forceful invisible energy as 'spirits' fought to break free from the visible, external constraints of the seed. In *Novum Organum,* Bacon contributes much of this force to external factors, and the relationship between the surface of the Earth and the spheres of the Moon, where sulphur and mercury combined in a 'potential' to create all manner of organic beings. But this potential could only be realized by a life force characterized by Bacon as 'attached spirits'. Some of these spirits were inanimate, while others were animate with the ability to endow a body with life or vitality, whether plant or animal life. Like Plat, Bacon theorized heat and moisture as alchemical properties required for fermentation, acting as agents to excite and release the 'spirit'.[301]

Between the 1620s and 1660s, horticultural authors were increasingly of the opinion a seed held within it a blueprint. While it held the potential to germinate, it was unable to do so spontaneously, and required external factors to precipitate the process most commonly associated with heat and moisture. There remained a view that the seed required fertilization before germination, and this happened, according to Cook, through the delivery of a 'sperm' like substance by *astrum.* There is a subtle, but distinct difference, in theories of matter between authors of the alchemical tradition. Plat, in particular, followed strong alchemical principles based on the belief that materials, for example base metals, could be heated and literally boiled down, so that they transmuted into

[300] Silvia Manzo, "Francis Bacon and Atomism: A Reappraisal", 214
[301] Bacon's writings on 'spirits' and 'pneumatic matter' are spread through his Works, Volumes 5, 6 & 7. See Francis Bacon, James Spedding, Robert Leslie Ellis, (eds), *The Works of Francis Bacon,* Vol 5, Translations of the Philosophical Works 2 (Cambridge University Press, 2011)

another chemical element such as gold. Following this principle, Plat applied this to his theory of seed germination, where the internal matter was literally heated down through fermentation such that it transmuted into another material matter or from seed to plant. In this case, nature was perceived as malleable and pliable.

As already noted, in the 1660s Cook, described the seed as 'endowed with a Vital Faculty to bring forth its like, it contains potentially the whole Plant in it.'[302] The blueprint of the seed remained intact, but in explaining the *intelligibility* of the seed, Cook pursued Aristotelian cosmology and the chemical theories of Paracelsus and van Helmont. He described the earth as a combination of sulphur, mercury and salt, (the three *tria prima* spiritual substances from Paracelsus), within which 'lies the *Astra's* of the Earth which bring forth all growing things.' Once the seed received 'this precious sperm' carried from the heavens by a 'Star-fire' the combination of the elements heat 'Father' and moisture 'Mother', led to germination 'for without both these no seeds can produce its kinds.' For Cook, there were a number of processes. The seed held all the information required to produce a plant of its kind, but required fertilization before the process of germination could occur. Importantly, the fermenting process did not reduce and transmute the seed from one material substance to another, as in Plat's explanation, but rather, it initiated a 'Vital Faculty', the seed's *intelligibility,* already contained within it. Cook does not openly subscribe to atomistic theory, although his explanation of the invisible working of the seed does reflect the notion of small particles of matter moving and exchanging in a pre-ordained pattern.

Improver Sharrock also acknowledged Paracelsus's alchemical theory of the 'Spirit working upon the Salt and Sulphur, Earth and other

[302] Moses Cook, *The manner of raising, ordering, and improving forrest-trees*, 7

constituent parts or Elements of the Seed.' In his explanation, the spirit was supposed to be made volatile by the heat of the earth and water, generally in spring and autumn when fermentation was most likely. At this point the spirit rose up and expanded throughout the plant, distending the sides of the seed stimulating plant growth. Sharrock hovered between an alchemical explanation, atomism or a combination of both. '[T]ill I am better informed, I desire to take no side.' He subscribed to the notion of a blueprint, 'so by Nature originally fitted specifically for the plant', but was less confident in his intellectual pursuit of the *intelligibility* of the seed, or the manner in which germination was precipitated. In the end, despite not want to take sides, he does apply, all be it in a questioning mode, atomistic reasoning.

> ..or whether there being a continual motion of particles from the earth, pressing upon the plant, those only get entrance whose shapes and figures are such, as correspond to the pores in the young Vegetable; which meeting in the body of the plant with its constituent parts in nature not unlike themselves, they easily are joyned thereto, and so cause an augmentation in the whole: or whether dissimilar parts, either to fill up the Vacuum made by distention, or for other reasons, got up into the plant, doe obtain there a change of nature, and from the form, Soul, Archeus, or other principle, are altered from their first being, into a likenesse of nature with the Seedling, and become homogeneous to it;[303]

Sharrock best illustrates the contradictions, concerns and confusion in the intellectual pursuit of what happened in the invisible world of the seed at the time of germination. Certainly there is evidence of discourse on fertilization, which, until around the 1660s, was considered an event that happened to the seed when it was in or on the earth, and that fertilization precipitated the germination process.[304]

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[303] Sharrock *The History of the Propagation and Improvement of Vegetables* (1660), 40
[304] See Chapter 9 of this thesis.

From the 1660s the view that a seed held all the parts of the plant in embryonic form was becoming embedded in botanical theory, although there was no consensus on the *intelligibility* of the plant and the internal mechanism. Descartes and Gassendi's mechanical philosophy expounded between 1620 and 1650 was influential, but applying this philosophy to living forms was inevitably tinged with an author's own intellectual curiosity. Even though Grew was an advocate of atomism, elements of seventeenth-century alchemical or chemical processes filtered through his narrative.[305] Indeed, he described the use of alchemical processes when experimenting in the distillation of plants to establish their taste and smell. In 1672, and with the use of a microscope, Grew expanded on explanations of germination. Unlike some authors, he did not subscribe to the seed requiring an external cosmic force to generate germination, although he did believe 'that there is a Vital World, which God hath made'[306] and '[T]here is a Vital Substance in Nature.'[307] According to Garrett, Grew presented two principles, one that he believed God should be understood as vital and incorporeal, and the other that God created nature in his own image. 'Universe consisteth, of the Corporeal and the Vital World…I shall prove that, there is a Vital Substance in Nature, distinct from a Body.' The other was Grew's scepticism that mechanism could account for vital phenomena.[308] Thus the *intelligibility* of the seed and plant appears in Grew's account to be encapsulated in this 'vital substance in nature'.

[305] See also: Brian Garrett, "Vitalism and teleology in the natural philosophy of Nehemiah Grew (1641-1712)" in the *British Journal for the History of Science*, 36.1 (Cambridge University Press, 2003), 63–81. Jeanne Bolam, "The Botanical Works of Nehemiah Grew, F.R.S. (1641-1712)". *Notes and Records of the Royal Society of London*, Vol.27, No.2 (Feb., 1973), 219-231.
[306] Nehemiah Grew, *Cosmologia Sacra: Or a Discourse of the Universe as it is the Creature and Kingdom of God,* London, (1701), Ch.3, Second Book, 18
[307] Grew, *Cosmologia sacra,* Ch.3, Second Book, 31
[308] Garrett, "Vitalism and teleology in the natural philosophy of Nehemiah Grew, 1641-1712", in the *British Journal for the History of Science* 36.1 (2003), 66

Grew’s experimental philosophy included practical investigation of the seed. Like Cook, he considered the innermost section of the seed contained all the matter and elements required for the production of a plant, and through dissection, confirmed his theory that the seed held within it an embryonic plant. In his writing he refers to the innermost part of the seed as containing a *‘Foetus’* which, in turn, was covered by the uterus, comprising the shell or outer coating, and described the seed as being ‘*born in the ground.’* How this embryo was released to grow, he claimed, relied on motion created by a combination of fermenting elements in the environment on the *outside* of the seed, with a corresponding activity of fermenting elements or principles *inside.*

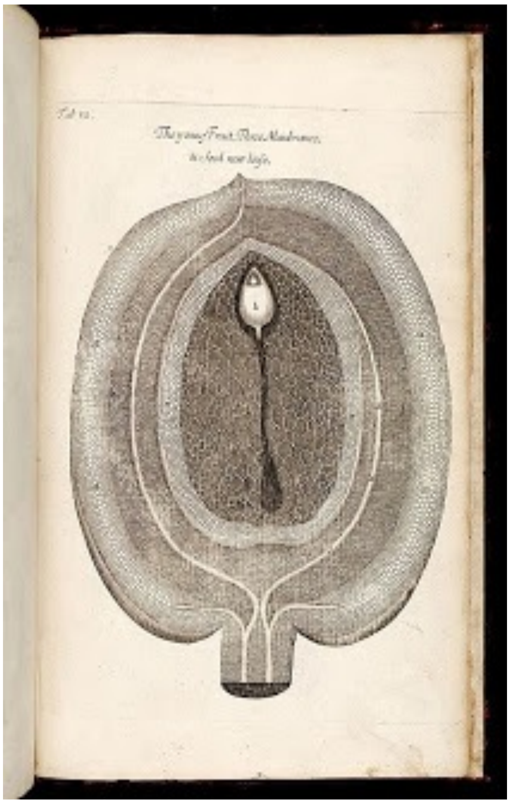

Figure 11. Taken from Nehemiah Grew *The Anatomy of Plants.*[309]

Using microscopic detail, Grew utilized experimental philosophy to support his assertions. In his investigation of the ‘great Garden-Bean’,

[309] Grew, *The anatomy of plants, read before the Royal Society (1682)*

Grew set about inscribing what he described as 'observations'. He noticed a small permeable opening which, 'tis so very small, as scarcely, without the help of *Glasses* to be discovered'.[310] This opening he called the *Foramen* (hole) and all seeds even those with thick shells or stones had such a perforation. 'That is, the *Bean* lying in the Mould, and a moderate access of some moisture, partly dissimilar, and partly congenerous, being made, a gentle *Fermentation* thence ariseth.'[311] Fermentation required a complex mixing of *principles* (atoms) from within and outside the seed. This was achieved by mixing external *principles* with the internal *principles* of the sap. Moisture and air 'to excite the *Fermentation*' were absorbed through the *foramen* and once mixed with the sap caused fermentation. Held within the lobes, the purpose of the sap was to pump a mixture of *principles,* including nutrients, into the various parts of the seed.[312] Fermentation created heat, and heat, in turn, created motion enabling the sap to percolate through the seed.[313] The seed began to swell allowing this mixture of *principles* to be filtered through the various layers of the seed. This sappy mixture fermented in the inner body until it entered the parenchyma. Continuing to ferment, the mixture passed into the plume and the radicle, until it percolated all inner parts of the seed. Driven by the heat of fermentation, the sap literally pulsed through the seed, pushing the newly germinated plant out of its protective seed coating. The internal *principles* combined with external *principles* to mix and remix into different combinations as the seed developed into a plant. First the radicle, pumped with sap moved in a downward trajectory into the soil. From Grew's description, as the root and seminal roots filled

[310] Grew, *The Anatomy of Vegetables. Begun: with a General Account of Vegetation Founded Thereon,* (1672), 4
[311] Grew, *The Anatomy of Vegetables, Begun*, 19
[312] Grew's description of the circulation of sap is not dissimilar to the research on blood circulation undertaken by William Harvey (1578-1657).
[313] Grew, *The Anatomy of Vegetables, Begun*, 19

with sap, so the level of sap was raised pushing the plume upwards.[314] '[T]he *Radicle* being thus impregnated and shot into a *Root;* 'tis now time for the *Plume* to rouze out of its Cloysters, and germinate too.'[315] As he sought to explain what was happening inside the seed as it germinated, Grew turned to a complex combination of alchemical and mechanistic philosophy.[316]

Close observations of new and diverse plants entering the gardens and the early modern landscapes, led to exploratory investigations of the nature of seeds. External observation of the germination phase was enhanced by religious, philosophical and botanical explanation of the internal workings of the seed. The diversity of seeds from around the world, and the experimental process applied to indigenous and overseas seeds, led to a notion that the blueprint of the seed was in some sense a universal characteristic.

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314 Seminal roots are adventitious roots that grow from the base of the stem during early seedling growth and take over the functions of the radicle. In his *The Anatomy of Vegetables, Begun*, 22- 28, Grew acknowledges and addresses the fact that some roots and branches do not always follow this pattern. See Grew, Ch.III *An Appendix Of Trunk-Roots and Claspers.*

315 Grew, *The Anatomy of Vegetables,* 26

316 For details of his experiments see *Of the Principles of Bodies*: *Experiments in Consort of the Luctation.* Exhibited to the Royal Society, April 13 and June 1, 1676. See also Wilson, *The Invisible World,* 205-6, 230-1

Chapter 6

Collecting Seeds

It is clear in the treatises of early modern horticultural and husbandry authors, that their observations, descriptions and philosophical encounters were influenced by a wide range of experiences combined with knowledge gained, from what Latour describes, as *inscriptions.* The many and varied *inscriptions,* from manuscript to print, to correspondence and diaries, formed a vast cycle of accumulation, of knowledge, experience and philosophical discourse that was drawn on by these early modern authors. This formed the background of their experimental philosophy, and their literary landscapes, modelling the Renaissance *naturalia* curiosity cabinet, acted as an important facet of collecting. With a natural history of plants displayed before the reader, the author turned his attention to the micro world of the seed as it presented in the macro world of nature. Observation of the external presentation of the seed led to philosophical speculation on the internal mechanisms, leading to more specialized species based investigations. By the turn of the century, from around the 1620s, speculation became theorized as experimental philosophy became species specific, for example, timber and wood, vegetables, fruit and flowers. Seeds, the improvers argued, had a blueprint which was immutable, and which carried an *intelligibility* that controlled fertilization and germination.

This section will concentrate on two specific features relating to the seed. It will include examples of the criteria for selecting and collecting seeds, and follow a discourse among authors on biological inertia. As will be discussed these two were strongly interconnected in the improvers drive to construct a 'model' seed. The seed must be of prime quality, carry the desired characteristics, and be viable with an ability to resist or respond to perturbation. As the improvers collected, so their selection criteria became more rigorous. As noted by MacGregor, while virtuosi and museum collections formed the foundations for collecting nature, these collections tended to focus on curiosity and rarity, omitting the common garden species, unless they were curious in their own right. It was, according to MacGregor, 'pragmatic naturalists' who really set the scene, using collections as 'practical aids to understanding, analysing and classifying the several realms of nature.'[317] These early seed collections were, in many ways, the precursor to what we now describe as modern day seed banks. According to Gáldy and Heudecker, seed banks are 'the most complete and encyclopaedic collection possible, given their specific collecting criteria.'[318] They continue by arguing that the modern mission of national seed banks varies according to collection principles, but most of them have research laboratories that investigate 'seed storage and viability'. It is this investigative function of seed banks that we see mirrored in the literary landscape of naturalists in the early modern period as they collected their seeds for the posterity of the nation. Viability and storage were critical features in the search for the model seed, and this chapter starts by considering the selection criteria employed by authors as they selected their seeds for propagation.

Nature's collections

It was several decades before the first seed bank was set up in England, most probably when the Royal Botanical Gardens was founded in Kew in 1759. Even at this point, however, there was greater interest in preserving living plants and herbariums, than seeds. According to Thick, there was a steady expansion in the commercial selling of seeds with the growth of market gardens and nurseries and an increase in private gardening in the later part of the seventeenth-century.[319] But before these enterprises could happen, there needed to be some scientific explanation of various *intelligibilities* in the blueprint of the seed. If we

[317] Arthur MacGregor, "Introduction" in A. Gáldy & S. Heudecker (eds), *Collecting Nature* (Cambridge Scholars Publishing, 2014)
[318] A. Gáldy & S. Heudecker (eds), *Collecting Nature*, 172
[319] Thick, "II The Trade in Seeds", *British Agricultural History Society* (1990)

return to the literary landscape of the early modern horticulturalist and husbandman, the author invites the reader into a literary laboratory, where seeds are selected and collected to a set of criteria and, in a sense, metaphorically banked in a scientific seed improvement portfolio.

In 1682, Grew collated together much that was known about the anatomy of plants, and along with his own observations, produced a detailed and exhaustive exposition of the minutiae of plant life which he presented as a series of lectures to the Royal Society. In a short and concise section contained within a voluminous collection of observations, he described how, 'Nature taketh several Methods' to disperse seeds once they were ripe. Grew believed a plant had a blueprint which imprinted a plant with the *intelligibility* to produce seeds and disperse them. However, the mechanism for dispersal was species specific, and achieved in all manner of ways, from falling directly down to the ground, to flying with hooks, wings or feathers on the wind, to being wound up into a coil like spring and spurted and slung away.[320]

Grew's observations on seed dispersal were not new, indeed they were noted, if not extensively written about, by Renaissance botanists, and later from the 1620s by the horticultural and husbandry improvers. However, his description serves to demonstrate some of the difficulties faced by propagators and farmers, that seeds dispersed in a range of different ways, and the smaller the seed, the more difficult it was to collect once distributed. Indeed, Kingsbury notes that agrarian communities through time have suffered significant loss when seed heads shattered spontaneously, especially in grains. Once lost to the ground, this spontaneous shattering made it extremely difficult for farmers to harvest grain. In this example, Kingsbury continues by arguing that for *Nature*, it was vital for the survival of plants to distribute seeds,

[320] Nehemiah Grew, *The Anatomy of Plants,* 199

and this was achieved by a shattering of the seed head. *Culturally*, however, non-shattering seeds enabled crops to be harvested.[321]

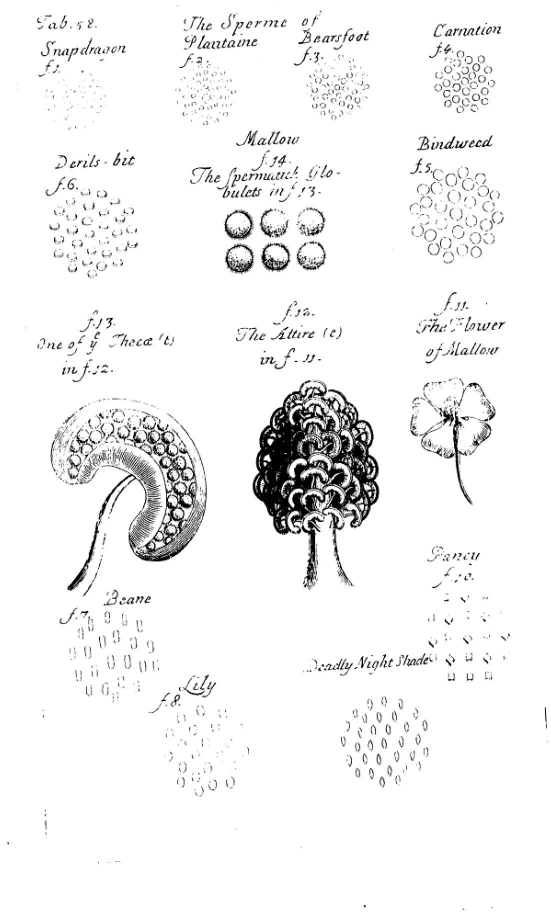

Figure 12. Illustration of seeds and seed heads drawn by Nehemiah Grew
The Anatomy of Plants

In the early modern period there was a recognition that seed heads shattered, and the way this was managed, was to collect the seeds directly from the plant as happened in the harvesting of crops. But if *Nature* dispersed seeds in her own time and in accordance with the blueprint of the plant, what did this mean to the propagator if he was to

[321] Noel Kingsbury, *Hybrid: The history & Science of Plant Breeding.* (University of Chicago Press 2009) 52. In the history of crop domestication, several important advances have involved breeding from a mutation in a crop plant that retained the seeds for longer which made harvesting much more effective.

collect his seeds before *Nature's* due time? What did they need to look for?

The Principle of Selection: A difficult Art

Several decades after the period under discussion, Charles Darwin presented his theory of selection by Man, describing it as 'a difficult Art'.

> '*Methodical selection* is that which guides a man who systematically endeavours to modify a breed according to some predetermined standards. *Unconscious selection* is that which follows from men naturally preserving the most valued and destroying the less valued individuals without any thought of altering the breed. *Natural Selection*…which implies the individuals which are best fitted for the complex, and in the course of ages changing conditions to which they are exposed, generally survive and procreate.'[322]

In relating Darwin's theory to the early modern period there are two interesting features. The first concerns Man's *methodical* selection, and the second an observation on Darwin's *natural selection.* Kingsbury argues the early stages of plant breeding had much to do with the latter two processes identified by Darwin, but due to the lack of periodization by Kingsbury, it is difficult to establish at what point *unconscious* selection turned to *conscious*.[323] What can be evidenced here is that during the early modern period conscious and methodical decisions were being made about the criteria used for selecting seeds, and their subsequent advancement, although the rationale for selection changed over time. The second observation concerns what Darwin refers to as *natural selection,* where we find evidence of the interaction between the seed with man or animal, insect or bird, and indeed natural

[322] Charles Darwin, *Complete Works of Charles Darwin, Second Edition, 1845*. (Delphi Classic 2015), 177-8

[323] Kingsbury, *Hybrid: The history & Science of Plant Breeding,* 25. Kingsbury does acknowledge there is no clear agreement on when *unconscious* selection turned into *conscious.*

elements. Such an intervention could influence the *intelligibility* of some seeds to the extent the subsequent plants acclimatized and produced seeds.[324] From the early days of Parkinson and Gerard's botanizing, to observations made by Johnson in his floras, there was recognition that plants grew in a range of environments. Many plants did not conform to expected patterns of behaviour, particularly plants arriving from overseas. There were many examples of plants that not only survived but also were able to adapt and acclimatize to the English environment. Was it possible that there was a universally shared invisible world within seeds, a commonly held *intelligibility*?

> Those flowers that haue beene vsually planted,' wrote Parkinson, 'in former times in Gardens of this Kingdome (when as our forefathers knew few or none of those that are recited before) haue by time and custome attained the name of English flowers, although the most of them were neuer naturall of this our Land, but brought in from other Countries at one time or other.'[325]

Parkinson's contemporary Johnson, noting John Tradescant the Elder's *Cupressus Virginiana Tradescanti,* concluded it to have produced English seedlings.[326] Meanwhile, Goodyer discovered and recorded several species of non-native elm, which appeared to have acclimatized in England. But it was not just the ability of plant to acclimatize that interested. It was the fact that plants from unknown foreign countries conformed to similar patterns observed in indigenous plants in Johnson's floras. As knowledge was accumulating so botanists and horticulturalists built and textualized their observations into their literary landscapes. Was there evidence that the blueprint of seeds had some kind of universal pattern, meaning some seeds could acclimatize to

[324] See Chapter 5 of this thesis.
[325] Parkinson, *Paradisi*, 11
[326] Gunther, *Early British Botanists and their Gardens based on unpublished writings of Goodyer, Tradescant and others,* 337

different environments and altogether different countries? Markham, on the other hand, was more circumspect when he updated Surflet's translation of Estienne's *Maison Rustique, or*, *The Countrie Farme,* to align the Mediterranean landscape and climate with the English. '[T]hough there be sundry sortes of seede, and euery Country hath his kinde and sowes such as best agrees with their nature.'[327] However, from the 1620s there was some certainty in the minds of the improvers, that held within the *intelligibility* of some seeds was an ability, in certain circumstances and conditions, to traverse land and water and thrive in the English landscape. Writing in the 1660s, Sharrock confirmed earlier observations with his own commentary, that the same plant could grow in a variety of places 'being shed would grow in any place, never so uncouth or stony; nay even carried away by the water, would grow wherever it was lodged in the banks, and that well and lustily.[328]

This *intelligibility* of the seed to acclimatize to different environments was a feature that was exploited by the improvers in their construct of a model seed, encouraging them to extend their search beyond the boundaries of England. They recognized, and recorded the ability of some seeds to prosper in different soils, and, in recording his journey through Brabant and Flanders in the 1644, Weston (1591-1652) noted:

> 'I will tell you (said hee) the reason, why it yeildeth more profit, is, because that Land is natural to bear Flax, which is called the Wealth of Flanders; and one Acre of good Flax is worth four or five Acres of the best Corn, which groweth between Dunkirk and Bridges..[329]

[327] Markham's (1616) augmentation of Surflet/Estienne *Maison Rustique, or*, *The Countrie Farme,* published by Surflet (1600)
[328] Sharrock, *The History of the Propagation and Improvement of Vegetables*, 11
[329] Richard Weston, Printed pamphlet: *A discourse of husbandrie used in Brabant and Flanders shewing the wonderfull improvement of land there; and serving as a pattern for our practice in the Common-Wealth The History of the Propagation and Improvement of Vegetables* (1650). Published by Harlib, 2nd edition.

In 1652(?) Dymock enthusiastically, if optimistically, recorded a range of qualities he had found in seeds. Seeds suitable for barren ground; others offered three crops a year; seeds that improved grass and 'causeth cattle to give milk in abundance', and seeds that could be sown on unploughed land.[330] The list was relentless, but also an indicator of the kind of *intelligibility* the improver was seeking in his seeds. It was all about the ability to acclimatize to a range of environments and soils in England, reliability, and yield, all of which would lead to greater prosperity. Although Dymock was a correspondent in the Hartlib circle, and by association an 'improver', his observations were in a sense more of a wish list, and did not replicate the very precise attention to characteristics and selection criteria that was evident in the earlier works from the 1560s onwards. It was the horticultural improvers who began to formulate more rigorous species related characteristics. It is to these characteristics that we now turn.

Selecting out - selecting in

As noted by MacGregor, collecting was a fastidious art, and collectors were consciously or unconsciously networking with, and through, artefacts.[331] This interaction might cause resistance and rejection - too ordinary, common or humble; or acceptance – curious, exotic or rare, and one can assume there was sometimes ambiguity. In the horticultural world of the late 1560s both Parkinson and Plat produced guidance on how to select seeds. Parkinson advised collecting seed from the 'principall or middle heades' where the 'Master seede, which is the best, and will produce the fairest rootes.'[332] The influence of Aristotelian cosmology is evident in Plat's advice as he recommended to '[G]ather

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[330] Cressy Dymock, Printed pamphlet, "Cornu Copia. A miscellanium" Published by Hartlib (1652?), 1-11
[331] Arthur Macgregor, *Curiosity and Enlightenment Collectors and Collections from the Sixteenth to the Nineteenth Century.* (Yale University Press 2008)
[332] Parkinson, *Paradisi*, 464

you carot and parsnip seeds &c from the highest spiring branches'.[333] In line with his alchemical philosophy and Aristotelian cosmology, Plat's criterion for selecting seeds was not based on the plant itself, but rather the seed's location on the plant. The 'master' seed was to be found closer to the heavens where the fire (heat) of the cosmos had the greatest effect.

> And this, saith [Giambattista della] *Porta*, is not onely to bee obserued in this plant, but in all others likewide, for those seedes which are contained within the middest of the bulke are more perfect themselues, and bring forth more perfect plants then those weake and imperfect ones, which occupie the outermost places; and so the graine, hee saith, in the middle of the eare bringeth forth a large corne then those which growe in the toppe or bottome thereof. [334]

Agricultural and horticultural practices associated with astrological activities, and the phases of the moon, were commonly present in the literary landscape of the late 1560s and rippled on well into the seventeenth-century. Although these were generally associated with sowing and harvesting, Googe, in his translation of Heresbach, identified the best time for collecting seeds was in cycle with the moon for 'they wyll endure longest, being gathered in the change [waxing] of the Moone.'[335] More generally, however, seeds were garnered from specific places on the plant, and Parkinson's 'Master' seed demonstrates a familiar and close correlation to classical text, and in particular Plato and Aristotle's social construct of male and female. Blank outlines Aristotle's conjectures concerning the role of the internal motions of seeds in inheritance,[336] and the degrees of perfection as outlined by Galen.

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[333] Plat, *The Garden of Eden,* 1654, 68
[334] Plat, *The new and admirable Arte of setting of Corne* (1600), image 11
[335] Googe/Heresbach, *The Foure books of husbandrie* (1577), 37
[336] Andreas Blank, "Material Causes and Incomplete Entities in Gallego de la Serna's Theory of Animal Generation" in Ohad Nachtomy & Justin E.H. Smith (eds) *The Life Sciences in Early Modern Philosophy* (Oxford University Press 2014), 133

According to Galen, Blank notes, ‘a seed that is less perfect in motion becomes a female, a seed more perfect a male.’[337] This, of course, links to the earlier discussion on germination where heat stimulates motion but in itself is produced by motion.[338] Whether or not heat was generated within the seed from an external ‘vital’ fertilizing force, or in Grew’s example, from internal perturbation, the notion that seeds held within them male and female characteristics was common. In constructing a model seed, the robustness and vitality of the male characteristics were held in higher esteem. For the Puritan improvers, regaining the earth after the Fall required a reinvigoration of male characteristics in all organic and inorganic organisms. More than this, powers held in female characteristics were to be controlled and meliorated as Dymock writing in 1653 explained:

> In the choice of seed-corn, prefer that wheat which is most weighty, as being more masculine and fitter for generation then the lighter gaines, in the production of plants, the earth is considered as female, whose sterility may be much helped by the extraordinary melioration of the seed.[339]

This was a theme that peremeated into the eighteenth century, and was, in various guises, reiterated in the writing of the period. In 1719 naturalist and botanist Richard Bradley (1688-1732) continued the theme with:

[337] Gallego, *Opera, 148* cited by Andreas Blank, *Material Causes and Incomplete Entities in Gallego de la Serna’s Theory of Animal Generation” in Ohad Nachtomy & Justin E.H. Smith (eds) *The Life Sciences in Early Modern Philosophy.*

[338] See Chapter 8 of this thesis.

[339] Cressy Dymock, Printed pamphlet, *A discourse for Division of Setting Out of Land* Part 2 (1653) contained in the Hartlib collection.

> Moses tells us, in his Account of the Creation, that Plants have their seeds in themselves; that is, every Plant contains in itself the Male and Female Powers.[340]

So, notions of male and female 'powers' or 'characteristics' were important elements in constructing the model seed, and in the Renaissance period of the 1560s were formulated within classical cosmology. For the improvers from the 1620s notions of male and female powers were closely linked to Puritan theology and the biblical story of Adams fall to the provocation of Eve.

Specimens of Nature

As one might expect the husbandry manuals of Fitzherbert and Tusser published in English focused on the agrarian calendar of ploughing, sowing and harvesting. Seed collection was connected to larger scale harvesting, although, issues of steeping and manuring were integral activities associated with enhancing seed performance. Googes's translation of Heresbach, *The Foure books of husbandrie,* and the Surflet translation of Estienne's *Prædium Rusticum,* concentrated specifically on estate management. It was amongst botanists like Parkinson, and horticulturalist Plat, where we find greater concentration on the selection of specimen seeds, while Bacon's discourse on seeds was designed to investigate the impact of art on nature.

The vast array of foreign seeds sweeping into and through the hands of collectors and botanists during the Renaissance period challenged their received wisdom, as many seeds simply did not conform to expected patterns of plant behaviour. With limited information on the provenance and origins of seeds, botanists and plant collectors applied their horticultural knowledge and watched and waited in anticipation. Years

[340] Richard Bradley, *New Improvements of planting and gardening, both philosophical and practical* (1719/1720), 9

of patience and careful experimentation enabled Parkinson to coax a reluctant tulip seed until there was, ‘a certain sign that it would bear a flower’. [341] Parkinson’s trial appeared to have worked, so he repeated the whole enterprise again, followed the same set of procedures, and after many years was able to list 125 new ‘varieties’ of tulips. This was an extraordinary achievement and, according to Anna Parkinson, her kinsman Parkinson continued to ‘breed’ new varieties using the same methods for daffodil, fritillary, auricula, and French anemones.[342]

Seeds and plants continued to crisscross continents and oceans, reaching the English shores in every increasing quantity, particularly when colonial adventurism started in earnest in Virginia. Plants and seeds, particularly trees, from the East Coast of America, began to appear in the grounds and gardens of stately homes and estates, but still held the characteristics of rarities and exotics, prerequisite for collections. According to Willes, Parkinson noted in *Paradisi* a correspondent from the new American colony who supplied him with ‘spider-wort’, while in the back of his copy of *Paradisi*, Tradescant ‘noted several American specimens among his list of eight-seven new acquired plants.’ The connection with America and Virginia continued with John Tradescant’ precarious botanizing adventure.[343]

The networking during this period was extensive, with the power of the artefact, in this example, the seed, carrying strong cultural messages backwards and forwards across the oceans. Imperialism, adventurism, and a claiming and taming of new territories and peoples, demonstrates the lengths and measures taken to ‘possess nature’. The American experience in the later part of the sixteenth-century was not a philanthropic exchange of seeds and plants. It was according to Drayton,

[341] Parkinson, *Paradise*, 63-4
[342] Anna Parkinson, *Nature’s Alchemist,* 108
[343] Willes, *The Making of the English Gardener*, 191. See also Andrea Wulf, *The Brother Gardeners, Botany Empire and the Birth of Obsession* (William Heinemann 2008)

a mercantile trading environment, where the collecting of artefacts for private consumption entwined the power of plant knowledge with political authority.[344] Getting seeds from foreign or 'outlandish' territories to acclimatize to the English climate was the trial of the horticulturalist, for in his success lay his authority and reputation.

Parkinson's example provides insight in the experimental methods used by one man, but his methods were not new as others, like Clusius, also followed a similar experimental route. What it serves to demonstrate is that with each network exchange the cycle of knowledge and experience accumulated. By the 1620s the improver's botanical and horticultural lens was firmly fixed on the blueprint of the seed, and how this might be passed within the plant from one generation of seed to the next. Thus the importance of choosing the right specimen, which held all the characteristics required to be passed on generationally, became central to constructing an improved model seed.

As already discussed, seeds were most generally collected directly from the plant, but herein lay a problem. What did the horticulturalist need to observe before plucking the seeds? The exchanging of seeds among women in Tusser's world provides an example of a social network, but no indication of the horticultural and botanical knowledge. However, we can assume from his declaration that, for Tusser, this kind of exchange was not unusual, and that women would have had significant knowledge about when to harvest and how to store seeds.[345] The literary landscapes during this period do, however, provide examples of how seed collection relied significantly on sensory observation and this was probably true for women horticulturalist as well. Colour, taste, weight, sound and the feel of seeds were important predictors of the health and

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[344] Drayton, *Nature's Government: Science, British Imperialism and the 'Improvement' of the World.*
[345] Thomas Tusser, *A Hundreth Good Pointes of Husbandrie* (1557)

viability of the seed prior to collection. As noted above, in the Renaissance period, the area on the plant from which the seed was collected was believed to determine future characteristics. Plat gathered ripe seeds, in his example, cauliflower seeds, 'which grow in yellow cups; and being ripe are also yellow themselves'.[346] In common with many of his contemporaries, Plat continued by judging a seed should be heavy and white inside. Googe, in his translation of Heresbach, found the best seed to be 'waightiest, and lyeth in the bottome, and such as is full, and being broken hath a good colour: such as is wrinckled, and thinne in the eare, is to be throwen away.'[347]

The improvers, however, were looking for a 'specimen' parent plant that displayed the desired characteristics. Cook advised collecting seeds from young thriving trees, as the seeds from old trees, he claimed, took on the characteristic of the old and after rapid germination withered and died. For 'Nature finding her self weak in these Seeds, doth (like the provident Mother) seek the sooner to provide for her weak Children.'[348] Continuing his theme Cook recommended his readers to 'gather them [seeds] off a straight and thriving tree, 'tis likelier they will run more up, and grow straighter than those which be gathered of Pollards.'[349] From a pragmatic and horticultural perspective, Cook was relaying botanical knowledge. Metaphorically, however, the promise of a Puritan New World was invested in spiritual improvement and education, as the young replaced the patronage of old, and wealth creation replaced poverty and dependency.

Cook collected his seed when they were 'through-ripe', or when they had already fallen from the plant, which was to him an indication the

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[346] Plat, *The Garden of Eden,* 73

[347] Googe/Heresbach, "The First Book of Entreatyng of earable ground and tillage" in *The Foure books of husbandrie* (15h77), 24

[348] Cook, *The manner of raising, ordering, and improving forrest-trees,* 6

[349] Cook, *The manner of raising, ordering, and improving forrest-trees*, 4-6

seed, was ripe.[350] Working mainly with tree seeds, he described some as hot to the taste (an element of fire) or dry (an active male principle). He handled his seeds, observing their form and shape, he tasted them and weighed them in his hands and felt their skins and shells to ensure they were dry with closed skins.[351] Gilbert worked with altogether smaller flower seeds concluded they be collected from the plant, 'when the stalks begin to turn yellow, the seed at the tope will be near ripe, therefore carefully observe the round seed vessel, if you find in it a small hole and black, gather it (the vessel) lest the seeds fall out and be lost before you are aware.'[352]

Profit from the Margins

Bacon was interested in difference, for it was within the margins of nature, on the edge of socially constructed normality; he believed most could be learned about nature. He argued that the Aristotelian view of seeking patterns in nature predisposed towards conformity and uniformity, whereas for him investigating the unusual was a means 'to observe the force and virtue and consequences of discoveries'.[353] He reiterated this view again describing himself as a gardener, in a garden of learning, where advancement was concerned with the areas of knowledge that are 'waste' and 'uncultivated'. [354] For Bacon the gardener, and for the botanists of the Renaissance period, and in the horticultural laboratories and the literary landscapes of the improvers, mutations were of interest.

[350] Cook, *The manner of raising, ordering, and improving forrest-trees,* 6
[351] Tree seeds are extremely diverse. Many trees encase their seeds inside hard outer shells, others within wing like structures that help them to fly. Fir trees encase their seeds in cones which when open spurt out the seeds, while chestnuts have a spiny outer casing. See George Bishop Sudworth, *The Forest Nursery: Collection of Tree Seeds and Propagation of Seedling.* Department of Agriculture, Harvard University (1900).
[352] Samuel Gilbert *Florist's vademecum and Gardener's Almanack* (1683), 50
[353] Francis Bacon, James Spedding, Robert Leslie Ellis, Douglas Denon Heath, *The Works of Francis Bacon,* Vol.4 (First published 1858. This edition published Cambridge University Press 2011), 114
[354] Bacon, *Works X.301*

Mutations were well known and documented from classical times, although this was not the word used to describe the event. Despite careful selection and collection, seeds could still produce a plant different to its parent, a mutation. Perdita in Shakespeare's *The Winter's Tale* having been told the cause of a (gilliflowers) streakiness, cared not to get slips of them for her rustic garden, for they had the reputation of being 'nature's bastards.' While Perdita disclaimed nature's streakiness, Hill considered it worthy of comment divulging to his readers:

> you may make one stalke to bring forth floures of many colours, if you take the seeds of every colour of the Gilifloure, and put them altogether into a thinne small rede or Terdill of a sheepe or goate, or else tied up in a thinne worne linnen cloth, setting the same in the earth well mixed with dung : which after the watering will cause a plant to come uppe, bearing the like number of colours in one stalke, as there were seedes sowen.[355]

It is difficult to know whether Gerard was perplexed or pleased when he declared that 'Nature doth seem to play and sport herself…as the worshipful gentleman master John Norden can very well attest, unto whom I gave some of the seeds aforesaid, which in his garden brought forth many others of beautiful colors'.[356] Certainly during the Renaissance period, some mutations, or changes, were perceived as collectable curiosities. It was the improvers from the 1620s who, in their horticultural and husbandry literary landscapes, and with profit and purpose in mind, placed 'nature's bastards' under investigation.

As is discussed below, mutations became of interest to horticulturalists involved in plant breeding, but mutations perennially caused

[355] Cited in Gunter, *Early British Botanists and their Gardens based on unpublished writings of Goodyer, Tradescant and others* (1922), 61 and taken from Thomas Hill, *Arte of Gardening* (1574).
[356] John Gerard, *The Herbal* (1633), 319

considerable problems and difficulties for those involved in the production of food. It was the improvers who began to question whether mutations were actually carried in the blueprint of the seed, and in some way transmitted from one generation of seed to the next. This was a consideration put forward by Cook when he proposed that some plants such as wheat and hops were particularly susceptible to mutations. According to Kingsbury, uneven ripening is Nature's way of reducing losses to predation and poor weather conditions.[357] However, in 1676 Cook's explanation was somewhat more complex. He recognised through observation and experience that seeds did indeed ripen at different rates, but that some seeds appeared to be susceptible to what he referred to as smut and mildew, 'smooted or mill dew'd' corn.' Cook went on to explain the biological and environmental factors, which, he believed, impacted on the *intelligibility* of a potentially 'infected' seed. He concluded that environmental factors overruled the *intelligibility* of the seed precipitating a 'Malignity', such that one ear of corn could produce 'black smooted grain' as well as 'perfect sound grain'. He described the mildew as a type of dew produced in the earth and drawn into the seed as it would draw nourishment. As the plant developed so the ears of corn produced kernels that ripened at different times. Unripe kernels were susceptible to a combination of internal absorption of a noxious substance. External factors, including heavy misty conditions, caused a reaction creating a black smut, which smothered the kernels and stopped them developing. If infected seeds were collected, and subsequently planted, they would through their lifecycle, continue to produce infected seeds, imprinting a mutating cycle into the blueprint of the seed.[358]

Mutations, on the other hand, encouraged Gilbert in his search to raise 'new varieties' from plants that presented with variegated changes.

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[357] Noel Kingsbury, *Hybrid: The history & Science of Plant Breeding*, 25
[358] Moses Cook, *The manner of raising, ordering, and improving forrest-trees,* 7-9

Marked by variety the blueprint of a plant, which seemed to have mutated, must surely be susceptible to propagation. 'Nay, a particular Flower among many other of one Plant, shall bring more double ones, than twenty others that are not qualified.'[359] Gilbert continued with guidance on looking for difference in a plant, as this indicated to him that 'Nature hath set one step forward in altering from the ordinary kind.' He was alert to the limitations of Art observing that pushing the plant, 'beyond the limits of Nature' could lead to a plant that never produced seeds.[360] It seemed the continual reproduction from seeds of plants carrying a mutation would, in Gilbert's argument, eventually weaken the blueprint to such an extent that it failed to respond to environmental stimulation. While this might appear to contradict the immutability of the seed's blueprint, it does serve to demonstrate a cautionary approach to the ability of man to potentially destruct nature. Warnings aside, Gilbert was an enthusiastic promoter of breeding from mutating plants. The double *Hepatcia,* he wrote, valued for their seeds, could be expected to produce many varieties. Breeding new varieties of daffodils required diligence and patience. Sowing the seeds of the best single ones (for the double bear none), it could take two or three years before they were mature enough to transplant. Auricula seeds produced the most 'diversity of Colour and different Faces, each adding a new grace to its kind…nature sporting her self', while seeds sown from 'well chosen flowers' would produce offspring differing in colours and stripes.[361] Returning to the earlier observation of Perdita, by the 1680s, 'nature's bastards' were becoming commercially marketable. Gilbert placed a value on his new varieties claiming auricula roots to be worth anything from one to five pounds each. Selecting, collecting and saving seeds all contributed to the commercial value of the resultant plant. Quoting a colleague, Gilbert relayed the problems associated with

[359] Samuel Gilbert, Samuel, *Florist's vademecum and Gardener's Almanack* (1683), 243
[360] Gilbert, *Florist's vademecum and Gardener's Almanack*, 243
[361] Gilbert, *Florist's vademecum and Gardener's Almanack*, 26

propagation by off-sets which 'quickly bear Flowers', but 'is only fit for a dull Florist.'[362] The art of using seeds to produce new varieties was full of anticipation and surprise and of interest to plant breeders and collectors.

[362] Gilbert attributes this observation to John Worlidge in his *Systema agriculturae,* or *The Mystery of Husbandry,* 1668

Chapter 7

Brought to Life

In his translation of Estienne's *Prædium Rusticum* in 1600, Surflet observed:

> 'that euerie Seed hath a certaine time to manifest it selfe in: whereto we must have due regard, to the end that there may be prefixed times to sow, and looke for the growth of euerie Seed.'[363]

What Surflet was expressing here was the notable feature that a seed appeared to have some mechanism, an *intelligibility* guiding it into life at its preferred time. There was, however, another feature of the newly fertilized seed, which also appeared to be universal, and that was its ability to remain in an ungerminated, inert, dead-like state. This was most often the state in which seeds were transported, stored and in the case of grains used for animal and human food. However, seeds in this state had the potential for reproductive failure, in other words, the germinating process failed to produce plants that reached maturity or seed. Storing seeds was (and remains) a fundamental activity associated with peasant and agrarian communities, but experimental philosophers were not so much interested in how to store seeds, as they were to learn the mechanisms by which seeds could remain inert.

Inertia was not a word that was used in the literature, but serves to describe a seed that has separated from the parent plant and remains inactive with no apparent signs of germination.[364] In today's botanical literature, dormancy is generally used to describe a seed in this state, but dormancy implies a period where the activity of an organism is temporarily halted, but the organism remains materially the same. An

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[363] Surflet/Estienne, *Prædium Rusticum,* 161

[364] Isaac Newton was the first to express the concept of inertia in *Philosophiae Naturalis Principia Mathematica* 1687

example might include an herbaceous plant that dies down in the winter, but is reawakened by the warmth of the spring to sprout and grow in the same manner as previous years. This pattern of plant behaviour, or 'constancy', was well recognized by early modern naturalists.[365] Inertia, on the other hand, in Aristotelian terms, is a property of matter in which it continues to exist unchanged and inactive, and, in the theory of physics, will remain so unless changed by an external force. Of course, this 'law of physics' is associated with Aristotle's philosophical theory on the movement of bodies and motion. But as has been discussed above, the concept of motion in botanical terms is more concerned with changes in material matter, and this comes about through heat, created by alchemical fermentation, or atomistic perturbation.

A more promising descriptor is presented in ecological studies. Biological inertia was a term coined by Gorham, and used by Summerfield to describe the 'conditions in which the plant is growing are totally unsuitable for satisfactory development of seed, seedling or adult, yet they are not severe enough, or changing rapidly enough, to eradicate the population completely.' What Summerfield suggests is exactly what the improvers of the 1620s to 1660s were beginning to systematically record in their literary landscapes. Every single factor within an environment, according to Summerfield, assumes importance when it begins to tax the tolerance of the plant. 'In order to find optimum conditions for plant growth, autecological studies should include consideration of all the plant growth stages, commencing with development from seed in one generation to the formation of seed for subsequent generations.'[366]

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[365] Constancy used in ecological terminology to describe a living system that can remain unchanged.

[366] R.J. Summerfield, "Biological Inertia – An Example" in the *Journal of Ecology*, (Vol.60, No.3 (Nov.,1972), 793-798. Eville Gorham, "Development of peatlands". *Quarterly Review of Biology* (32, 1957), 145-66. A.R. Clapham, "Autecological studies

'Inertia' in a living system indicates resistance to external fluctuations, and it is this interaction of resistance and inertia that responds to perturbation. In the case of a seed, biological inertia is a state of inactivity, which can either be induced naturally, or artificially. The inert feature of seeds was of particular importance to early modern husbandmen and horticulturalists. There was a balance between keeping a seed 'alive' in its inert state, with the potential for that environment to stress the seed to such an extent it failed to germinate or germinated precipitately. Today, the storage of seeds in seed banks is a widespread and valuable *ex situ* contribution to conservation. A historiography of seed storage might certainly demonstrate that maintaining seeds in their biologically inert state, required intimate knowledge of the type of seed and it's ecological requirements, with the technical acumen to maintain and store quantities of seeds over time. Much of the historiography concerning seed storage is contained within economic history, often framed within an economic discourse of grain shortages. McCloskey and Nash considered grain storage a means of insurance in the medieval agricultural economy, concluding that stores of grain were low because the cost of storage was high. They argue a crop was stored on average for six months due to the fact that it needed to be eaten. Komlos and Landes, on the other hand, consider that the quantity of grain stored was not to do with high interest rates, but rather low productivity in medieval agriculture.[367] Focusing as they do on

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and the Biological Flora of the British Isles", *Journal of Ecology,* 44, 1-11 (1956). See also Betsy Von Holle, Hazel Delcourt, & Daniel Simberloff "The importance of biological inertia in plant community resistance to invasion" in the Journal of *Vegetative Science* 14 (2003), 425-432. The article argues that biological inertia in resident community of plants is a form of resisting invading species.

[367] Donald N. McCloskey and John Nash, "Corn at Interest: The extent and Cost of Grain Storage in Medieval England" in the *American Economic Review* 74:1 (1984), 174-87. John Komlos and Richard Landes, "Economics: Grain Storage in Medieval England" in *The Economic History Review* (New Series, Vol.44, No.1 (Feb.,1991), 36-45. See also John S. Lee, "Grain Shortages in Late Medieval Towns" in Ben Dodds, Christian D. Liddy, (eds) *Commercial Activity, Markets and Entrepreneurs in the Middle Ages*: Essays in Honour of Richard Britnell (2011). 1526 grain shortages in Suffolk, 1527 shortage of grain, 1528 sale of grain stored in Colchester. Thanks to Malcolm Thick for directing me to these references.

productivity, these economic arguments lack reference to the risk of the seed in storage. Other than a brief mention of vermin, rotting and mildew, all of which are unquantifiable risk factors, there is little information about the technology of storage. In terms of innovation, McCloskey and Nash consider there was a reduction in grain loss as storage facilities were upgraded from wood to stone and brick. These economic arguments involve fairly large-scale grain storage activities, whereas, seeds produced in the home and in small-scale neighbourhood and market enterprises also required storing from season to season. Memories of hunger and famine, replayed in the treatises of Plat and Richard Gardiner, held fast in the minds of many. Hill's horticulture project may well have appealed to Cecil's national projects as it promoted a vision of a nation of self-sufficient gardeners, and a means of ameliorating hunger and potential social unrest.[368] Against a backdrop of economic variables, early modern horticultural authors included in their construction of a model seed some considerable understanding of biological inertia and how, in this state, a seed might either resist or respond to perturbation. The potential for failure or success was a challenge embraced in the literary landscapes of horticulturalists and husbandmen, as they sought to apply experimental philosophy, Bacon's 'vexing' nature, to the *intelligibility* of the seed.

What becomes evident is a quest for an understanding of biological inertia as it pertained to the science of germination and the technology of storage. The previous chapter considered the criteria used in the selection of horticultural seeds in particular. This chapter will focus on the criteria employed by authors from the period in selecting a seed, which, while in an inert state, was also considered viable for future germination. A seed in its inert or dormant period appeared inactive but, rather than appearing dry and dusty, should, as described by Sharrock,

[368] See Chapter 2 of this thesis.

be 'a full and dead ripeness.'[369] This period required theoretical understand of the external (dry) and internal (full) qualities of the seed. For a seed to be viable, the balance between dryness and fullness (containing juice) had to be exact. Methods for assessing the quality of seeds were based on weight, external appearance, internal colour, and, as discussed in Chapter 6, to a large extent on 'fitness', 'masculinity' and 'strength'. Following on from the characteristics of ripeness, were queries as to how long a seed could remain inert, a feature of the seed mimicked artificially in the technology of storage. Observation that in the wild or an uncontrolled environment, a seed could break its own inertness, were associated with soil conditions, climate and other environmental factors along with the seeds own 'nature'. It was also observed, that through artificial replication and intervention by man, inertia could be prematurely broken or extended. The literary landscapes of husbandry and horticulture evidence a preoccupation with inertia from the successful germination of a seed to the ecological interaction with its environment.

The Particular Art of Steeping

> Some prudent sowers have I seen indeed
> Steep with preventive care the manag'd seed
> In nitre, and black lees of oil; to make
> The swelling pods a larger body take:[370]

Any gentleman farmer or estate manager would certainly have noted Virgil's promotion of prudence and care. Steeping had a long classical tradition, and was a technology regularly practiced for a variety of reasons, but was principally a method used to break the dormancy or inertia of the seed. Steeping involved immersing seeds in a warm liquid

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[369] Sharrock, *The History of the Propagation and Improvement of Vegetables*, 42
[370] Virgil, Works: In English Verse, Volume 1, 123. Translated by the Rev. Mr Christopher Pitt. London M DCC LXIII (1863)

mixture, and as the seed absorbed the liquid, so the internal section became swollen and the seed sprouted. At a botanical level this was expected plant behaviour, fitting with the Aristotelian theme of nature's patterns. However, the seed did not always respond in expected ways, and there were oft times that, rather than germinate, the seed responded to heat and moisture by rotting, or failing to germinate. Steeping was, in fact, an exact art and one that was discussed in some detail in the literary landscapes of the period, becoming significant for the improvers in relation to the blueprint of the seed.

Agrarian historiography has tended to focus on land usage and management, and much has been written about the efficacy of manure in keeping the land in good 'hart'. Somewhat subsumed within the historiography have been observations on steeping seeds, but they have tended to be within a macro dimension, whereas the literary landscapes under discussion were involved, at many levels, with a micro investigation of the seed. Of course, collations of steeping recipes designed to treat and improve were plagiarized and recycled among treatises, but there were also from Plat, Bacon and others, specific trials designed to investigate. Thick's analysis of Plat's manuscripts serves to demonstrate how polymaths, like Plat, were in investigative mode, proposing many 'a guess' or 'queries'.[371] Fussell, however, states that the thinking of 'Tudor and early Stuart scientists' was confused by theories of alchemists which meant that agriculturalists were only fixed on looking for 'one general principle that was the stimulant of plant growth' by using salt.[372] An emphasis on salt is also present in Smith and Secoy's observations on practices in steeping and the efficacy of salt as a

[371] Thick, *Theoretician or gentleman enthusiast? Sir Hugh Plat and agriculture*. Paper presented at British Agricultural History Society, Winter Conference 2012
[372] G.E. Fussell, "Crop Nutrition in Tudor and Early Stuart England" in *British Agricultural History Society* (Vol.3 1955), 95-106

pesticide and a stimulant in plant growth.[373] It is important to point out, however, that salt was a principle ionic compound, and an essential ingredient in Paracelsian alchemical practice, and was pursued for its potential improvement qualities.[374] Authors in their literary landscapes did circulate examples of preventative recipes with, as noted by Thirsk, the often quoted and much-used method of steeping in brine mixed with unslaked lime. This, it was claimed, prevented smut and deterred birds, while other recipes used 'salt, red leather, and water, and yet another sheep dung steeped in water' to achieve the same results. Thirsk also notes that 'many experiments' were carried out to test various steeps, prompting inventors to apply for a royal patent.[375] Fussell also referred to an apparently unsuccessful application, by three contemporaries of Bacon, who took out a patent 'for a process of steeping seed in rape oil…to promote germination'.[376] This information was, according to Fussell, contained in an anonymous treatise published in 1634, entitled *A direction to the husbandman.* As a result of his interest in the life of the country gentleman, Markham seems to have plagiarized this work into his *The inrichment of the vvweald of Kent* first published in 1625.[377]

Nevertheless, it would appear the art of steeping had a value, not just in terms of promoting healthy germination, but, as a potential profit making chemical mixture, based on the alchemical principals of fermentation. Certainly Bacon believed the alchemical process of steeping would profitably manipulate the seed. At a practical level it was

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[373] Allan E. Smith & D.M. Secoy, "Salt as a Pesticide, Manure, and Seed Steep", *Agricultural History* Vol.50, No.3 (July 1976), 506-516

[374] See Hugh Plat, "Salt of the Earth" in Chapter 8 of this thesis.

[375] Joan Thirsk (ed) "Agricultural change: policy and practice 1500-1750" chapters from *The Agrarian History of England Wales* Vol.3 (The Press Syndicate of the University of Cambridge, 1990), 20-21. Thirsk, Vol IV SP/14/187 no 22a

[376] Fussell, *Crop Nutrition in Tudor and Early Stuart England*,in *British Agricultural History Society* Vol.3 (1955), 105

[377] Anon, *A direction to the husbandman in a new cheape and easy way of fertilizing and enriching arable ground* in *Gervase* Markham, *The enrichment of the vveald of Kent: or, A direction to the husband-man* (1625)

believed steeping protected crops from birds and vermin, while accelerating germination so crops would, according to Plattes, outgrow weeds.[378] At an alchemical level, the literary landscape of the Renaissance horticulturalist and husbandman, focused on the perceived malleability of nature, and the power of art to change nature and alter and improve plants, or, as identified by Surflet, the 'certaine time' at which the seed 'manifest(s) it selfe'.[379] Parkinson, concluded it was impossible to interfere with the natural order of plant life as 'their appointed time is natural vnto them..there is no power or art in man, to cause flowers to shew their beauty diuers moneths before their natural time nor to abide in their beauty longer then the appointed natural time for euery one of them'[380] The improvers, however, were investigating the effects of interventions on the blueprint of the seed

'Guess' and 'Queries': The Art of Sir Hugh Plat

Plat was actually more interested in the alchemical processes associated with manure, particularly marl, than he was in steeping. However, he did raise some methodological issues described by Thick as 'a guess' wherein he offered the idea of future experiments, and 'queries'. The latter, according to Thick, often 'crowded at the end of paragraphs or inserted in margins' of his notes, offers further interest as Plat distinguishes between the needs of different species and growing environments. Rather than repeating the circulated recipes designed to treat plant pathogens and kill vermin, Plat becomes plant and seed specific. In his trial of steeping corn in a mixture of dung and water, he concluded:

> 'qre if these waters will not serve for all other seedes in like manner, as also whether the same bee not excellent to water trees and flowers that

[378] Gabrielle Plattes, *Practical husbandry improved: or A discovery of inifinite treasures* (1656), 37

[379] Surflet/Estienne, *Prædium Rusticum*

[380] Parkinson *Paradisi,* 11

> grow in potts. Qre whether this secret is best in whott, moiste, or dry, or cold grownds. qre also iffy t will not make beans & pease very forwarde.[381]

Plat's manuscripts confirm that steeping was common practice but his trials and experiments were, according to Thick, sophisticated and extended beyond standard 'treatments' to include, for example, particular mixtures of steeps for seeds planted in barren ground. Each concoction included carefully assessed and measured quantities illustrating Plat's alchemical knowledge, his understanding of the needs of different seeds and species of plants and the environment in which seeds were sown and harvested.[382]

The Vigour and Virtue of Francis Bacon

The belief that the alchemical process of steeping would profitably manipulate the seed was a theme built upon by Bacon. Many of his suggestions were not new and were imbued with classical text and medieval recipes, but Bacon was not satisfied with the uncritical circulation of traditionally accepted methods of steeping. He set out a series of experiments, not unlike Plat's, to investigate the effectiveness of 'treatments'. Where wheat was steeped in different mixtures of animal and pigeon dung and water, urine, wine, ash, soot and chalk, how would these combine with the 'goodness of the seed' to produce the best crop of the 'Highest, Thickest, and most Lustie'? Drawing on his knowledge of seed nourishment, Bacon proposed types of mixtures the seed could absorb. 'For that the *Seed* naturally drawing the *Moisture* of the *Dung*, may call in withall some of the *Propriety.'*[383] He provided methods for improving taste, tenderness and sweetness, and perhaps the most ambitious 'Making Plants Medicinable.'

[381] I am grateful to Dr. Thick for allowing me to quote from his Conference Paper, BAHS, Winter Conference 2012

[382] Thick, *Sir Hugh Plat*, 92-96

[383] Francis Bacon, *Sylva Sylvarum,* Century V, 105

> the *Steeping* of the *Seed* or *Kernell* in some *Liquour*, wherein the *Medicine* is *Infused:* Which I haue little Opinion of, because the *Seed*, (I doubt,) will not draw the Parts of the *Matter*, which haue the *Propriety:* But it will be farre the more likely, if you mingle the *Medicine* with *Dung;* For that the *Seed* naturally drawing the *Moisture* of the *Dung*, may call in withall some of the *Propriety.*[384]

But, there was another query that Bacon was assuredly interested in which moved him again to the margins of nature. To what extent, he considered, was it possible to manipulate the seed such that it was artificially set into germination earlier than its 'certaine time'. Bacon sought to demonstration more than a simple experiment that heat and moisture precipitated germination. He set out to investigate how the application of heat and moisture affected germination rates. Using a hot bed made out of well-rotted horse dung and sifted earth two fingers deep; he steeped the seeds all night in a mixture of water and cow dung, before sowing them on the top of the hot bed. Measuring the germination rates he estimated turnip and wheat seeds came up half an inch above ground within two days without watering and radish, cucumber and peas the third day. Bacon did a comparative experiment using warmth and water, but with un-steeped seeds, and found they germinated more slowly. He then offered an alternative experiment steeping seeds in different mixtures and varieties of dungs, wines, urine, soot, ashes and salt some more successful than others.

> This is a Rich *Experiment* for Profit; For the most of the Steepings are Cheape Things; And the Goodnesse of the Crop is a great Matter of

[384] Bacon *Sylva Sylvarum*, V Century, Experiment [500], 129. Herbal remedies have a long history, but more recent research seems to pick up on what Bacon was writing about. For example, modern technology in plant breeding has produced a variety of broccoli that according to the IFT Institute of Good Research reduces LDL-cholesterol levels.

Gaine; If the Goodnesse of the Crop answer the Earlinesse of the Comming vp: As it is like it will; Both being from the vigour of the *Seed;* Which also partly appeared in the Former *Experiments*, as hath beene said. This *Experiment* would be tried in other *Graines, Seeds*, and *Kernells:* For it may be some *Steeping* will agree best with some *Seeds.* It would be tried also with *Roots* steeped as before, but for *longer time.* It would be tried also in *Seuerall Seasons* of the *yeare*, especially the *Spring.*[385]

As with Bacon's claims on species change,[386] his experiments on forcing or 'accelerating' germination also drew a response from the improvers. Austen, as ever attempting to bring nature back from the brink of Bacon's disorder, did not deny the findings of the experiments and Bacon's use of a hotbed to speed up germination, but he concluded that:

'For the *hasty*, and *sudden springing up* of *seed* upon a *Hot-bed*, is but a forcing of Nature.' This forcing of nature resulted in weaker plants and he continued 'But I conceive the *vigour*, and *virtue* (gotten by such *steeping*) will be *soone gone*, it will not be *lasting*, as the *naturall properties of the seed*.' [387]

Two processes were being observed in these experiments. It was known through steeping practices, that a seed could be prompted out of its inert period by replicating the prerequisite conditions for germination, warmth and moisture. The second process was less well received, as the results were incompatible with Austen's *natural laws* and the seed's blueprint. The chemical process of coating the seed with fertilizer (manure) was demonstrated by Bacon to prompt earlier germination. An unexpected result noted by Austen concerned the application of manure to the seed which, not only acted to promote germination, but, continued to act as an accelerant on the developing plant. This resulted

[385] Bacon, *Sylva Sylvarum*, V Century, Experiment 409
[386] See Chapter 4 of this thesis.
[387] Ralph Austen, *Observations upon some part of Sr Francis Bacon's Naturall history as it concernes fruit-trees, fruits, and flowers*, (1658), 2

in weakened plants, which seemed to Austen to contradict the *intelligibility* of the seed.

Cook was more species specific, and although he was mainly concerned with propagating trees, he did spend some time trialling a wide range of mainly flower seeds. This drew him to conclude that the blueprint of the seed determined the germination rates, as annual plants were fast growers, and would respond to early germination for 'tis the nature of them'; but trees carried an altogether different blueprint and were slow growers.[388]

> When your Forrest-Tree knoweth its continuance to be long, and that Naturally it hath many Years to produce its like, it will not be much forced by Art or Artificial means; for who can by the best Art or Care that can be used, force the Keys of an Ash to come up in a Year, or to grow but one Inch?[389]

Sharrock replicated Bacon's experiments hoping to procure 'those wonderful speedy Germinations', although the accuracy of his investigation must be in doubt. However, he concluded that after long infusions in milk, strong muck water, unquenched lime and various other concoctions 'none of the Seeds (of which I tryed many sorts) came up the first three or four days.'[390]

Bacon and Plat were of the view that nature was essentially malleable and could be transmuted, although even at this point there was certainty from Surflet and Parkinson that the seed had its own due time. The improvers, on the other hand, rejected Bacon's claim, certain that

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[388] Cook, *The manner of raising, ordering, and improving forrest-trees*, 14-15. Cook was referring to annual plants which germinate, grow, flower and seed in one year. In Cook's reference their blueprint determined them as rapid growers and therefore amenable to accelerated germination.
[389] Cook, *The manner of raising, ordering, and improving forrest-trees*, Chapter VIII, 15
[390] Sharrock, *The History of the Propagation and Improvement of Vegetables,* (1659), 129

the blue print and *intelligibility* of the seed would not respond favourably to extreme 'vexing'.

Storage

How long could a plant remain inert was a question of concern? The storage of grains for food and future seeds was, as has been discussed, fraught with technical and organic difficulties. In many ways it was an uncertain science, as seeds could disintegrate, rot, get mildew or be destroyed by vermin. The main source of knowledge came from observation, although these could be many and various. In its biological inert state, was a seed dead or alive, and were there any observable signs? Although this question was not actually verbalized, the viability of seeds for propagation was considered. There was definitely a view that a seed could become redundant, and 'too old' was a well-used phrase throughout the period. Have beside a special regarde for your Seedes," wrote Hill, 'that they beed neyther to olde, withered, thinne, and emptye.'[391] Yet in contradiction, he advised housewives to collect seed when they were 'dead, ripe and dry.' What horticulturalists were questioning was the length of time a seed could remain inert and still be viable, for in constructing their model seed they required both the knowledge, and the technology, to artificially copy nature. The literary landscape of the improvers was associated with specialist environments, orchards, vegetables, trees and flowers, wherein each species had its own specific blueprint and *intelligibility*. Cook recorded his observation that seeds of forest trees could remain inert in the soil for many years, which led him to conclude that seeds of different species held their own unique periods of inertia. '[For] many of these Seeds and others will lie near two years in the Ground before they come up.'[392] So rather than generalized observations from the likes of Hill, observations within

[391] Hill, *The Gardeners Labyrinth*, 27
[392] Cook, *The manner of raising, ordering, and improving forrest-trees,* 4

specialist landscapes began to indicate that biological inertia was held within the *intelligibility* of the seed and was species specific.

Understanding inertia, and the technology of storage, had a commercial imperative. Vegetable and flower seeds tended to be sold in groceries or procured from itinerant salesmen or at markets. Provenance was unknown and often the seeds were unviable. For the likely benefit of the commonwealth, and certainly with the advent of market gardens and commercial nurseries, processing and storing a model seed required improvement in both botanical knowledge and technological innovation.[393] Thus, there were three critical phases in managing biological inertia. The first was the state or presentation of the seed as it was harvested and collected, the second was when to collect and harvest seeds, and finally, how to mimic nature.

When seeds were collected directly from the plant they were dried and then stored. With a large element of guesswork estimates on the period of inertia for any seed was inevitably based on storage procedures, and the success rate of this was likely to have been variable. Instructions on how to collect and store seeds were comprehensive, while the period of time a seed could remain inanimate was speculative. Hill gave a generalised storage rate for all seeds of three to four years if, as instructed, the housewife collected and preserved seeds from herbs and vegetables by a moon on the wane.[394] Following a process of drying, the seeds, he directed, should be packed into leather bags and stored in wooden boxes constructed from the box tree.[395] Plat instructed lettuce seeds be dried in the sun before being separated from the chaff, while vegetable seeds such as onions, chibols and leeks were to be preserved

[393] See Chapter 11 in this thesis.
[394] Hill, *The Gardeners Labyrinth*
[395] Possible reference from the classics and although box was found in England by this time it is unlikely to have been widely used.

in the huskes and heads.[396] Sharrock identified the inanimate period of time from ripeness to germination in 'divers' plants as ranging from two to three weeks extending to over a year.[397] For Worlidge storage was an economic issue and writing in *Systema Agriculturae* he argued the:

> The preservation of Corn when it is plenty and good, is of very great advantage to the husbandman, and the Kingdom in general; for in scarce and dear years, the Husbandman hath little to sell to advance his Stock, and the Buyers are usually furnished with musty and bad *Corn,* from forreign parts, or from such that were ignorant of the ways to preserve it. Therefore in cheap years it will be very necessary to make use of some of these ways for the storing of your plenty of corn, against a time of scarcity. Principle aim is to stop the corn heating or becoming moist as this would cause it to shoot.[398]

The advice varied according to the author and the seed, but in line with the humoral theory of Galen, all were of the common view, that a seed in a biologically inert state could be kept alive (healthy) and viable in a cool, dry environment. However, the sheer diversity of seeds collected from around the world, and in indigenous environs, made for a complex and contradictory discussion in the early modern period. As any visitor to the Wakehurst botanical park and the millennium seed bank, cannot fail to notice, investigation into the specialist storage needs of individual species of seeds from around the world continues today. Plat, Bacon and the improvers of the early modern period were just as engage in this enterprise as they sought to develop and justify their own model seed.

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[396] Plat, *The Garden of Eden*. Chibol, the full-grown *Allium fistulosum*, or Spring Onion also known as Stone Leek or Rock Onion. Rarely used now, it is recorded at least as far back as William Langland's *Piers Plowman* of around 1362.

[397] Sharrock, *The History of the Propagation and Improvement of Vegetables*

[398] Worlidge *Systema Agriculturae* 1688)*,* 54

Chapter 8

Fringe Science

The plough and manure was pivotal in agricultural cultivation and, to a large extent, land and soil management has been central to the research of agrarian historians. There are many methods for assessing agricultural knowledge with economic historians measuring crop yields, to Thirsk's argument for an alternative agriculture and the introduction of industrial crops.[399] Other researchers have studied the manuscripts and books collected into the libraries of the elite. Assessing levels of knowledge is often gauged through levels of practice, in other words, to what extent does knowledge gained from text influence practice? In his study of classical traditions in west European farming, Fussell reviewed a wide range of classical text contained in libraries, but he remains uncertain as to the actual impact of knowledge gained from text on practice.[400] Ambrosoli, on the other hand, in his survey of ownership, comments on the annotations and marginalia, which, he suggests, indicates a strong connection between text and practice. To support his argument, Ambrosoli documents the spread of new and innovative agricultural practice by tracing the introduction of new seeds and plants originating from Europe. In England, he concludes, a modified continental 'model' of agriculture influenced, in particular, the smaller landowners. This model, Ambrosoli argues, was circulated through the translations of continental botanical and agrarian writings. He does, however, rightly point out, that text was not the only source, citing the Grand Tour of Europe as a powerful means of transmitting knowledge.[401] To this, we can also add the culture of collecting from around the world, and many of the features identified in Chapter 3 of this work. Other authors who have undertaken reviews of libraries of the elite include Willes, who came to a

[399] Thirsk, *Alternative Agriculture*
[400] Fussell, *The Classical Tradition in West European Farming* (David & Charles 1972)
[401] Ambrosoli, *The Wild and the Sown*, 257

similar conclusion as Ambrosoli, that the printed word, in particular, had a profound influence on practice leading, in the horticultural world, to what she describes as 'the making of the English gardener'. [402]

In her research of rural communities in England 1086-1348, Kirby argues that using scholarly textual sources fails to help us understand practice among 'the lower orders'. In a specific chapter addressing the matter of manure Kirby concludes from her research of the physical environment and recorded testimony, that peasants 'understood that the land needed nourishment'. She also argues that by the thirteenth and fourteenth centuries, 'the world had long been understood in elemental terms, and as part of a universal scheme in which all matter comprised a combination of one of four elements: warm, cold, moist and dry.'[403] The knowledge gained from manuscripts, such as the writings of Walter of Henley, corresponds Kirby argues, to peasant knowledge of different types of soils. Both Kirby and Jones argue peasant farmers were following a 'scientific' approach to land management,[404] but how closely these findings can be related to knowledge transmitted through texts, as opposed to oral traditions, is difficult to judge.

Returning to the cycles of accumulation, *inscriptions* in the form of manuscripts, treatises and manuals, were repositories of observations, classifications, application and experience, trials and tribulations, contradictions and uncertainties, and the comparison and integration of classical and oral traditions with new innovations and ideas. Every interaction between human and artefact expanded networks across time and space. From botanizing indigenous flora, to seeking the new and exotic, one method of transmitting knowledge was through *inscriptions*.

[402] Margaret Willes, *The Making of the English Gardener.*
[403] Susan Kirby, *Encountering the Environment: Rural Communities in England, 1086-1348*. Extract from Chapter 4 *As common as muck: keeping the land in good heart*. (Unpublished PhD Thesis, University of Leicester 2013).
[404] Richard Jones, "Manuring as Art and Science in the Middle Ages". Conference Paper. British Agricultural Society Conference, *Science and Knowledge.* (Winter 2012)

Rising levels of literacy connected a new readership into a world of knowledge beyond the rarefied atmosphere of royal courts, universities and monastic orders.[405] As Latour argues, the final product of any scientific endeavour comes as a result of a compilation of many layers of *inscriptions.* Therefore it seems relevant to the nature of this study to place the treatises that have arisen from these cycles of accumulation metaphorically under the microscope. The literary landscapes of husbandry manuals and horticultural treatises provide us with an example of how authors used these landscapes to construct their scientific knowledge.

This chapter will follow the authors into their literary landscapes and continue by considering what Latour and Woolgar describe as socially constructed scientific knowledge.[406] Chapter 7 in this thesis considered the application of manure, and other mixtures in seed steeps, with examples of some of the observations made on the effects of interventions. This chapter will continue the theme of manure in more detail, but will not replicate documented research on methods of collecting and applying manure in the medieval and early modern period. Moving beyond the Aristotelian and Galen principles of hot, cold, moist, dry, as applied to manure and the soil, this section will consider whether there was any development in scientific thinking beyond these classical principles. The chapter focuses particularly on the works of Plat and Markham, who sought to explain the chemical and ecological impact of traditionally accepted methods of manuring practices on the soil and the seed. Plat, with his strong attachment to alchemy and the works of Paracelsus and Palissy, hypothesized on the nourishment requirements of seeds drawn from the soil and manure. He analysed the component parts within soil, and gave recommendations on fertility and treatment. Markham sourced most of his information from classical and continental

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[405] See Elizabeth Eisenstein, *The Printing Revolution in Early Modern Europe*, 257
[406] Latour & Woolgar, *Laboratory Life*

writings, and his own experience and observations, and while he plagiarized works, he nevertheless drew together much of the knowledge of the period and compiled a framework that matched soils with manure and species of seeds. These examples will be followed by observations from improvers.

Craving much Dung

An understanding of elemental theory is, according to Jones, essential to understand the world order as it pertained to medieval and early modern agriculturalists. Conceptualised from Plato's *Timaeus,* and synthesized by Aristotle, the cosmos comprised four elements, fire that was hot and dry; air, which was hot and moist; water which was cold and moist, and earth which was cold and dry. Combinations of these four elements formed the basis of all physical matter. From this elemental theory, Jones argues, developed Galen's four humours 'which inseparably linked the elements to the four corporeal fluids of blood, yellow bile, black bile, and phlegm.' Animals and plants also possessed their own humoral 'temperament', which, when consumed, influenced and affected human humours. 'Consequently plants, animals, objects and entire landscapes were attributed with considerable 'agency': all had the capacity to alter human character and well-being.' These views, according to Jones, remained influential from medieval and into the early modern period, and in the context of this research, is a theoretical framework utilized in the literary landscapes of early modern authors. Summarized by Jones as 'every soil had its elemental characteristics this dictated how it was prepared and when; ground treatments sought to create seedbeds that mirrored the healthy warm/moist state of the human body, and to exploit the vertical movement of the elements through the soil according to seasons and lunary phase.'[407]

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[407] Richard Jones, Holly Miller, Naomia Sykes, "The 'Elemental (e)Turn': the archaeology of elemental philosophy and humoral principles". *Academia.edu* (UNDATED), 6

The constituent qualities of soils were described and manures defined, in Galen humoral theory, to balance hot soils (sandy, gravel) with cool manures and conversely cold soils (clay) with hot manures. According to Kirby, at a peasant level, the medieval naming of fields and furlongs suggests an understanding of the types of soil being cultivated. This would have required knowledge of the constituent parts of the soil and their relative temperatures.[408] Non-animal fertilizing agents, such as ash and marl, were also categorized according to temperature and moisture levels. Manure at a modest level was made from a mixture of organic matter and animal and household waste, and generally held in dung heaps. Animal manure, when relatively pure, was graded and applied to balance the temperature and moisture of the soil, for example, a cool manure such as well rotted horse or beasts waste could be used generally, but also on hot sandy soil. Keeping the soil in 'good hart' combined Galenic theories of humoral balance with Aristotelian elemental theory. The importance of manuring is demonstrated in the translations of continental husbandry manuals and the English publication of Fitzherbert's agricultural treatise, and was, thereafter, increasingly incorporated into the literary landscapes of the horticulturalists. Writing in 1523 Fitzherbert claimed that:

> Horse donge is the worste donge that is. The donge of all maner catell, that chewe theyr cudde, is verye good. And the dounge of douues is best, but it muste be layde vppon the grounde verye thynne.[409]

Fitzherbert was aware that his land had to be worked harder than ranker ground and his instruction on the different types of plough for different soils was detailed. When ploughed, his land was left to stand under rain, frost and snow in order to break down the clods. Not only was he one of the first contemporary writers to write at length about the plough and

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[408] Susan Kirby, *Encountering the Environment: Rural Communities in England, 1089-1348*

[409] Fitzherbert *The boke of husbandrye*, 15

ploughing, but he also warned against the causes of soil erosion, as did Surflet, who also described different soils urging the reader to 'know the conditions of every ground.'[410]

In the horticultural world Parkinson was there to remind his readers that their gardens required regular manuring. Reiterating classical traditions he recounted the matching of hot manures 'the soyle of horses' with 'colde ground', while the 'soyle of Cattell is colder and moisture' therefore suitable for hot sandy soils. This balance of heat and moisture, often associated by historians with keeping the soil fertile, was, according to Parkinson, the concern of successful seed germination. With the right balance of heat and moisture, 'it will cause any seedes for this Garden to prosper well, and be more forward then in any other ground that is not so holpen.'[411] As well as his knowledge of traditional and classical sources, Parkinson drew on his experience and observation. In a busy kitchen garden, with its high annual turnover of vegetables, he recommended an annual application of dung, 'that without continuall refreshing it would quickly become so poore and barren, that it would not yeelde the worth of the seede.' [412] Surflet's translation of Estienne's *Maison Rustique* also outlines the requirements of various kitchen garden seeds categorized in general terms as seeds and plants that 'crave much dung', and those that required no manure.[413] This was a shift away from the knowledge of dung as solely an enriching agent for the soil, to include observations concerning the effects of manure on the seeds. At this stage, the main observations were twofold (1) that seeds would fail to germinate unless the balance of heat and moisture was correct and (2) that seeds and plants would not prosper in impoverished soil. This is where Plat starts in his theoretical discourse on the properties of soil.

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[410] Surflet/Estienne, *Maison Rustique*, 28
[411] Parkinson, *Paradisi, kitchen garden section*, 461
[412] Parkinson, *Paradisi, kitchen garden section*, 462
[413] Surflet/Estienne, *Second Booke of the Covntrie Hovse*, 57

> Mr. *Bernard* concludes thus' wrote Plat in *The Jewel House*, 'That Marl is a natural, and yet a divine soyl, being an enemy to all weeds that spring up of themselves, and gives a generative vertue to all seeds that are sown upon the ground by the labour of man.[414]

In reviewing the works of Plat, Debus focuses on the considerable influence Paracelsus and Palissy had on Plat's alchemical propositions and experimental philosophy. The fact that Palissy's observations were made in France was not lost on Plat, and he proposed Palissy's theories more of a guide than a faultless proposition. Debus mentions, but does not focus on Plat's theory of salt as it pertains to seed nourishment, but rather its application and Plat's attempt to secure a cheap and constant supply. It was Plat's mercantile endeavours and interest in economically beneficial projects that Debus sought to demonstrate. [415]

Thick also pursues the interrelation between Plat and the works of Palissy and other continental writers including Paracelsus and Franciscus Valetius (Francisco Vallés) (1524-1592) Professor of Medicine at Alcalá de Henares and physician to Philip II of Spain.[416] Thick extends Plat's knowledge base beyond the confines of continental authors describing him as the first English author who collated information on the different regional variations in England of knowledge and practice of soil fertilization. [417] Plat's recording of regional patterns of agriculture, horticulture and economic processes, contributed to what McRae

[414] Plat, *The Jewel House*, 116

[415] Debus, *The Chemical Philosophy Paracelsian Science and Medicine in the Sixteenth and Seventeenth Centuries* (Dover Publications Inc. 1977), 416. Debus, "The Chemical Philosophers: Chemical Medicine from Paracelsus to van Helmont", *History of Science* (12.4 Dec.1 1974), 235-259

[416] See also Debus for detailed recording of the interchanges between Plat and Franciscus Valetius's *De sacra philosophia, sive de his quae scripta and physics in libris sacris* first printed 1587 in *Chemical Philosophy*, 417

[417] Malcolm Thick, *Sir Hugh Plat*, 80-114. "Sir Hugh Plat and the Chemistry of Marling", *Agricultural History Review*, (42, II), 156-157

described as a growing collection of chorographies.[418] Plat and Markham, both produced works on soil fertilization and manuring, building their economic arguments on a platform of improvement.

Plat analysed different soils to establish whether they intrinsically held their own levels of fertility, and in *Diverse new sorts of Soyle,* he debated the relative merits of the application of a range of fertilizing agents to the soil. Plat considered marl, lime and chalk to be hot fertilizers, which could be applied to, and mixed with, cold moist soils. He extended his research by analysing marl and found it had traces of marine organisms and shells, snails, coal balls and eggshells all of which contained salt.[419] Like many fertilizers when first produced, or dug out of the ground, marl was hot and required a period of time to cool, a similar process to the rotting down of animal manure. Once cool, marl itself was cold, but also according to Plat, suitable for cold barren land, which seemed to contradict the practice of matching hot manures with cold soils, cold with hot soils, wet with dry soils and dry with wet soils. In Plat's analysis what made the material hot was the level of salt contained in the marl. 'For it is well knowne, that salt is inwardlie hot, and therefore it is accounted an help to the act of generation'.[420] At a time when the view that plants were nourished by earth held sway, central to Plat's discourse was his theory that it was salt that was vital for seed and plant nourishment.

One of the key ingredients in Paracelsian alchemy was salt, which Paracelsus, described as a vegetative salt, a compound Plat claimed came in many forms and was vital for seed and plant nourishment. '..there is not any kind of vegetable whatsoever, that coulde grow or

[418] Plat, "Diverse new sorts of Soyle not yet brought into any publique use" in *The jewel house of art and nature,* (1594). See also Chapter 2 of this thesis.
[419] Shell-marl is very different in its nature from clayey and stone marls, and, from its effects upon the soil, and is commonly classed among the animal manures.
[420] Plat, "Diverse new sorts of Soyle not yet brought into any publique use", 23

flourishe, without the action of salt, which lieth hidde in euerie seed..'[421] Although it was recognized that salt was found in animal manures, the content and quality depended to a large extent on the quality and quantity of the animal food source. In light of this, Plat's investigation into the constituent parts of marl was an important contribution to the science of manuring, but importantly, Plat raised issues concerning the seed. He countenanced in Paracelsian terms, that seeds held salt within them, but also he considered that salt was the main external source of nourishment for the seed. Alongside the need to balance heat and moisture for seed germination, Plat seems also to be suggesting that salt should be balanced to ensure an internal and external equilibrium.

Bacon's contribution to any theory of manuring was limited and appears to be a collation of known features. His particular contribution relates to theories of heat, and in *Novum Organum* he noted that dung of animals, when it was old, had the power of heating, and 'fattening of the land'.[422] The traditional usage of Aristotelian and Galen symmetry of hot, cold, dry and moist was written in manuscripts and continental husbandry treatises of Heresbach and Estienne, and less so in the works of Fitzherbert and Tusser. But Bacon was not interested in simply reiterating the known; his investigation was about *how* manure worked, in other words, the component parts and materials and how they interacted. How was it that an apparently cool material, such as well-rotted manure, created heat?

When Plat analysed marl, he described it as hot when removed from the ground, but over a period when removed from its origin, it cooled. In similar fashion, Bacon concluded that certain matter such as animal manure, lime, ash and soot, originated from heat but, when cooled,

[421] Plat, "Diverse new sorts of Soyle not yet brought into any publique use" in *The jewel house of art and nature,* (1594), 10
[422] Bacon, "Table of Degrees or Comparison in Heat" in *Novum Organum* XIII

retained certain 'relicks of their former heat.'[423] All dung, Bacon ascertained, chalk, seas and, salt, and the like had a secret disposition and tendency to heat. Both Plat and Bacon were applying observations and alchemical theories in their scientific investigations of *how* manures worked, and in Plat's case, extended to include the relationship between salt and the seed. There is no evidence that Plat moved his investigation into trials, and certainly no evidence that his theories were put into practice by farmers of the period. However, what his investigation reveals is an extensive cycle of accumulation, as classical and continental models and writings, medieval traditions and the collation of regional patterns, all contributed to Plat's knowledge base and his experimental philosophy.

Montgomery places Markham as the first to write about soil husbandry and soil erosion as it related to England.[424] Describing soil as a 'strategic resource', Montgomery argues that soil erosion is not caused by the axe, the instrument of deforestation, but the plough, the instrument that lays the earth open to the elements. The fundamental condition for sustaining civilization is the soil and its fertility and, according to Montgomery, Markham was cognizant of the fact that 'what made good soil depended on the local climate, the character and condition of the soil, and the local plants (crops).'[425] Although Montgomery cites Markham as a leading light in his concern about the environmental degradation of soil, Markham in fact drew much of his information from the continental writings. However, he was cautious, and no longer content to rely on translations from 'many famous and learned men, both in Fraunce, Spaine, Italy and Germany':

[423] Francis Bacon, part of the *Novum Organum* taken out of the Second Book, 27
[424] David Montgomery in *Dirt: The Erosion of Civilizations,* University of California Press (2007)
[425] Montgomery in *Dirt: The Erosion of Civilizations,* (University of California Press 2007), 95

> from whence we by translations haue gotten some contentment, though but small profit; because those forraine clymates, differing much from ours, both in nature of earth, and temper of Ayre, the rules and obseruations belonging vnto them can be little auailable to vs, more then to know what is done in such parts, a thing more appertaining to our conference then practise.[426]

Markham was realistic enough to realize that, unlike the estates of Heresbach and Estienne, people could not choose their site. Like Plat, he identified regional variations with a desire to produce literature, 'contayning the knowledge of the true nature of euery soyle within this kingdome.' He spoke of England as his geographical territory, although, he only identified Hertfordshire, Cambridgeshire, Essex, Lincolnshire, Nottinghamshire, Huntingdonshire, Middlesex, Kent and Surrey. As noted by Montgomery, Markham was particularly alert to soil erosion, describing such soil as *loose* and *fast*, having been parched and baked by the sun. '[T]hen the ground vpon such exceeding drought doe moulder and fall to dust..now hauing lost that glewinesse it is light, loose, and euen with a mans foote to be spurnd to ashes.'[427] Loss of fertile soil made it impossible for the 'seede to sprout through the earth'.

Kirby argues that peasant farmers were not only aware of the type of soil they were tending, but also matched manures according to elemental theory, and indeed much of the information contained in the translations of continental husbandry manuals followed this model. Markham, however, extended the model by matching particular seeds and crops to the soil and the manure. In the first instance he considered black clay, which he suggested was suitable for three crops, 'barly, pease and wheate'. The richness of this soil type required no manure, and indeed Markham considered soil that contained 'much fatness' was liable to cause blast and

[426] Gervaise Markham first part of *The English Husbandman* (1613), 30
[427] Markham, *Good husbandman,* 10. See also Markham's *Farewell to Husbandry* and *The Inrichment of the Weald of Kent* (1625)

mildew ‘and turn as soote’. In another example, he echoed Bacon’s experiments in germination and rapid plant growth, claiming ‘much fatness’ could cause crops to grow so fast:

> they are not able to stand upright and falling downe flat to the ground, the eares of Corne smothering one another, they bring forth but light Corne, like an emptie huske, without a kirnell.[428]

Not only could soil turn to dust, but so too could corn seed. Along with identifying problems, Markham provided solutions, and that was to match the seed to the soil. Although he cited rye as a crop with seeds that could tolerate hot, dry sandy conditions, for the seed itself was dry, on the whole Markham used elemental theory when matching manures to soil. In essence he remained consistent with classical and traditional methods where the aim was for a ‘balance’ of heat and moisture in the soil. What was different in Markham’s review of classical, continental and the medieval texts of Walter of Henley, was his attempt to record in detail some well established correlations, noted by Jones, between sheep (dung warm/dry) with wheat-growing on cold/wet claylands; and cattle (dung warm/wet) with barley growing in cold/dry sandlands.[429] In this he was continuing to promote the principles of elemental and humoral theory in relation to management of the land and the seed.

In the medieval world presented by Jones and Kirby, elemental theory and Galen humours governed and framed the world-view, a view, which according to Jones, permeated into the early modern period. Plat’s world-view embraced elemental theory as noted in his investigation on germination.[430] However, he was interested in *how* matters worked, and for this he turned to the alchemical theories of Paracelsus and the

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[428] Markham, *Good husbandman,* 3
[429] Richard Jones, Holly Miller, Naomia Sykes, “The ‘Elemental (e)Turn’: the archaeology of elemental philosophy and humoral principles”. *Academia.edu* (UNDATED)
[430] See Chapter 5 of this thesis.

ceramicist Palissy.[431] It was in his discourse on salt as a means of enriching soil that Plat began to consider issues of seed nourishment, a theme that demonstrates the influence of Paracelsus three principles of salt, sulphur and mercury. What these examples demonstrate is a complex interweaving of different theoretical frameworks as authors sought to explain the workings of nature. In the literary landscapes of our polymath investigators, it is of no surprise that observations could lead to discoveries, sometimes accidental, as they continued to construct their model seed.

Order over disorder

Cressy Dymock was doubtful, he was doubtful about the long held views presented for consideration by others.

> 'that though we by experience finde that all the foresaid materials, and diverse others, as oft-tilling, Husbandry, seasons &c. change of seed and Land, resting of Lands, fencing &c do cause Fertility: yet we are very ignorant of the true causes of Fertility, and know not what Chalk, Ashes, Dung, Marle, Water, Air, Earth, Sun, &c. do contribute: whether something Essential, or Accidential; Material or Instrumental' Visible or Invisible;…whether nourished by Vapours, Fumes, Atoms, Effluvia? Or by Salt..'[432]

Dymock was not alone in his observations about cause and effect. Plat was one investigator whose analysis of marl and salt were later reviewed by Hartlib when he considered the improvement of poor quality land, fenland, coastal regions and heathland. Given the considered high salt content in these soils, Plat's discourse on fertilization and seed nourishment were of obvious interest. Writing in 1651, Hartlib recorded:

[431] For a review of Plat's manuscripts and printed works on agriculture and manure see Malcolm Thick, *Sir Hugh Plat*, 80-114
[432] Cressy Dymock and Samuel Hartlib Printed Pamphlet, *'A Discoverie For Divison Or Setting Out Of Land,* Part 2 (1653)

> [I]n *Queen Elizabeth's* dayes *Ingenuities, Curiosities* and *Good Husbandry* began to take place, and then *Salt Marshes* began to be fenced from the Seas; and yet many were neglected'.[433]

Puritans aspired for self-improvement and the improvement of others in their Commonwealth, so the improvement of land, particularly barren and poor lands, fitted well with their Christian eschatology. Hartlib and his correspondents were not unrealistic, and when considering the cost of improving fen and coastal lands on the margins of fertility, they found it 'very great'. They surveyed the environments and in Hartlib's *Legacy*, there were observations of indigenous species such as field orchids considered at this time in history to be 'rare'. It is unlikely that a classification of rareness was associated with an endangered species, but rather these orchids fitted with perceptions of unusual and exotic. What this example demonstrates is some understanding of the natural environments in which certain plants and seeds could flourish, although this did not necessarily stop the drive for improvement as the Irish plantation experience demonstrates.[434] Creating order from disorder required concentrated effort.

In his specialist vegetable garden, Sharrock actually wrote very little about manuring, but he does contribute evidence of a reliance on elemental theory and humoral balance. He improved his kitchen garden with manure to produce a 'rich, deep, moist, and feeding Soil'.[435] He undertook some trials, whereby he noted that seeds of wild plants, in this case chicory, could be ameliorated by transplantation into better

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[433] Samuel Hartlib, *His Legacy*, *or An Enlargement of the Discourse of Husbandry* (1652), 40

[434] See Chapter 1. Following the publication of Boate's *The Natural History of Ireland* (1651), Cromwell, supported by Hartlib, proposed removing indigenous species and people from the country and importing people and planting trees of non-indigenous variety.

[435] Sharrock, *The History of the Propagation and Improvement of Vegetables*

soil. Such was the success of this transplantation from field to garden, the plant was renamed ‘Garden-Cichory’. The considered opinion that land outside of human control was so varied, from a lush and over-productive marl to poor and barren soils, made it difficult to control the ‘seed’ in its germination and subsequent growth into a plant. However, transplanting the seeds of plants from the wild into an ordered and controlled environment required careful management as not all seeds responded in the same way. His trials, Sharrock informed his reader, demonstrated that vegetable or herb seeds responded well when transplanted into enriched soil.

Blith, a correspondent to Hartlib, was frustrated by what he saw as wastage of an abundance of ‘soyle’ (manure) in London. Surveying his landscape through the lens of an improver, he noted ‘barren lands, forrests, common fields, and other heaths, wastes, moors’, all of which could be improved through careful environmental management.[436] He observed the draining of the fens, describing reclaimed and marginal land as subject to ‘sea-drowning’.

> First, The sound dry Land, seldom, or never drowned. The Second shall be your constant drowned Lands in times of great Flouds. And the Third shall be your lowest Land of all, that lieth constantly so wet and cold, that it is turned into a very Moor or Bog[437]

A central ingredient in the improvement of barren land was manure, and Blith’s recipe would have been recognizable to other agrarian improvers.

> Lime, Marling, Sanding, Earthing, Mudding, Snayl-codding, Mucking, Chalking, Pidgeons-Dung, Hens-Dung, Hogs-Dung, or by any other means, as some by Rags, some by coarse Wool, by Pitch Markes, and Tarry Stuff, any Oyly Stuff, Salt..[438]

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[436] Walter Blith, *The English Improver, or, A New Survey of Husbandry* (1649), 87
[437] Blith, *The English Improver, or, A New Survey of Husbandry*, 58
[438] Blith, *The English Improver, or, A New Survey of Husbandry*, 133

Blith elaborated by explaining ingredients should hold liquid, foulness, salt and good 'moysture', and a balance of ingredients suitable for seed germination and plant growth. His publication set him apart from earlier agrarian authors. He was a supporter of enclosure, and as others before him had scoped their literary landscapes, so he moved an expansive barren landscape into an enclosed manageable arena. Within this designated space the land, and everything it produced, was managed in a continual cycle of improvement. The quality of manure intrinsically linked to improving crop yield. Initial tilling and manuring of the land, Blith continued, would 'raiseth Straw, Stover, and Fodder.' The straw used to winter cattle in turn created manure; dry stover stalks and leaves were used for fodder, and the grain was harvested. Every organic product was utilized in a sustainable programme of improvement, in the care of sheep, cattle and horses, their output (dairy products and meat), and the quality of their manure.

One of the problems facing improvers during this period was the nature of the land they were trying to improve, most of which produced nothing more than poor grass and weeds.

> ..impoverished Soard Compleatly, and therefore let it be Dry or moyst, Sound or Rotten, Rushey or Mossey, Fenny, or run over with a Flag Grass, or Ant-hills, Mossure, or wild Time..[439]

Surveying this apparently impenetrable and wild landscape improvers had to consider how to improve the land, and importantly, what crops to grow and where best to source seeds. Blith optimistically claimed:

> 'it will yeeld abundance of gallant Corn to supply the whole Country, & raise great Summes of Money to your Purse, and afterward (if you yet Plow Moderately) it may keep as many Cattell,'[440]

Citing Flanders as an example, Blith continued:

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[439] Blith, *The English Improver, or, A New Survey of Husbandry*, 133
[440] Blith, *The English Improver, or, A New Survey of Husbandry*, 133

> yet that very Land well Manured and Tilled, Dunged, Limed, Marled, or Chalked, or otherwise made fat and warm, will bring forth good Glover: and other rich commodities, as they do in *Flaunders,* upon so coarse Lands bestow good cost[441]

Blith, in his agricultural landscape, improved the land and then selected the seed to suit the improved soil. Considering artisans and employment for the poor, he recommended dyers crops such as weld (indifferent land), woad (rich and warm soil) and madder, although seeds from this plant would not ripen in England. He then turned his attention to the fens and marshes recommending hemp and flax grown from seeds sourced in Holland.[442]

> Whereby it is plaine, that as the various temperament of earths doe require various Seeds and Plants: so they doe require various compositions of Manure, to bring them to a temperament: which compositions can never be found out, but by practise and triall of sundry conclusions upon small quantities of Land…'[443]

Worlidge was a major contributor on agricultural themes to the Hartlib circle. Unlike many authors, Worlidge, in summarizing manuring practice, does not refer to classical text but rather reviews sixteenth-century and contemporary writings. His overview included Plat's analysis of marl in his *Jewel House,* and the writings on marl from Markham and Bernhard Palissy. Worlidge was particularly interested in the fixing of salt in the soil from the ash of stubble burning (devonshiring), which he considered was a nutrient for the seed and ultimately the plant. 'This kind of *Manure* either by Burning as before, or with the fixed Salts of any thing whatsoever, doth also much more enrich your Crop than any other Dung or Soyl'. He concluded: 'we must perceive that in the same Land one sort of Seed will thrive where another will not….and that any sort of

[441] Blith, *The English Improver, or, A New Survey of Husbandry*, Second Book, 183
[442] Blith - other crops included hops, saffron, liquorish, rape and cole. Second book, 178
[443] Gabriel Plattes, *Practical husbandry improved: or A discovery of infinte treasure,* (1656), 40

Grain or Seed will in time extract and diminish such Nutriment that it most delights in.'[444] As with previous authors, Worlidge was restating Markham's collation of evidence, that different species of seed responded to particular manures.

Not so for Cook, who did not recommend the use of manure on forest trees commenting their 'Fore-Fathers have not met with such Kindness, therefore their Children do not, nor cannot digest it (manure) so well.'[445] Manures, he claimed, particularly hot manures, speeded up germination and promoted rapid growth. Therefore, he concluded, 'neither your Forrest-trees not their Seeds require much Dung', and to acclimatizing a forest tree required accommodating the seed with the type and condition of soil recognized by its *intelligibility*.[446] Cook continued his speculation by differentiating between seeds and plants from hot countries and those from temperate climates like England. He recognized plants from hot countries required constant heat to keep them alive, but 'what is it then that Plant does feed on?'[447] Drawing on Paracelsian theory he believed that moulds (soils) carried sulphur, mercury and salt in the dung and conducted an experiment to ascertain the level of nourishment in strong animal dung as compared with poorer manure such as 'grass or greed Weeds' (green manures). He concluded that both manures contained salt, but that some seeds could digest the chemicals from stronger animal dung rapidly leading to faster growth. Like Plat, Cook debated the role of salt in the nourishment of seeds and plants:

> Every one knowes that 'tis the Nature of salt, that the dryer and hotter 'tis kept, the more it keeps its own Body, and doth not turn to water: And when it stands in a cold and moyst place, it then dissolves a little

[444] John Worlidge, *Systema agriculturae,* or *The Mystery of Husbandry* (1668), 60
[445] Cook, *The manner of raising, ordering, and improving forrest-trees*, 14
[446] Cook, *The manner of raising, ordering, and improving forrest-trees*, 15. See also Chapter 9 of this thesis.
[447] Cook, *The manner of raising, ordering, and improving forrest-trees*, 16

> time to water; and when 'tis turned into this Element of Water, then is it fit for the nourishment and feeding of seeds, especially Annuals.[448]

Drawing on Paracelsus Cook described 'every body or tangible substance' as a 'curdled fume' or gas, each with its own 'matrix' for example, wood, stones or metals. Anything that grew out of the earth was a 'fume', with the moisture of liquid mercury 'which is various' sending several fumes for herbs and trees. Cook was unconvinced that it was solely salt the seed digested, although he believed the earth held salt, sulphur and mercury, and that plants contained the same. In the 'year 1666' Cook ran a further experiment in which he dried some 'good Rich fresh Earth' and weighed it at eighteen pounds and a half. He placed the soil in a flowerpot, sowed with purslane seed and kept the pot for one year watering regularly. Once the plant had seeded at the end of his experimental period he cut of the purslane and weighed it at six pounds two ounces. He then dried the soil and weighed it finding it to be eighteen pounds seven ounces. From this he concluded the seeds did not feed on the earth, but rather they absorbed (digested) water.

> ..the Earth is spongy and porous, fit to receive the several Influences of the Heavens, of Heat, Rains, and Dews; and stores them up for the Conservation of her products: and when the seed or plant desire it, is put into Motion by the Coelestial heat the earth freely gives out of her store, according as the Plants can dispose of it.[449]

This was a replication of an experiment previously conducted by van Helmont the results of which he published in *Oriatrike or Physick Refined* 1662. Cook theorized the main element ingested by seeds was water, but they also gained nourishment by digesting salt or a mixture of mercury, sulphur and salt in the form of a 'fume'. Cook's investigations moved the discourse on manure as soil improver, and manure as seed nourishment, to consider seed specificity. Cook believed the seed held

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[448] Cook, *The manner of raising, ordering, and improving forrest-trees*, 17
[449] Cook, *The manner of raising, ordering, and improving forrest-trees*, 28

an imprint, a blueprint that regulated and ordered the life process of the plant. Each species of seed, he argued had its own specific needs, so for example, in his theory horse-dung was suitable for seeds and plants of quick digestion and growth, cow-dung for hot seeds such as annuals, and sheep dung for tender and small seeds and crops such as corn crops. Given that tree seeds were slow growing, they had little need for manure.

Cook continued the theme of salt as nourishment for seeds. The two constituent qualities of salt as described by Cook were its strength (of heat) when solid and its ability to dissolve and dissipate in moisture at which point it 'steams forth, and that it is which nourisheth all Plants.'[450] Using first hand experience to reinforce his theory, Cook described the 'Sea brake the bank in a Marsh of my Fathers,' and flooded the land with seawater. The first summer Cook observed it was dry and the 'Gras was clearly burnt up', next summer was wet and the grass began to recover, third summer 'Grafs enough' and by the fourth year the grass had recovered and was abundant.[451] Cook's observations led him to the conclusion that the rain over the years allayed the strength of the salt so the seed was able to digest and germinate.

The early works of Plat and the contributions from the improvers, demonstrate the complex juxtaposition of theories with observation, experience and experimental philosophy. There is no one theory that overrides the other, or is conclusively held. The interaction between the seed and manure, the notion of fertility to the soil and nourishment for the seed, and the intervention of the human hand, all contributed to the building of scientific knowledge.

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[450] Cook, *The manner of raising, ordering, and improving forrest-trees*, 17
[451] Cook, *The manner of raising, ordering, and improving forrest-treesI*, 18

Chapter 9

Nature's Workshops

In 1682 following a series of lectures to the Royal Society, Grew wrote:

> 'So Poppy, being an annual Plant, is highly prolifick: for instance, the White Poppy; which commonly bears about four mature Heads, in each of which, there are at least ten Partitions, on both sides whereof, the seeds grow; and upon ¼ part of one side, about 100 seeds; that is, 800 on one Partition: which being multiplied by 10 (the number of Partitions) makes 8000; and 8000 again by 4 (the number of Heads) makes 32000 Seeds, the yearly product of that Plant.[452]

What better way to describe the seed than Nature's workshop, a biological laboratory, and seed factory? These are not, of course, descriptors that would have been used by authors of the period, but in their trials and investigations they were scrutinizing the internal workings of the seed. As this chapter demonstrates, the end result of all the preceding 'trials of nature' was to get any as many 'prolifick' model seeds as possible.

A number of innate characteristics associated with the seed have already been discussed, particularly the *intelligibility* of a seed held within an immutable blueprint. In evolutionary terms the seed has its own mechanisms for dealing with particular environmental and climatic conditions, and we know from seed bank collections, they can remain inert for considerable periods. In the early modern period propagators, whether horticulturalist or husbandmen were consciously constructing and *inscribing* desirable characteristics. Propagators were selecting and discarding each plant on the merits of these characteristics. But there

[452] Grew, Chapter II, "Of the Number and Motion of Seeds", Part IV "The Anatomy of Seeds" in *The Anatomy of Plants*, (1682), 198

were consequences, as every time a plant or seed was selectively discarded or designated into the model seed, diversity was compromised. Improvers and specialist growers selected their specimen plants according to the requirements of their literary landscapes, be that timber, fruit, vegetables or flowers. Hartlib collated a range of correspondence relating to the specialist requirements of agriculture in his search for seeds with potential.

Selecting the right seed from a specimen plant was critical for the performance of the new plant. Guiding the seed into germination and growth, was the art of the propagator who managed the *intelligibility* of the seed environmentally. Sowing techniques, nutrition and now the care of the plant, all played vital roles in constructing a model seed. The outcome of these endeavours have historically been associated with produce, so for Thirsk the changing fashion in the consumption of vegetables led to the introduction of new varieties, and an increase in the amount of land under cultivation.[453] Other outcomes identify what the seed itself could manufacture as a letter addressed to Hartlib's correspondent Austen demonstrates. 'Now I have planted an Orchard of Walnuts, Hearing that they yield plenty of oyle, & of value to painters, &c.'[454] Of course, for the agrarian, the most important outcome was a high yielding crop, and seeds not afflicted by smut, mildew and other plant pathogens. However, as Evans notes in his study of innovations to improve crop yield, notions of yield rely on a continual increase in the amount of land under cultivation, because any increase per hectare was limited. He concludes, 'a combination of improved varieties of crop plants and technological innovations continues to increase productivity,

[453] Joan Thirsk, *Food in Early Modern England*
[454] Copy letter in scribal hand A (John Beale) to &? 8 September (no year) 28 August 1657 42/134A-35B letter for Mr Austin. Contained in the Hartlib Papers.

but the highest yields are approaching limits set by biological constraints.'[455]

As the study of the seed in the literary landscapes of the early modern improvers is demonstrating, in true Baconian style, they were testing the biological constraints set in the *intelligibility* of the seed's blueprint in their effort to construct a model seed. Throughout their trials of nature, propagators in their literary landscapes described fertility in anthropomorphic terms, as a combining of male sperm with the female essence, or 'power', held within the soil or in the seed itself. Propagators in their trials considered germination, how the seed received nourishment, steeping to improve fertility, response to biological inertia, and essentially, acclimatization to the ecological environment. Plants grown from these seeds became specimens for the model, and these were the seeds that now had to prove their worth by yielding their own seeds. As the propagators tried and tested, so the seed released its *intelligibility,* and a network between humanistic and non-humanistic actants occurred. We now, in Latourian style, follow the scientist into his literary laboratory, and focus on the landscapes of the propagators as they continued with their trials of nature.

We found in Chapter 1 physician and botanist Matthias de l'Obel had extensive connections throughout Europe. He was a Renaissance intelligencer who, through his relationships, connections and communication, disseminated knowledge via networks. The ephemeral nature of correspondence means we have no intimate knowledge of these networks, although l'Obel left a legacy of his mastery in his publications. Some four decades later, another intelligencer was involved in gathering and disseminating collections of publications and correspondence. In the 1630s Samuel Hartlib was busy collating

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455 L.T. Evans, "The Natural History of Crop Yield" in *American Scientist*, Vol.68, No 4, (July-August 1980)

information in a bid to emulate what Bacon most desired, a collection of natural histories. One of Hartlib's intentions was to collate horticultural and agricultural knowledge as understood at the time, and what becomes evident in his collection, is that knowledge, like broadcasted seeds, was scattered indiscriminately. In the same way as Renaissance collections were placed into museums and opened to the public, so Hartlib wanted to plant his knowledge into a fertile landscape, a public arena, in a 'More exact Method'.

As an unnamed and undated letter to Hartlib aptly demonstrates, knowledge was dispersed and untended, although many of the enquiries outlined were already being documented in the literary landscapes of the horticulturalists. The science of the seed was still being formulated and accumulated as Hartlib's unnamed correspondent considered:

1. 'An Account of the depth of ground, that each seede, when sowne, doth require, for the just production & perfection of it, beyond which also if case, it will bee buried & not at all to bee after seene.'
2. An Account of the time of shooting or Germination proper to each Plant, commonly produced by seed, carefully allowing for the difference of the earth, or for the seasonablenesse or vnseasonableness of the aire, weather, or other the like Accidents. And whether those that shoots forth, soone or late, may be reduced in any orderly Classis.
3. The great variety & curious elegance of the figure of all seeds as contemplated more narrowly, by the helpe of Microscopes, or Augmenting Glasses.
4. The weight of seeds, respectively one to another, pitching vpon some one steely hard seed for a medium.
5. The difference of the fertility of one plant above another, which can not bee collected by any other soe well as by the last medium. An Example of which, hath beene already given by that accurate scholar Petrus Laurmbergius, who for any thing I know, was the first, that told vs the prodigious Luxuriousnesse of one plant in one yeare, to multiply

above 2. Hundred thousand for one.[456]

This set of enquiries reaches the conclusion at the centre of the improver's intent, that the model seed produces a plant that in turn produces many replicating seeds. In the same way as a cloned plant was an imitation of the parent plant, so the model seed would replicate its parent, but with the potential to produce hundreds, if not thousands, of seeds. Vegetative reproduction is a form of asexual reproduction in plants. It is a process by which new organisms arise without the production of seeds or spores, and can occur naturally or be induced by horticulturists. Many cuttings, for example, can be taken from one plant significantly increasing the stock, but if quantity is the desired outcome, then cloning or vegetative reproduction has biological limitations. Not all plants are suitable for cloning, and any increase in stock is limited compared to the quantity of seeds an individual plant might produce. More generally, propagators considered seeds an option in terms of yield, but as has already been discussed, the botanical investigation of seeds led to many and varied queries and solutions.

Questions concerning a plant's fertility are found in the husbandry and horticultural literature from 1520s, where estimating the number of seeds produced by agricultural crops was a feature of the husbandry manuals. Fitzherbert estimated the bushel of seeds to be sown on 'An acre of grounde', but was less confident at estimating overall productivity.[457] There were too many unpredictable variables from the weather and soil quality to ploughing and sowing methods. Richard Gardiner's book was devoted entirely to vegetable growing. He made no attempt to estimate the number of seeds produced by his vegetables concluding that by collecting his own seeds, he was able to grow enough

[456] Copy letter in Hand H? to Hartlib undated 8/22/4A. Lauremberg was particularly interested in fertilizing agents for the soil.
[457] Fitzherbert *The boke of husbandrye*, 10

vegetables to be 'Very profitable for the common wealth and greatly for the helpe and comfort of poore people.'[458] Plat in his treatise *The new and admirable Arte of setting Corn* published in 1600, was more precise, and claimed that sowing seeds individually allowed for greater seed production. John Parkinson, on the other hand, recorded in 1629 that England produced insufficient seeds to produce enough crops to feed the population.[459] It was not until the 1640s we find evidence within Hartlib's correspondence of a specific reference to 'the difference of the fertility of one plant to another.'[460] Hartlib improvers sought robust seed production in indigenous and newly introduced varieties. To support their endeavour they recommended setting up trials and experimentation, the outcomes of which would be shared.

> …the Countrey Farmer translated out of French is enough; but its no ways framed, or squared for us here in England: and I fear the first Authors went on probabilities and hear-say rather then experience…Gentlemen try so few experiments for the advance of this honest and laborious calling (agriculture)…Gentlemen and Farmers do not meet and communicate secrets in this kind, but keep what they have experimented themselves, or known, from other.[461]

Carrying all the hallmarks of Bacon's natural history *Sylva Sylvarum,* Hartlib set out to compile a body of knowledge in husbandry and horticulture, to reform customary practices and legitimize the implementation of his aspirational agenda for improvement. In so far as seeds and plants were concerned, there were three main strands to the Hartlib investigation including a survey of indigenous crops and plants and a survey of plants and seeds found on the continent and the New World that might be suitable for the English environment Finally, and

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[458] Richard Gardiner, *Profitable Instrvctions for the Manuring, Sowing and Planting of Kitchen Gardens,* (1599)
[459] Parkinson, *Paradisi*
[460] Hartlib, *Ephermerides* 1657 Part 2 Hartlib May 1657-December 1657 29/6/14A
[461] Hartlib, *His Legacy* (1652)*,* 75

importantly, a methodology using comparative observations to estimate the fertility of different plants and their suitability in different growing environs.

In 1645 Hartlib published an incomplete treatise entitled *Discourse on the Husbandry of Brabant and Flanders* written by a correspondent Richard Weston.[462] The treatise, originally circulated in manuscript, was written from the viewpoint of a landowner who travelled abroad seeking new and innovative knowledge of husbandry. Written as a legacy for his sons, it is clearly designed to stir curiosity and expand knowledge by setting an investigative agenda. There is ignorance, Weston claimed, of 'the ordinary seeds which are commonly sown amongst us.'[463] Nor, he continued, is the 'countrey man' familiar with the 'very great varieties'.

> the ordinary Yeoman is ignorant of the diversities of *Barley's*, for there is not only the ordinary *Barly*, but also big sprat-Barly, which hath lately been sowen in Kent with good profit..[464]

Investigating and undertaking local botanical surveys of indigenous crops echoed the botanizing trips undertaken prior to the 1640s and the Civil War by Gerard, Parkinson, Johnson and Goodyer, and others involved in cataloguing the indigenous. Identification of the sites where indigenous plants grew even on the 'stony beaches of the sea, where there is little or no earth' offered solutions.[465] Identifying the environment and location of plants, collecting seeds or plants, and acclimatizing them in gardens and agricultural plots would improve them, and add to the diversification of crops available in the market. Searching for indigenous flora continued, and writing in 1651 from Lisneygarvy, county Antrim, Robert Child, collaborator of Hartlib, stated 'I haue gathered diverse of

[462] Richard Weston (1591–1652) was an English canal builder and agricultural improver.
[463] Hartlib, *His Legacy,* 68
[464] Hartlib, *His Legacy*, 68
[465] Johnson, *Itineris Plantarum* (1629)

the seeds of the plants of this country which by the next I will send you, that they may be delivered to Morgan, who keepeth the Garden at Westminster.'[466]

Weston was looking for suitable forage crops for growing in England and there were two strands to his search. First he wanted a survey of the different crops and fruit grown in counties around the country and the other was to investigating indigenous species. But this exercise of plotting locally grown and indigenous species and varieties was not simply an exercise in diversity. Within this investigative model was a notion that out there in the field, and the wild, and untamed natural environments might be varieties that were resistant to plant afflictions that devastated the fertility of plants. 'There is a kind of *Wheat* in *Buckingham-shire* called *Red straw-Wheat*, which is much commended:'[467] The Hartlib Circle were looking for seeds that held specific qualities: an immunity to smut, mildew and blasting, and seeds that would give double increase as 'Flax, Oats, Pease and other divers other things of importance.'[468]

> '..for we see that the transplanting of Plants into gardens, doth very much meliorate or better them; and without doubt all those grains which are in use with us, were first picked out of the fields and woods; and by ingenious men found useful for man or beast.'[469]

To complement local and indigenous surveys, Weston and others sought examples from the continent on the management and improvement of lands and crops across Europe including, '*France, Spain, Italy, Holland, Poland, Germany*'.[470] Examples of great profligacy were cited in 1657

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[466] Robert Child, Hartlib Papers 15/5/5A. See also Ambrosoli, *The Wild and the Sown,* 317-320
[467] Hartlib, *His Legaye*, 14
[468] Hartlib, *His Legacy,* 63
[469] Hartlib, *His Legacy*, 69
[470] Hartlib, *His Legacy*, 69

when seeds from a variety of Italian wheat grown in England caused enthusiastic claims of 'progious encrease', only for those claims to be dashed the following year when the crop was destroyed by blasting.[471] Failures, however, did not stop the search for new introductions, new species and varieties that would prosper on rank and 'fenny' land. 'I desire ingenious men to send home whatsoever they have rare of al. sorts…all sorts of Vegetables not growing with us as *Pannick, Millet, Rice*, which groweth in Fenny places in *Millan*.'[472]

Evidence on the level of activity associated with this proposed investigation is limited but, despite this, Richard Weston's landscape of enquiry formed part of a cycle of accumulation contributing to the formulation of theories of fertility. Fertility, wrote a correspondent of Hartlib in 1655, is the 'nourishment of the plants *viz.* the Earth, the Salt, the Water, or Dew the warmth and the spirit of the Plant it self.'[473] This unknown correspondent was identifying the biological potential and limitations of the plant taking account of environmental factors that ultimately influenced or affected its *intelligibility*.

It remained common practice to follow the long established practice of estimating yield per acre and the number of crops the ground could support each year. The question raised here is whether this was estimating the fertility of the seed or the fertility of the soil?

> Another kind of seed to be had, which will likewise afford three crops a year, and two loads and half in one Acre, one load thereof being worth two loads of ordinary Hay, besides an excellent winter pasture.[474]

[471] Hartlib, *Ephemerides,* Part 2 (No. 54 May 1657 – December 1657) 29/6/14A and 29/16/19B
[472] Hartlib, *His Legacy*, 63
[473] Hartlib, *His Legacy. A Philosophical Letter concerning Vegetation or the Causes of Fruitfulness* 1655. See also Plat and salt as a nourishment for seeds and plants in *The Jewel House of Art and Nature* (1594)
[474] Hartlib Papers. Cressy Dymock, "of Husbandry" in *Cornucopia,* 3

Blith's method to improve the seed and increase yield was to mow the first crop, lay this to hay, and reserve the second crop for seed. 'And if we can bring it up to perfect seed, and it will but yeeld four bushels upon an acre, it will amount to more than I speak of by far, every bushel being wooth three or four pound a bushel.'[475] Rather than estimating yield on an increase in cultivated land, Hartlib's correspondents were seeking to get more than one crop in a season, and they needed a variety of plant that could produce two or three lots of seed per season. Sharrock, in line with Blith and Dymock, also proposed two crops a year 'you cut it, and thresh the tops, and so preserve the seed, you shall have at least five bushells of seed from every Acre.'[476] The yield per acre of any crop had a value, and while the improvers measured yield by the acre, they were also considering what Evans described as the 'biological constraints' of the seed.[477] For this they engaged in comparisons, 'that every eare of corne containeth one with another 16 or 20 single graynes, and that from one graine or seed of corne sometimes two or more eares spring out.'[478] Comparing different varieties of the same species enabled the improvers to discard and select.

The fertility of the soil was no less important. Hartlib and his followers were seeking to improve otherwise rank land in order to grow a wider range of crops. Estimates regarding different crops and the quantity of seed required per acre were presented to and published by Hartlib as, for example, the profligacy of lucerne, a forage crop noted by John Gerard in his *Herbal*. The merits of indigenous species like clover, versus the introduction of continental sainfoin and lucerne, had been the subject of botanical exchanges in the Lime Street community and among

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[475] Blith, *The English Improver Improved, or, The Survey of Husbandry Surveyed* (1652) Second book, 185
[476] Sharrock, *The History of the Propagation and Improvement of Vegetables,* 42
[477] L.T. Evans, "The Natural History of Crop Yield" in *American ScientisT,* American Scientist. Vol. 68, (1980)
[478] Hartlib Papers. Extract from Dymock's *Husbandry Design* in scribal hands E & B 58/23A.

communicants of l'Obel.[479] The Puritan improvers were not content with recording the introduction of new forage crops, they wanted to extend botanical thought by applying a method of assessment as a means of estimating the relative fertility of the different species. Nevertheless, great difficulty was experienced in estimating the fertility of new crops for they required a period of acclimatization, and, as often noted, yield could be unpredictable. The fecundity of any seed may well be lauded, but the practicalities of trials could mean several years of possible loss of profit as evidenced by this anonymous contribution published by Hartlib on the merits of sainfoin.

> It appears not much the first Yeare, especially if the land bee Poore, so as the Owner, hath beene often tempted to despaire to plough up that, which afterwards hath flourished well; Therefore it is sowne with another crop to answer the Rent of the Land, The second Yeare likewise it comes not to much, not being yet rooted, Yet improoves the Value of the Land for Pasture, And being eaten with sheepe, they both thrive very well upon it, & make it stock the better, But the third Yeares, it seeds Plentifully, & Yields a great Burthen, And the fourth , it comes to perfection.[480]

None of the methods outlined above were satisfactory in creating a model for measuring fertility. Ranging from estimates of yield per acre to yield per plant one correspondent attempted a mathematical approach whereby the 'weight of the seeds,' was compared 'respectively one to another, pitching vpon some one steely hard seed for a medium.'[481] The search for robust, productive plants continued among Hartlib's correspondents, while within the horticultural and husbandry literary landscapes, authors provided directives on how to manage plants

[479] John Gerard, *Herbal*. See also Mauro Ambrosoli, *The Wild and the Sown,* 273-291 for introduction of new crops to England.
[480] Hartlib Papers, Copy Memo On Sainfoin, Anon 52/152A-153B: 153B BLANK [52/152B Undated
[481] Hartlib Papers, 8/22/4A Copy Letter in Hand H, ? to Hartlib

selected as suitable for seed collection.

True colours

Figure 13. *The French Gardiner,* Nicolas Bonnefons/John Evelyn 1675

Renaissance horticulturalists and Puritan improvers gathered their seeds from diverse locations. Seeds from indigenous plants were collected, as well as from gardens, cultivated areas and from overseas. Handpicked collections were relocated into the enclosed, protected literary laboratory of propagators. Within this literary landscape Aristotelian elements were controlled in protected enclosures where heat (fire), water, air and earth were managed. Let not your seeds dry, wrote Parkinson, 'draw water from wells in the morning and put in a barrel… so it may take the heat of the Sunne beames…for cold and salt water is enemie of to all sorts of hearbes.' Hesitating in his advice, Parkinson continued, 'although that *Theophrastus* say, that salt water is more conueinent than anie other to water certaine plants.'[482]

Moisture (water) in the wrong place, however, could prove detrimental. Weston, in Hartlib's *Legacy* described smut in wet years and mildew in dry, when in a moist season 'which moisture either corrupteth the roots of the Plant, or the nourishments of it, or the seed in its *Embrio*: or perhaps in some measure all these.'[483] Improver Cook considered there were certain climatic conditions that impeded the growth and fertility of plants and was particularly salutary about mildew and smut. Mists in the valleys were 'drawn up by the Sun in the Day-time, and wanting wind to assist its Motion..doth hang in the lower Region, and when the Sun sets, it falls upon your Plants with its thick clammy substance.' This substance, Cook claimed, was drawn through the pores of the Plant and ingested into the sap. The sun draws the vapours towards it 'just as a great Fire draweth the Air in a Room to it'.[484] Again, we find Cook utilizing Aristotle's elemental theory as he considered an imbalance of heat (fire), moisture and air. In fact, Cook was very close to an ecological explanation as corn smut is a plant disease caused by the pathogenic fungus *Ustilago maydis* that particularly affects maize. Mildew, on the other hand, is caused by a different variety of fungi. Spores from infected plants are spread by rain and wind, and the weather conditions that Cook had described as hot and humid. For Cook, his 'clammy substance' once ingested into the plant, afflicted seeds and subsequently the plants, and seeds thereafter 'produceth its like.' Seeds from an afflicted plant were discarded, as were seeds that failed to germinate.

[482] Parkinson, Paradisi, 162
[483] Hartlib, *His Legacy,* 13-14
[484] Cook, *The manner of raising, ordering, and improving forrest-trees*, 8

Air, earth, heat (fire) and water are all implicit in Gilbert's advice for melons and cucumbers, which, when they come up:

> be sure to give them air, or else they will presently turn yellow and spoil, your choicest seeds, cover them with glasses from the Sun, a little from the earth to give them air, and some part of the day take raise them off to acquaint them with the Sun by degrees, which grown strong, remove them into rich earth, in your Garden, keeping them from the midday Sun, till well settled and rooted, by often, but gentle watering.[485]

Seeds that did germinate were observed and characterized. Some plants, like annuals, reproduced themselves quickly and if they showed any unwanted mutation, were weeded out.

> Carrots are vsually sowen in March and Aprill, and if it chance that some of them doe runne vp for seede the same year, they are to be weeded out, for neyther the seed nor roots of them are good:[486]

Others, like Cook's forest tree seeds, were slow growers requiring patience and diligence of care.

As discussed in Chapter 10, the timing of the sowing period was particularly important for fruitful growth and crops, but also for the production of specimen seeds. Vegetables grown on an annual basis were susceptible to bolting or running to seed. In Parkinson's case the cause was due to 'the nature of the seed' combined with rich (hot) ground and climatic conditions.

> For the blacke Reddish (radish), although many in many places doe sowe it in the same time, and in the same manner that the ordinary is sowen, yet the nature thereof is to runne vp to seede more speedily then the

[485] Gilbert, *Florist's vademecum and Gardener's Almanack*, 251
[486] Parkinson, *Paradisi*, 464

> other, if it haue so rich ground to grow vpon, and therefore the best time to sow it is in August, that so it may abide all winter, wherein is the chiefest time for the spending thereof, and to keepe it vntill the beginning of the next yeare from running vp to seede the gathering whereof, as also of the other sort, is all after one manner, that is, to be pulled vp when the pods change whitish, and then hanged vpon bushes, pales, or such other thing, vntill they bee thorough dry, and then beaten or thrashed out vpon a smooth plancher, or vpon clothes, as euery ones store is, and their conueniencie.[487]

Running to seed was a serious problem for the horticulturalist as all the advice presented in the literature directed towards the production and collection of strong and healthy seeds.

The early modern literary landscapes provided advice and directions on preparing the seed for sowing and the environment in which it was sown. Like the Renaissance collector who selected and displayed artefacts with desirable characteristics (which might be based on curiosity, wonder or rarity), in constructing his model seed, the improver was selecting plants for seed production. In so doing, he, like his Renaissance counterparts, selectively 'weeded out' those plants that failed to display desirable characteristics.

Plants deemed acceptable for breeding were treated with specialist care as Googe, in his translation of Heresbach explained:

> The fyrst yeere you must breake of the stalks that growe, for if you plucke them vp by the rootes, the whole settes will follow, which are to be preserued for two yeere with dounging and weeding. All the yeers after, you must not gather them in the stalk, but pull them from the roote, that the rootes being opened, may the better spring, which except you doe, you hurt the Spring. Him that you meane to keepe for feede,

[487] Parkinson, *Paradisi,* 464

> you must in no wise meddle withal..' [488]

Parkinson described overwintering cabbages in a cold dry place before planting them out with protection in March, so 'thereby you may be sure to haue perfect good seede, if your kinde be of the best.'[489] With his keen horticulturalist eye, Parkinson marked out the 'choysest and strongest plantes which are fittest to grow seede' and would then strip the lower leaves to avoid 'rot, spoyle or hinder them from bearing so good seede.' Lettuce was thinned and transplanted two foot apart

> 'In this is vsed some arte to make the plants strong to fiue the better seede without danger of rotting or spoyling with the wet…mark out the choysest and strongest plantes which are fittest to grow from seede, and from those when they are a foote high, strippe away with your hand the leaues that grow lowest vpon the stalke next the ground, which might rot, spoyle or hinder them from bearing so good seede.'[490]

Parkinson's advice was based on the *intelligibility* of the seed and its biological need to remain in constant balance and harmony with Aristotelian elements and Galenic humours. This was advice replayed in the specialist landscapes of the improvers as Sharrock, in choosing his lettuce seed, advised the reader to, 'mark the plants that you see strongest for seed, and after they have begun to shoot stalks, strip away the lowest leaves, for two or three hands breadth above the ground, that by them the stalk be not rotted.'[491]

In agricultural historiography, yield and crop production has generally been attributed to the preparation and fertility of the soil, and certainly

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[488] Googe/Heresbach, "Of the order of Gardening" in *The Foure books of husbandrie* (Second book 1596), 54
[489] Parkinson, *Paradisi* p.464
[490] Parkinson, *Paradisi*, 464
[491] Sharrock *The History of the Propagation and Improvement of Vegetables*, 33-34

this was at the core of the literary landscapes of the period. Soil fertility was also central to the Hartlib programme for the improvement and cultivation of poor quality land. They concluded that selecting seed to suit the growing conditions was important, but also recognized that enlarging the amount of land under cultivation required an increase in capital investment and labour. Less well considered in the historiography, were the investigations and trials by improvers into plant fertility, and how this influenced seed selection and the construction of the model seed.

Chapter 10

Sowing the Seeds of Knowledge

The previous chapter recorded a small, and apparently insignificant observation, made in Hartlib's *Legacy* of a field orchid, a 'rare' find. In this vast landscape, beyond the scope of the literary landscapes constructed by their authors, seeds and plants generated their own lives. They could lie dormant and inert, they could flourish and perish, travel and propagate, and may never have been noticed. Large quantities of seeds and plants were arriving on the shores of Renaissance England. Observations of these new, exotic, and often unknown, specimens were recorded in herbals, and the early horticultural treatises of Plat and Parkinson and indigenous species in the floras of Johnson. Recording and cataloguing was not enough for Paracelsus, who maintained nature 'as it is under the hands of Nature, imperfect'. In their investigations, improvers sought to construct a model seed, to perfect what was imperfect. Chapter 8 focussed on problems associated with the earth and soil, concluding that it was a difficult environment to 'control', and vulnerable to the interactions between the heavens and the earth. Many theories circulated as man attempted to control his environment, from Aristotelian elemental theory and Galen humours, to Paracelsian alchemy and Lucretian atomism.

This chapter will focus on the sowing of seeds, a time when so much of a community's wealth and wellbeing, and a propagator's reputation, was invested in a simple act of dropping a seed onto the ground. In Aristotelian terms, when a seed was sown it would go through a transformation that, according Lindberg, would lead to a change in form, but not in matter. Change in this sense, was a 'process of replacement, the new form replacing the old one'.[492] For Aristotle, the world was

[492] David Lindberg (ed), *Science in the Middle Ages.* (Chicago History of Science and Medicine 1976), 49

predictable and orderly, where every natural object had its own 'nature', and where an inner activity was the driving force for change. What Bacon challenged was Aristotle's view that observation of objects in their natural state would reveal their 'nature'. Aristotle believed artificial manipulation would merely, 'interfere and tell us that if we set up conditions that prevent the nature of an object from revealing itself, all we have learned is that it can be interfered with to the point of remaining concealed.' [493] As has been discussed, Bacon recognised change, but did not support Aristotle's theme of continuity in a world that was orderly and organized. Observation was not sufficient for Bacon, as it relied on subjective perceptions and anticipated outcomes, when objective evaluation would lead to observations of the unexpected. Interfering with and 'vexing' the unexpected would, in Bacon's mind, reveal nature's secrets.

That nature was unpredictable is evidenced in the literary landscapes of the period under discussion. Certainly there was a theme within the literature that supported Aristotle's view, that, as Lindberg points out, things developed towards ends determined by their natures. But, as has been discussed, seeds did not always conform to Aristotle's theme of continuity and order. Therefore selecting specimen seeds became central to the improvers modelling. Nonetheless, all the investigations, collecting, selecting, and trialling, could in the end, be jeopardized, so, the whole process came under the investigative lens of authors as they set forth their trials in their literary laboratories.

Agrarian practice and the sowing of seeds have generally been associated with agricultural historians Thirsk and Fussell.[494] Much of their emphasis has been on such topics as land preparation, rotation,

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[493] Lindberg, *The Beginnings of Western Science,* (The University of Chicago Press 1992), 51-55
[494] Fussell, *Farming Technique from Prehistoric to Modern Times,* 85-106

diversification, the introduction of new and industrial crops, and the development of mixed husbandry. Economies of scale and productivity are central to their arguments, while the landscape of the seed in the history of agriculture lies hidden in the hand of the sower as he broadcasts, and the harvester as he reaps. In their literary landscapes, authors considered potential influences on sowing, the weather, astrological signs, and for the improvers, the botanical requirements of the seed.

The Nature of Things

The classical texts, on which to a large extent these husbandry manuals relied, actually seemed to produce confusion among authors. As they attempted to combine prudent practice with environmental circumstances, the key arguments centred on the type of seed, how much should be sown, how thick or thin and the condition of the soil. Farmers looked to the skies to read the weather as Surflet wrote in his translation of Estienne's *Rustique Maison:*

> Your farmer although he neede to not be bookewise must have knowledge of the things foretelling Raine, Wind, fair Weather, and other alterations of the Seasons.[495]

Signs foretokening, snow, winds, rain, fair weather and foul, thunder and frosts, heat and drought, the list was comprehensive. In the literary landscape of the husbandman and horticulturalist, reading the skies was part of the skill of the propagator. With a mixture of Aristotelian elemental theory and biblical references, Surflet likened the husbandman to an astrologer, as he drew down the effects of the sun and moon from which '..beasts, plants, trees, and hearbes do take their generation, nourishment, grouth and perfect consumations.'[496] The sun

[495] Surflet/Estienne, *Maison Rustique,* The First Book (1600), 32
[496] Surflet/Estienne, *Maison Rustique*, 40

and moon were in the region of the heavenly bodies along with stars and the planets. This was the area Aristotle described as comprising a fifth substance, a powerful element he called ether or *quintessence*. Lit by the sun, the moon was variously strong, depending on whether it was waxing (increasing) or waning (decreasing). Each phase 'hath likewise more or lesse force to mooue the humours of naturall things to worke their effects.'[497] As the light and heat increased, so moisture was spread towards the 'outward parts' whereas when the moon was on the wane, the humidity and moisture was drawn inwards. In a simple and logical framework of understanding, growth required a spread of moisture outwards so, in the case of plants, moisture was drawn through the inert (dry) seed helping it to germination.[498]

In his translation of Estienne, Surflet is referring to the ancient art of astrology, a practice that can be traced back to Palladius, and to *Tetrabiblos,* an astrological handbook written by Ptolemy. Astrology was an important influence emanating from sixteenth-century European university and scholarly communities, where it was taught from the beginning of the fourteenth century as part of the arts and science curriculum. [499] Generally divided into three themes, mathematics,

[497] Surflet/Estienne, *Maison Rustique*, 40

[498] Planting by the moon is still recommended with twenty first century supporters presenting a variety of scientific explanations. The Earth is in a large gravitational field, influenced by both the sun and moon. The tides are highest at the time of the new and the full moon, when sun and moon are lined up with earth. Just as the moon pulls the tides in the oceans, it also pulls upon the subtle bodies of water, causing moisture to rise in the earth, which encourages growth. Website: Gardening by the Moon 2014. It may also be a time when the days are longer, day length being a significant factor when plants benefit from an increase in (sun) light and warmth. However, the full extent of the influence of the moon on growth patterns in plants remains unresolved. Rudolf Steiner (1861-1925) was founder of the anthroposophical movement. Steiner, clearly influenced by Aristotle, associated the elements of earth, air, fire, or water with corresponding parts of the plants. Earth corresponds to root, water to leaf growth, fire to seed production, and air to flowers. Using astrological signs, planting would then correspond with the different signs, so when planting crops for their fleshy roots, you would plant them in an earth sign, and so forth.

[499] H. Darel Rutkin, "Astrology" in Park & Daston (eds) *The Cambridge History of Science*: (vol 3., Early Modern Science 2006), 541. Ann Moyer, *The Astronomers' Game: Astrology and University Culture in the Fifteenth and Sixteenth Centuries.* (The University of Pennsylvania January 1 1999). See also Steven Vanden Broecke,

natural philosophy and medicine, Lindberg divides astrology into two sets of beliefs, one concerning the physical influence within the cosmos, and the other astrology as the art of casting horoscopes.[500] It was the influence of astrological forces of the planets, stars, and the moon that was of general concern. Lindberg concludes, that Renaissance and early modern observers had compelling reasons for believing that the heavens and the earth were physically connected. He cites examples, that are surely drawn from academic observations, such as the heavens as a source of light and heat, that the seasons were connected with solar and lunar motion, and the magnetic influences of the compass.

How astrological predictions were received by authors, is less well researched, and to some extent, notions of planting by the phases of the moon have been associated by historians with folklore, tradition and uncritical plagiarizing, and recycling, of information from classical texts. Certainly the concept of planting by astrological signs does have its roots in elemental theory as Ptolemy writing in his astrological handbook *Tetrabiblos* demonstrates:

> [T]hat a certain power emanating from the eternal ethereal substance… permeates the whole region about the earth. For the sun…is always in some way affecting everything on the earth, not only by the changes that accompany the seasons of the year to bring about the generation of animals, the productiveness of plants, the flowing of waters…but also by its daily revolutions furnishing heat, moisture, dryness, and cold in regular order and in correspondence with its positions relative to the zenith. The moon too…bestows her effluence most abundantly upon mundane things, for most of them, animate and inanimate, are sympathetic to her and change in company with her. Moreover, the

"Astrology and politics in the Renaissance" in Brendan Dooley (ed.) *Companion to Renaissance Astrology*, (Brill 2014)

[500] Lindberg, *The Beginnings of Western Science*, 274-280. See also, William R. Newman & Anthony Grafton (eds) *Secrets of Nature, Astrology and Alchemy in Early Modern Europe.* (The MIT Press, 2006), 1-37

> passages of the fixed stars and the planets through the sky often signify hot, windy, and snow conditions of the air, and mundane things are affected accordingly. [501]

We can glean some insight into attitudes towards astrological predictions from the literary landscapes of the authors, and one can understand the use of astrological readings when dealing with witchcraft. Hill's Renaissance garden was infused with danger, with malevolent and malicious forces bent on destruction, and where there were many 'evil and Garden monsters' from which the seed must be safely guarded. Steep your seeds for a night, he instructs, in a mixture of Hoosleeke (*Houseleek*) or Singreen (*Sempervivum tectorum*), that they may 'draw and drink in the substance of the herb' to keep them safe.[502] Soot was another property that would safeguard the seed against harm, and possible witchcraft, but in extreme cases of monster invasion Hill recommended:

> that those seeds may be preserved in safety from all evil and Garden monsters, if the bare head without flesh, of either Mare or the Asse (having been covered with the Male) be buried in the Garden, or that the middest of the same fixed on a stake set into the earth, be erected.[503]

Hill's gardening almanac was dictated by the phases of the moon, and the course of the planets. His final instructions were for the housewife as she sets out to collect and preserve the seeds from herbs and vegetables. From sowing to reaping, Hill describes his garden as a battleground. He was a man who created order out of potential chaos, enclosing his land with fencing to keep out the wild and unruly aspects

[501] Cited in Lindberg, *The Beginnings of Western Science*, 275-6
[502] Singreen *Sempervivum tectorum,* common name houseleek. Commonly grown on the roof of houses to protect from thunderstorms. Anglo-Saxon *singrëne,* modern English *singrim, sil-green.* Believed to protect generally against decay and against witchcraft.
[503] Hill, *The gardeners Labyrinth*, 34

of nature. He sought refuge and comfort in classical texts, soaking up their advice uncritically. There was, however, scepticism in certain quarters, with such debunkers as the Puritan William Fulke [1538-1589], who wrote: *'an inuective agaynst the vayne and vnprofitable predictions of the astrologians as Nostrodame…Hilli'*.[504] If the ground was prepared and the seed sown in moist conditions then, according to Fulke, there was no requirement for astrological readings.

Whereas Hill was an advocate of astrological reading, Googe proposed some caution on the reliability of readings:

> Besides that, although you sow in the encrease of the Moone, it sometime falleth out, that notwithstanding your seed be fat, full, make a white flower, and be nothing corrupted or hurt, yet some evil constellation (which the Gardiners doe call the course of the Heauens) doe hinder them that they profit not, nor yet thriue anie thing at all.[505]

Continuing his theme, Googe referred back to Theophrastus's revelation that seeds had their own 'certaine time', and that astrological readings might not only be incorrect but, could be injurious to the seed with 'some evil constellation'.[506]

Nevertheless, agricultural astrology is one of the oldest forms of astrology, and over time has been applied to animal and poultry husbandry, the felling of timber, and in sowing and harvesting of crops. Tavenner observes that Roman and Greek agrarian writers promoted planting by the cycles of the moon, and there is evidence of this planetary influence being absorbed into the literary landscapes of

[504] William Fulke, *Antiprogrnosticon contra inutiles astrologorum praedictiones Nostradame* (1560).
[505] Googe/Heresbach, *The Foure books of husbandrie*, 160
[506] Googe/Heresbach *The Foure books of husbandrie,* 161

Renaissance authors.[507] Plat was a proponent of the influence of the moon, and his views were latterly referred to in a printed pamphlet published by Hartlib in 1655.

Sowe English Annise-seeds, when the Moon is at the full, in February, or any time between the full and the change: if frosts will not suffer you to take the full Moon, harth them into the ground with a rake stricken thick upon them; then strew new horse-dung thinly uponthe ground, to defent the seeds from the frost – These will ripen about Bartholomev-tide; then respecting the Moon, as before, sowe again, and these seed will be ripe sooner than those which were sown in February. The seeds will also come up well, being self sown, onely break up the ground about them when they begin to ripen' and in a reference to Plat 'is taught in that excellent Book, called The Garden of Eden'.[508]

There were, however, problems associated with astrological readings, not least the management of exotics, where sowing was less reliant on astrology, and more so on artificial heat. As is discussed below, in an effort to replicate the generative force of the sun, artificial structures such as hot beds and hothouses were created, both described by Gerard and Parkinson. The influence of the moon, however, did not lend itself to artificial interpretation, and so remained a directive in the literary landscapes. It is possible, that some of the authors under discussion in this work, had access to a wide range of natural philosophy and scientific books, often held in the libraries of their patrons and employers. It may well be their views of astrology were reinforced by Renaissance academic, and scholarly writings, emanating from European communities. Whether or not such advice was adhered to is not possible to ascertain, but in a more prosaic attitude, and with an Aristotelian flavour, Surflet concluded: 'Seeds doe grow the better when they be

[507] Eugene Tavenner, "The Roman Farmer and the Moon" from *Transactions and Proceedings of the Americal Philological Association,* (Vol.49 1918), 67-82
[508] Samuel Hartlib, *The Reformed Commonwealth of Bees* Part 1 (1655), 11

sown vpon warme daies, or daies that are neither hot nor cold, than and if they be sown vpon hot, cold, or drie daies.'[509]

Elizabethan natural philosophers and polymaths had understood the different life cycles of plants, referring to them as as annual, biennial and perennial. However, one of the difficulties they experienced, when receiving unknown seeds (or plants) from overseas, was a lack of knowledge of the life cycle. Determining when seeds should be sown, when to expect flowers and fruits, and finally the timing of the production of seeds, was important information. Astrological signatures were not helpful in these circumstances, and it was during this period that horticulturalists began to create and structure a planting timetable.

Parkinson attempted to produce a planting calendar in his herbal, but the seeds and plants were so many, and so diverse, that the result was unsystematic and incomplete, relying on text rather than a chart.[510] Indeed the concept of a chart, or information displayed in tabular form, was still relatively underdeveloped. Even by the seventeenth-century, both the Royal Society and Académie Royale des Sciences, made great efforts to discover the 'laws of the weather' by displaying observations in tabular form. 'Positioned midway between text and image, the table was a device of synopsis, of "seeing together", which, it was hoped, would reveal subtle correlations between all manner of variables: the fluctuations of the barometer; the phases of the moon; the outbreaks of diseases; the advent of storms although the rhetoric was in terms of new-fangled 'laws of nature.'[511] The charts, however, were difficult to interpret and became a collection of data that in the end failed to fulfil the brief. A similar pattern can be observed in the horticultural world where text, as opposed to charts, was used to instruct when seeds

[509] Surflet/Estienne, *Maison Rustique,* The second book, 160
[510] Parkinson, *Paradisi*
[511] Daston, "Super-Vision: weather watching across space and through time at the early Royal Society and Académie Royale des Sciences". Conference: *Curiously Drawn: Early-modern Science as a Visual Pursuit,* (2012) Kohn Centre, Royal Society.

should be sown. The difficulty horticulturalists faced, was the diversity of species, and varieties, all of which had their own specific requirements.

Why astrology remained integrated into the literary landscapes for so long, may be explained by Allen, who described natural history as a 'network of practices and observations..passed on by one generation watching and copying another.' [512] Alternatively, Lindberg suggests that astrology fell from favour in the latter part of the seventeenth-century, although he suggests there is no clear evidence as to why this was the case. Equally, Allen notes that aspects of a shared research culture helped bind a community together, where investigative commitments, practices, equipment led to the conception of an investigative tradition.[513] The literary landscapes of the improvers, who were active from around the 1620s, provide some evidence as to why astrology became less popular. As they built their model seed, so their confidence grew in environmental management, and to support their suppositions they began experimental trials. The question was not so much why astrology, particularly advice of planting by the moon, remained integrated at some level in the literary landscapes, it was more do with evidence. *How* the moon influenced seeds and plants was a question of importance as Sharrock concluded:

> I prescribe nothing concerning the observation of the faces of the moone, because I much doubt of any effect therefrom. Neither doe Gardiners that work, nor Authors that write, prescribe alike rules; but contradict each other in their direction, for the particular observation of this Planet, as to any intended production. Nor is it agreeable to my reason, that the moones being in the full at the first explication of the two dissimilar leaves, or germination of the plant, should cause a double flower, this germination according to this present History, differing little

[512] David Allen, "Naturalists in Britain", *Journal of the Society for the Bibliography of Natural History* (8 1977), 93-4
[513] Allen, "Natural History and Visual Taste: Some Parallel Tendencies" in Allan Ellenius (ed) *The Natural Sciences and the Arts* (Upsala: Almqvist & Wiksell International 1985)

from other augmentations of the same plant..[514]

Attempting to predict the macro influences was just one of the many phenomena facing authors in their literary landscapes. 'Testing' the *intelligibility* of the seed, however, required micro investigation.

Setting trials

According to Drayton, botanical gardens were originally set up as sites of research, but to know all kinds of plants, let alone collect them in one place, became increasingly unrealistic. Botanical gardens were only available to a few, and Drayton considers that *Hortus siccus,* collections of dried botanical specimens, along with the printed book, began to displace the garden as the principal instrument of botanical research. The printed book, Drayton claims, could contain far more plants than contained in a European botanical garden.[515] Certainly, Gerard, added newly discovered plants to his *Herbal,* and Parkinson sought to catalogue all know world plants in his *Theatrum Botanicum*. However, as already noted in Chapter 1, the private gardens of natural philosophers in Elizabethan London were centres of research and collaboration. It is possible to visualize Parkinson studying his individual specimens, or Cook, in the 1650s walking the forest floor collecting and examining tree seeds. The treatises of the improvers were concerned with 'live' not dried samples.

Field crops

Thirsk argues that alternative agriculture was central to the rural economy, until the population began to rise again in around 1500. At this point demand on grain was greater than farmers were accustomed to producing, and food shortages began. As a result, Thirsk states there was a return to what she calls 'mainstream agriculture', as a measure to

[514] Sharrock, *The History of the Propagation and Improvement of Vegetables*, 24
[515] Drayton, *Nature's Government,* 20

increase the production of grain.[516] This was the period when William Cecil delivered his opinion that, 'whosoever doth not maintain the plough destroys this kingdom', and the period when Fitzherbert and Tusser penned their husbandry treatises, and Plat wrote his pamphlet *Sundrie new and Artificiall remedies against Famine*.[517] There continued to be poor harvests in the 1590s, and the first four decades of the seventeenth-century witnessed good and bad years, although, according to Thirsk, overall productivity increased, and wheat prices stabilized. What are less evidenced, are the underlying causes of increased productivity. Various explanations have been presented, from the advantages of enclosure, to the specialization of livestock and grain growing. Thirsk presents a summary of various factors, reaching the conclusion, that alternative agriculture offered a viable means of income generation, to economically ameliorate the volatile nature of grain markets. Within her economic arguments, Thirsk does observe that 'the renaissance of mainstream agriculture in sixteenth-century England was accompanied by a subsidiary renaissance in innovative horticulture, which was at first confined to kings, nobility, and gentry, and which remained subdued so long as bread production was the prime necessity.'[518] Horticulture, once the prevail of the elite in England, became the research centre for the study of the seed, and it can be argued, that one of the innovative changes in agriculture, along with enclosure and other arguments of improvement, was the transfer of knowledge from horticulture into husbandry.

Given the economic and political imperatives for maximizing productivity, authors and translators of husbandry manuals, sought explanations for loss of seeds at any stage. Googe in his translation of Heresbach noted:

[516] Thirsk, *Alternative Agriculture*
[517] William Cecil cited in Thirsk, *Alternative Agriculture*, 23
[518] Thirsk, *Alternative Agriculture*, 35

> ..that each corne that is found within the eare is not apt to grow, for God hath created some of them for the foode of liuing creatures, and some for seede corne. There be in euery eare certaine abortiue and bastardlie cornes, which will neuer fructifie, but become vtterly vnprofitable..[519]

Broadcasting, a method of walking the land, and casting seed across the soil, was the traditional method of sowing crops. Estimates on how much seed to use were variously based on the acreage (furlong) to be covered, or the quality of the soil. In fact estimates aside, the actual quantity of seed sown per broadcast was dependent on hand size and length of stride.

> Set thy lefte foote before, and take an handefull of pees: and whan though takeste vp the ryghte foote, than caste thy pees fro the all abrode, and whan thy lefte fote ryseth, take an other handeful, and whan the rught fote tyseth, than case them fro the. And so at euery ii paces, though shalte an handful of pees: and so se that the fote and the hande agree, and than ye shal sowe euen.[520]

Similar advice was to be found in Googe, 'you must sowe your Ridges with an equall hande and all alike in euery place, letting your foote (specially the right foote) & your hand go togeather…Wheate, Rye, Barly, Otes, and other, cheefely such as beare Coddes, as *Milium,* and *Panicum,* must be sowen with a ful hand, but Rape seede only with three fingers.'[521] Once broadcast, the soil was harrowed to lightly cover the seeds to protect them from birds and vermin. The amount of seed sown on any particular soil type was a topic covered in classical texts, and certainly Surflet's translation of Estienne's *Maison Rustique* refers to Xenophon's *Oeconomicon* recommendation that less seed should be

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[519] Googe/Heresbach, *The Foure books of husbandrie*
[520] Fitzherbert, *The boke of husbandrye*, 8-9
[521] Googe/Heresbach, *Foure books of husbandrie*, 24

sown on poor ground.[522] Alongside judging soil suitability, seeds were sown according to their size, with larger seeds spread fairly thickly by the handful and smaller seeds sown thinly. '..it must be sowed very thinne: for being a very small seede, it must not be sowed with the full hande as Wheate is, but onely with three fyngers:'[523] Fitzherbert advised 'to sowe all maner of corne thycke ynough, and specially beanes and barley for commonly they be sowen vpon ranke ground, and good grounde wylle haue the burthen of corne or of wede.'[524]

The method, by which they sought to achieve maximum results, was to set the sowing in terms of measurements.

> An acre of grounde, by the statute, that is to say. xvi. fote and a halfe, to the perche or pole, foure perches to an acre in bredth, and fortye perches to an acre in lengthe, may be metelye well sowen with two London busshelles of pease, the whyche is but two strykes in other places….And to plow a square forowe, the bredthe and the depenes all one, and to laye it close to his felow. For the more forowes, the more corne, for a generall rule of all maner of cornes.[525]

There was no means by which any of the above recommendations could be tested or trialled. The growing of food was not a luxury, one that could be observed and investigated, as the elite might observe, and investigate plants in their private gardens and collections. Nevertheless, trials were occurring and while it is perhaps expansive to consider these to be 'field' trials, Plat, in particular, was investigating the performance of agricultural seeds in relation to sowing practices. Quite simply he was considering the botanical requirements of seeds.

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[522] Surflet/Estienne, *Maison Rustique*
[523] Googe/Heresbach, *Foure books of husbandrie,* 30
[524] Fitzherbert, *The boke of husbandrye*, 10
[525] Fitzherbert, *The boke of husbandrye*, 8

'Our new kind of husbandry'[526]

Plat was well aware of the horticultural practice of dibbing holes and setting individual seeds, which he concluded led to healthier plants and better seed production. By the time *The New and Admirable Art of Setting Corne* was published in 1600, he had written about seed germination, plant propagation, soil preparation and manuring, all of which led him to believed one seed per hole was the most profitable measure for increasing yield. Plat formulated his theory on the basis of observation, and his experimentation in germination, leading him to conclude that alchemical fermentation caused the seed to swell. As the seed germinated so it first put out a root and a shot (stem). Each seed, he confirmed, should have sufficient space and access to warmth, water and air, to enable it to grow unfettered from overcrowding.

Dibbing involved making holes in the soil at finger depth, or with a dibbing tool or stick, or 'shaftman deep' (a measure of about six inches deep), and a seed or seeds then planted in each hole. As already noted, Plat was cognizant of famine, and conscious of crop failure, he sought to considered contributions 'put down by others' in explaining crop failure. He reached a conclusion, that a combination of the weather and planting depth was the main cause of loss and poor yields.

> 'what about the weather some attribute the same vnto the heauens, and the iniuries arising of heate, colde, and continuall showres of raine, that doe often happen; so as sometimes the grounds are benummed with frosts, and sometimes parched with heat, somtime they make a rich & fertile shew, and sometimes they wither and waxt barren;[527]

Plat was particularly interested in the example of winter sowings, which he claimed endured the 'injurous nature of cold'. When broadcasting,

[526] Plat, *The new and admirable Arte of setting of Corne,* (1600), image 4
[527] Plat, *The nevve and admirable arte of setting corne* (1600), image 9

the depth and width of the furrow was measured by the plough, with spacing of seeds measured by hands and feet. However, when it came to broadcasting, the trajectory of the seeds across the soil was random, and Plat stated there was no way of managing the different depths into which seeds fell. Landing on top of the clods of earth, large seeds were unable to draw the vegetative salt, or so deep in the furrows they lacked the heat required for germination. These seeds were destined to fail:

> 'naked and bare to all weather, or verie slenderly clothed with a poore and thinne garment, not able suffientlie to defende the inward and secret fire of nature, from such outward and piercing enemies.' [528]

Plat had observed the slip of the hand of 'some silly wench' who:

> hauing a fewe cornes of wheate, mixed with some other seed, and being carelesse of the worke shee had in hand, might nowe and then in steed of a Raddish or Carret seede, let fall a wheate corne into the ground, which after braunching it selfe into many eares, and yielding so great increase, gavest occasion of some farther trial.[529]

Applying this accidental outcome to his observations of winter sowings, he set forward an experimental planting plan, which he contrived to support his prediction, that individually sown seeds would produce greater yield. He briefly identified different types of soils, for example, clay, sand or stoney; but was more interested, in what he described, as the earths 'upper crust', which could be anything up to three foot deep. This was the sowing and growing medium for the seed, imbibed with the alchemical principles required for the seed to germinate, and for the plant to grow.

> Euerie ground hath naturallie an vpper crust of earth, whicht by the

[528] Plat, *The nevve and admirable arte of setting corne,* image 6
[529] Plat, *The nevve and admirable arte of setting corne*, image 2

> liuelie and viuifying heate of the Sunne, the comfortable nature of the Aire, together with the congelatiue part of the rain (for so M. *Bernard Palisie* termeth it, being the first Author of a sixth element) which often falleth vpon the ground.[530]

Turning the soil with a spade would, in Plat's view, keep the earth of the upper crust warm, aired and moist. In addition, the upper crust should be as fine a tilth as possible to enable the seeds to be sown with precision, each in its own hole at the correct depth. Plat reviewed the various methods for making holes, and while fingers were suitable for sowing a small number of seeds, he was after high yield, and for this he turned to the mechanical arts. He reviewed previous experiments, including a rake like instrument with pins that was pushed into the ground, but this produced too few holes. Another system involved a 3ftx3ft board drilled with holes the width of a man's finger, which was laid on the ground so a dibber could be pushed through the holes into the ground. He discounted this because the planting hole clogged with soil. Plat, theoretically revamped the planting plank by replacing the holes with pegs or spikes, which when pushed into the ground produced a consistent depth and width for each seed. In a cumbersome manner, the board was repeatedly lifted and lowered, to produce a line of holes into which a seed was placed.

> 'concerning the depth, you must haue an especiall care, that your seed may lie within the rich crust of the earth, and that his bed wherein he lyeth, may also bee of the same goodnesse... [531]

There is no evidence that Plat's sowing board was made or trialled but

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[530] Plat, *The nevve and admirable arte of setting corne,* image. Bernard Palissy (1510-1590) was a French Huguenot ceramicist. See Hanna Shell, "Casting Life, Recasting Experience: Bernard Palissy's Occupation between Maker and Nature", in *Configurations,* 12:1 (2004) by the Johns Hopkins Unitveristy Press and the Society for Literature and Science), 1-40

[531] Plat, *The nevve and admirable arte of setting corne*, image 6

he predicted that it would increase yield.

> I would not haue any man to thinke, that I doe heere set downe anie exact number of bushels, from which nature can at no time varie: for if the yeare, the heauens, and the ground it selfe, together with the fatall influence of the starres, doe all conspire together, the number of our bushels will fall short.[532]

Fussell does comment on Plat's sowing board, considering it to be a small contribution within the wider field of technological advancement that continued into the era of the improvers.[533] However, it does depend on how the historian views Plat's ideas, for in the context of this research, Plat was applying the 'science' of the seed to technology of sowing and planting project. As Akrich notes, machines and devices are, 'composite, heterogeneous' and 'part of a long chain of people, products, tools, machines.'[534]

Back to nature

The literary landscape of the horticultural world was filled with speculations, investigations, trials, claims and counterclaims. In scoping the environment, Surflet was able to present an ideal of the 'position (of a) countrie house situated where the Aire, Water, and Earth did all affoord their best and most desired fauours and qualities'[535] Air, water, earth, and heat (fire), were all to be harnessed for the benefit of humans and animals, but also for seeds and plants. Garden beds were positioned facing north to south to gain full benefit of light and warmth from the sun. Water, in this ideal environment, was clean, fresh and easily available. The horticultural landscape was divided into sections

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[532] Plat, *The nevve and admirable arte of setting corne,* image 9
[533] Fussell, *The Farmers Tools*
[534] Madeline Akrich, "The De-Scription of Technical Objects" in Bijker & Law, *Shaping Technology/Building Society: Studies in Sociotechnical Change* (Cambridge, Mass, MIT Press 1992), 205-224
[535] Surflet/Estienne, *Maison Rustique*, 30

including, flower gardens, vegetables and orchard, with each subdivision honed down from the macro to a more micro level. The landscape was further divided into discreet areas, including hotbeds and hothouses, nurseries, seed boxes and kitchen gardens. These areas formed the framework in which horticultural trials were undertaken, and where the horticulturalist observed the seed in close proximity.

Within these scoped and defined areas, planting the seeds required skill and knowledge. Observations on the emergence of the plant were in tune with Aristotelian cosmology, but, at this stage, Surflet understood that the seed '..hath two ends, that is far the Root, which hath altogether to doe with the Earth, and the Branches, or vpper-most part thereof, which hath altogether to doe with the Ayre and the Heauens..'[536] This led to a belief that seeds could be planted the wrong way up. Included in Heresbach *Husbandrie* were instructions on setting artichoke and chestnut seeds. 'Beware that you sette not the (artichoke) seede with the rong end vpward, for so shall your Artichoch prooue very little and euil fauoured'[537] and, plant your chestnut seed 'with the sharpe end vpward, and a foote a sunder: the furrowe must be a shaftman deepe.'[538] By imitating nature, the Renaissance propagator encouraged the plant to reach the masculine sphere of the cosmos, where it would be imbibed with *quintessence,* the constituent matter of the heavily bodies.

The improvers continued this theme, but with a strong emphasis on advancement, as they scrutinizing the external appearance of the seed determined how it might be sown. In his forest garden, Cook's careful observations led him to consider, 'the very Form and Shape of Seeds hath instructed me how to set them', and, 'how best to set them by their

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[536] Surflet/Estienne, The Second Booke of the *Countrie Farme*, 160
[537] Googe/Heresbach, *The Foure books of husbandrie*, 73
[538] Googe/Heresbach, *The Foure books of husbandrie*, 95

Form and Weight.'[539] Influenced by his observations of the seed as it was in nature, Cook considered which way up the seed should be planted. An acorn seed, he noted, landed in moss or 'mold' with its small end downward, so the shape determined which way up the seed should be planted. Peaches were planted with the crack uppermost, other seeds with the crack downwards in order to release any collected water to avoid any risk of rot to the seed coating. Cook also noted a small opening in the seed located in the 'small end' of large seeds like nuts and acorns and, like Plat, considered the root to be the first section of the plant to appear.

> For if you observe any Seed, of what Tree soever it be that grows in *England*, first it puts forth a Root at the small End, and when that Root hath laid hold of the Ground, then it puts forth the shot of the tree at the very same place where the Root came..[540]

While the way up a seed is planted may seem insignificant, in the wider scheme of horticulture it formed part of an accumulation of botanical knowledge. The growing requirements of seeds were being observed, investigated and *inscribed* in the horticultural landscapes.

Documenting the part of the seed from which the root emerged, reinforced the belief that the seed held within it an embryonic plant, but was also metaphorically associated with human settlements and the 'putting down [of] roots'. The fragility of the embryonic Puritan settlements in New England colonies, exploration and new discoveries, all contributed to 'thinking' botany. Observations of the germinating process of the seed also, led to a growing consensus that the root, as the first part of the plant to emerge, was also the most fragile. Sharrock noted that if the neb, the point at which the root emerged, was

[539] Cook, *The manner of raising, ordering, and improving forrest-trees*, 5
[540] Cook, *The manner of raising, ordering, and improving forrest-trees*, 5

destroyed in anyway through human, animal or insect action, the plant would not grow.

> 'Tis to be observed in all these great seeds, that though the pulse, or thick part of the grain perish, yet if the Neb and small leaves are entire, the seed may prosper; as I have seen Feild-beanes that have been eaten through with wormes, prove good thriveing seed. But tis reported, that Pismires (ants) have learned the wit to spoyl the seed from growing in their storehouses, by biting off the very Neb before they repose the grain.[541]

This formulated some scientific observations that the seed needed to be in close contact with the soil, so the root once emerged, would immediately be locked into the warmth and nourishment of 'Natures Womb'. From his forest seedbed Cook recorded:

> 'so that if the Acorn hath had a convenient quantity of heat and moisture (but if too much of either of these, then is deadly to all seeds) then the seed spears forth, and if it be not committed to the Ground before it be dryed, and the spear withered, then for certain that seed, Acorn, Nut, or Stone will never grow.'[542]

Protected culture

The whole process of sowing seeds was closely linked to Aristotelian elemental theory. Getting the correct balance of hot, cold, wet and dry was pivotal in meeting the botanical requirements of the seed. Observation of the seed itself, whether it was dry, moist, hot or cold, also determined when it should be sown. In a concerted effort to improve, investigations focused on *how* things worked, as authors recorded their trials. The search to solve practical problems was driven,

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[541] Sharrock, *The History of the Propagation and Improvement of Vegetables*, 37
[542] Cook, *The manner of raising, ordering, and improving forrest-trees*, 35

according to Glaken, by science, technology and the practical knowledge of plant propagation.[543]

As collections of exotic plants amassed in Renaissance Europe, so technological innovation in the form of hothouses, sought to replicate their natural environments. The earliest glasshouses can be traced back to the 1500s, with examples found across Europe and in England but, as noted by Welbaum, they were extremely expensive structures commissioned by wealthy collectors.[544] Beyond the economic reach of many horticulturalists, another recognized method for raising early seedlings and exotics was the creation of hotbeds, also called hotboxes, utilizing manure as a heating agent. Access to protected environments depended on the level of patronage afforded, and among the propagators in this research, Cook certainly wrote of a glasshouse on the estate of his employer the Earl of Essex. More generally, however, the horticultural environment was created without such technological innovations, and so every effort was made to give maximum protection for seeds and plants.

The kitchen garden

In reality, most vegetables were grown by women, and certainly not in 'kitchen gardens', generally the domain of head gardeners on private estates and gardens. Nevertheless, Parkinson set his instructions to his readers, while Markham was more prescriptive in his attention to the 'Country Housewifes Garden'.[545] After describing the tightly formed and artistic nature of the flower garden, Parkinson set his kitchen garden in a less formal manner, as the growing of vegetables meant it was 'subject

[543] Clarence Glacken, *Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth-Century* (University of California Press 1967), 313
[544] Gregory E Welbaum, *Vegetable Production and Practices* (CABI 2015), 90
[545] Gervase Markham, "Country housewife's garden" in *A way to get vvealth* (1652)

to mutation and alteration'[546]. As with other contemporaries, Parkinson advocated growing a mixture of vegetables on a plot of ground that, 'may serue euery mans particular vse as he shall haue occasion to employ it.' One of the reasons for dividing the plot was to enable access to keep the soil clear of weeds, as they reduced plants access to water. This was all part of plant management essential for healthy seed production, and, as noted by Markham, in 'these hearbes require more moysture: yet must you have your beds diuided, that you may goe betwixt to weede.'[547]

Heresbach's kitchen garden was divided into sections and planted with a combination of vegetable crops. Seeds were spaced according to the estimated size of the crop, and with sufficient space to enable the hot and wet elemental qualities of air to circulate around plants. Setting small seeds together minimized the risk of loss, and enabled the small plants to be transplanted and brought on. As described in *Husbandrie:*

> They vse to knitte vp a good deale of seede togeather in thinne lynnen clothes, and so to lay them in the grounde: but to make them greater headed, when it hath wel taken roote, they vse to plucke it vp by the blades, and rayse it so, that as it were hangyng and borne vp by the earth, it is forced to fyll the emptie place that lyes vnder it:[548]

The improvers and specialist growers were intent on developing their model seed. They recognised a blueprint which was immutable, but which was susceptible to manipulation. How far this blueprint could be manipulated was at the forefront of Bacon's investigative proposals, and the trials of the improvers set a botanical framework for their model. Sowing at the correct time was imperative. Seeds were vulnerable to

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[546] Parkinson, *Paradisi*, 462

[547] Markham & Lawson, "The English Huswife" Book III in *A Way To Get Wealthy Containing Six Principall Vocations, or Callings* (1668), 60

[548] Googe/Heresbach, *The Foure books of husbandrie* Book II, 60

cold and wet, and hot and dry, and when planted in elementally imbalanced circumstances, were liable to run to seed and became unsuitable for seed selection. But it was a balance of choices, and sometimes the risk was worth taking if it led to early cropping. 'Note that our Gardiners', wrote Sharrock, 'though there be some perill, chuse to sow early, because they have much advantage by all sorts of forward commodities; so Turnips sowed early, many run to seed, yet one good then is worth three at another season.'[549]

The nursery

The specialized care of certain plants is demonstrated by the construction of hotbeds and hot houses, but the introduction of seed nurseries into the horticultural literature, illustrates a growing understanding of seed cultivation. Fruit and timber were typically sown in specialized environments, in nursery beds and transplant beds, and Surflet provides an early description of a 'seed nurcie' for growing fruit. This was a controlled environment, where the soil was prepared for the specific needs of the seeds.

> you shall cause to be digged good and deepe, a great quarter in a good earth and cherishing mould: and that if it be possible a Winter before you sow them, to the end it may thereby become well seasoned, and you shall almost mixe amongst it halfe as much dung as the earth comes to that you turne vp, that so it may ripen and rot with the earth..[550]

There remained contradictions in the literary landscapes as Surflet, opposite to Plat, recommended placing three or four seeds into one hole.

> Stonie kernells ..without remouing of them to any other place, then sew

[549] Robert Sharrock, *The History of the Propagation and Improvement of Vegetables,* 13
[550] Surflet/Estienne, *Maison Rustique,* Third Booke of Covntrie Farm, 336

> in euerie hole, three, foure, or fiue stones: and if all of them spring vp and take root, yet you must let none but the fairest stand and continue graft vpon in the place, and as for the rest, they would be pulled vp and removed to some other place. [551]

Nurseries had a place in Renaissance horticulture, but, as with hothouses, tended to be attached to gardens of the elite. The improvers, more popularly referred to nurseries, as protected enclosures in less grandiose environments. Cook, in his management of the Early of Essex's estate, developed a large nursery with the intent of improving the quality of forest trees. Austen grew his fruit trees in his orchard with aim of producing fruit tree saplings destined for grafting and inoculation, as well as seed production.[552] The art of sowing was, according to Austen, bound in a balance of order between 'the Heavens and the Earth'. Each plant to be placed according to the 'nature of the Soyle and Climate; And (as they say) to marry and match together Heaven, and Earth.'

> it must be the skill, and diligence of the husbandman to place and set his Tree in such sort that the heavens may give their influence and warmth, for encrease and refreshing of them.[553]

Austen worked with large seeds, which he sowed in beds a yard broad, with about one foot spacing between each seed. The beds were levelled with a rake, and the seeds sown, each species separated into its own area, buried 'about a handful deep or less' and raked over. None of them, he instructed, should be left uncovered, and there the seeds would 'rest' through the winter. Both Austen and Cook were cognizant of biological inertia or dormancy of seeds, reckoning that both fruit and tree seeds were slow growers and long to germinate. The development

[551] Surflet/Estienne, *Maison Rustique,* Third Booke of Covntrie Farm, 337
[552] Inoculation in horticultural usage was to graft a bud (or eye) from one plant into another.
[553] Ralph Austen, *The Spirituall Use of an Orchard; or Garden of Frvit-Trees*, 14

of nurseries as protected environments was certainly influenced by the length of time forest and fruit seeds and saplings were required to be left undisturbed.

To avoid early germination and possible damage to the radicle, Cook recommended sowing fruit and timber seeds when they were dry. Each species in his book was given a short chapter outlining sowing instructions. Like Austen, Cook did sow some seeds before the winter months, but only if the seed had already begun to spear, in Aristotelian terms, had reached a 'wet' stage. He preferred to keep his oak seeds in a cool dry room, and through the winter months into January, when there was less chance they would spear early or spoil due to the cold and wet. At this point, he would prepare the soil and plant the seeds about 'an Inch and a half, or two Inches deep.' Delaying sowing was a risk management strategy on his part, as it avoided the seeds being 'spoyled by Mice or other Vermin' and adverse weather. Cook, treated elm seeds rather differently. Elms, he observed, held their seeds, in what he described as 'Hops' that began to fall in March. Imitating nature, this was the time he collected and dried the seeds before planting them within four or five days. In this case, he proposed sowing 'the seeds and their Vessels…let them be covered about half an Inch thick.' Having raised his seeds, Cook then transplanted them into a nursery for the stage of their growing pattern.[554]

Observation of the shape, size and weight of a seed, determined the specialist requirements for each species. Cook, set out sowing and plant care instructions for each of his trees in his desire for 'Raising and Improving'. The predicted size of the plant influenced the initial spacing between each seed. It was noted that plants in the wild could overcrowd

[554] Cook, *The manner of raising, ordering, and improving forrest-trees*

leading to weakened specimens, 'for a tree pent up cannot spread.'[555] Art would improve nature through the environmental management of each individual seed. Every plant should have access to the elements, and balancing these elements within a growing environment was the job of the improver, 'so our Worke is nothinge else but the Changinge of nature and the Conuersion of Elements.'[556] Depth and spacing of planting was based on the growth needs of individual species of seed, although, it was not unusual to plant several varieties of vegetables in one bed, a method used by commercial growers for producing fast maturing annual crops. Spacing between plants depended on the speed at which a crop grew, when it was harvested, the approximate size of the plant, and its longevity. Trees, for example, were started in a seedbed or nursery, and then transplanted as saplings. Along with the sensory pleasure Cook experienced from growing trees, his principle aim was to produce specimens of value for timber and seeds. For each tree, Cook provided explicit instructions on how to prepare the soil, and how deep to sow the seed usually about two inches. Spacing became more important when the saplings were transplanted into the nursery space where they were grown on.[557]

Seed box

Sowing small seeds required a different method as they were to be sown close to the surface.

> Now, as to the Seed you intend to sow, whether it be of Trees, Plants, or any sort of Grain, the smaller your Seed is make the ground the finer; the quicker your Seeds be of growth, and the more they run into stalks or leaves.[558]

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[555] Cook, *The manner of raising, ordering, and improving forrest-trees*, 47. Cook was referring to Bacon's *Natural History,* 113

[556] Hartlib Papers. No 24, Copy Treatise on a Secret of the Ancients [in Hand]. Undated 16/7/7B

[557] Cook, *The manner of raising, ordering, and improving forrest-trees*

[558] Cook, *The manner of raising, ordering, and improving forrest-trees*, 25

Both Sharrock and Gilbert offered planting advice for small seeds. 'Once the soil is firmed, and following sowing, they should be covered over 'the thickness of a man's Thumb, with fine sifted earth', wrote Sharrock.[559] Gilbert instructed the soil should be fine for the small seed such as the auricular as if buried too much all, 'seeds, paines and expectations could be easily lost.'[560] There is precision in Sharrock's instructions, as he uses thumbs and fingers to measure depth and spacing. Seeds could be sown in a variety of ways furrows, trenches, earthing up, harrowing, raking, or, setting single seed in a hole made with a stick. Whatever the method, the seed was to be covered by soil, to protect against winter cold. Different seeds required sowing at different depths, as some seeds had not the strength to push through too great a depth of soil. Peas, for example, could be grown in trenches spaced 'half a yard or lesse':

> …all seeds must be covered with the earth, which is done, either by sowing the ground…sowing under furrow is for such seeds as must endure the winter, the depth of the ground being part of their security against the winder cold: nor are all seeds of strength to shoot their germen through so much earth.[561]

Gilbert grew many of his seeds in growing boxes, a miniature version of a nursery. He wished to, 'now make Publick' the production of prized and varied specimens:

> About the first day of *September*, having boxes of eight or ten inches deep…fill them half full of fine sifted rich and light earth, rotted Cow dung and sandy earth….on which sift through a fine sieve willow earth, a finger and half or more thick…then having separated your seeds from

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[559] Sharrock, *The History of the Propagation and Improvement of Vegetables,* 16
[560] Gilbert, *Florist's vademecum and Gardener's Almanack*, 44
[561] Sharrock, *The History of the Propagation and Improvement of Vegetables*, 24

> their husks or combeds, with a Sieve that seeds will but just pass through you…sow your seeds…and set them out in such rain…for the rain will drive the seeds as far as necessary into the fine sifted light mould.[562]

During this period, there was increasing evidence that planting advice was designed to meet the growing requirements of individual species. At what point of the year a seed should be planted was still important. 'Some seeds are sowen at the breaking of the Frost, and the very beginning of Spring, and that upon a hot bed, for the greater security and speed of the Plant to be propagated.[563]

Reliance on the predictive features of astrology seem to have been less influential to the improvers, who were more concerned with managing weather conditions, and providing protective environments for seeds and plants. The botanical requirements of the model seed led to innovative and technologically creative environments, from Cook's impressive tree nursery, to Gilbert's seed boxes.

Mechanical Arts

Botanical observations made by authors in agricultural and horticulture literature had an impact on practice and innovation during the seventeenth-century. Various environmental methods throughout the sixteenth and seventeenth centuries had been promoted as ways of increasing yield, but none of them had proved consistently effective, nor was there general agreement on outcomes in the literature. Too many variables filtered into seventeenth-century literature for any real consensus on productivity. Theories on steeping as a means of improving yield met with mixed responses in the seventeenth-century while sowing on barren or poor land led to uncertainty as to whether to sow seeds thickly or thinly. However, an increase in the botanical

[562] Gilbert, *Florist's vademecum and Gardener's Almanack* (1683), 32
[563] Sharrock, *The History of the Propagation and Improvement of Vegetables*, 35

knowledge of the seed itself arising from the horticultural literature, coupled with a notion that one seed per sowing pocket led to increased yield caught the attention of the Hartlib circle.

In true Baconian style some members of the Hartlib circle concentrated on the mechanical arts. After quoting Bacon 'The Introduction of Noble Inventions seemeth to be the very chief of all humane actions, which former Ages sufficiently witnessed', Dymock set himself the task of resolving a problem originally identified by Plat. In what appeared to be a repeat of Plat's explanation for seed failure Dymock reiterated the concern that much of the seed was lost in planting either, because it was buried too deep or, covered too thinly. The cause, Dymock claimed was in the ploughing and sowing which he expressed in economic terms.

> It beeing experience true, that the husbandman for one bushell of grayne sowne, seldome reapeth five, although it bee as certainely knowne, that euert Eare of Corne, contayneth one with another about 16 or 20 single graynes, & that from one graine or seed of Corne, sometimes 21 or more Eares spring out.[564]

Dymock reviewed the use of different energies including springs, weights, wind, water, horses and man in his search for 'Perpetual Motion', but was 'guided in that search to tread another path'. He claimed the machine he invented would service many needs, one of which was the sowing of seeds. In his short treatise *An invention of engines of motion* published 1651 he does not describe his machine, although it is possible some form of it was trialled.[565] It was an ambitious instrument that claimed to plough, sow or set corn, harrow and dung but in Hartlib's *Ephemerides* appears to have received mixed reviews.

[564] Hartlib Papers, Number 35 62/50/17A-18B Copy in Petty's hand, Cressy Dymock's Husbandry Design. Undated
[565] Cressy Dymock, *An invention of engines of motion* (1651)

Dymock's machine stated one reviewer did 'plough well, and drop the seed indifferently well'.[566] However, this was not a view held by others:

> The saving of Time by Mr Dymock's Instrument and new way of Husbandry will be worth some millions a year to the Nation because that time may be allotted to the prosecution of other Imploiments.[567]

Gabriel Plattes was also interested in considering the role of the 'Engin' or 'Device' for the sowing of corn. In *Certaine new inventions and profitable experiments necessary to be known to farmers, and others* published in 1640 his particular concern related to the consequences of dearth when the price of corn seed was high.[568] The balance between consumption of seeds or sowing them in times of dearth was one Plattes hoped to address. Recognising the need to be conservative in times of high cost and low productivity he claimed his machine was both efficient and cost effective. However, there is no evidence it was ever built or trialled. The principles, however, were set out:

> 'Whereas many men in this land have found by good experience that Wheat, Beanes, Peason, and other corne and seeds of divers sorts, being set at convenient depth and distance, do yeeld a wonderfull great encrease and benefit, more then by being sowen the common way (broadcasting).[569]

Worlidge provided an overview of Plat's sowing board and his claim of increased yield. Based on one seed per sowing pocket, and seeds sown at a three inch distance and three inches depth, Worlidge commented on Plat's assertion that, 'thirty Quarters of Wheat on an Acre of Ground',

566 Hartlib Papers. 64/17/1A. A Relation of Mr Dymocks New Inventions of Husbandry given to Mr Hartlib from Wadworth neare Doncaster the 22 of March 1653
567 Hartlib Papers. 28/2/37A. No 4 Ephemerides 1652 Part 2 Hartlib 1652 (7 Oct - 31 Dec)
568 Gabriel Plattes, *Certain new inventions and profitable experiments,* (1640)
569 Hartlib Papers, Platte, Pamphlet *Certaine new inventions and profitable experiments*

would yielded 'but twenty Quarters'. Sceptical of this claim, Worlidge noted that environmental factors such as the weather, or land quality, played a significant part in productivity and yield. The second factor that played on Worlidge's mind was the Puritan drive to find employment opportunities on the land for the labouring poor, women and children.[570] Plat's wooden sowing board precluded their involvement because the weight and manoeuvrability of the structure required the strength of a man.

Worlidge then turned his attention to Plattes method of setting corn, and his two inventions, and it is within Worlidge's literature we find a clearer description of Platte's engines. One was similar to Plat's earlier sowing board, but had iron pins rather than wooden ones and was, according to Worlidge, a 'troublesome' product, but one he felt had potential if trialled by 'Skilfull men'. The second of Platte's engines was intended 'for the poorer sort' and the capacity of 'every ordinary workman', although the suggestion was it would require four workmen because the engine came in two parts. In concluding his review, Worlidge considered only men 'not Children nor Women' could manage the engines, and in addition they would require too many setters for what he described as tedious work. There were, in addition, design faults one of which concerned the general robustness of the engine to cope with a variety of different soils, clay being one of the most difficult to plough. Worlidge presented his own version of a sowing machine, which would 'disperse your Corn, Grain or Pulse…at what distance, and in what proportion you please to design.' One horse and one man manoeuvred the machine, but importantly for Worlidge the machine delivered the seed equally thereby removing human error. Having set the machine to

[570] John Worlidge, *Systema agriculturae*. Picking of grains was seen as suitable employment for children. Hartlib *Ephemerides* 1648 31/22/23B. The poor should grow 'flax and hemp'. Hartlib papers 62/12/1A-4B. The calling of 'work for the poor' see Mcrae, *God Speed the Plough*, 155-6 & 167-8.

sow at the desired space and depth, the ‘instrument will always keep the same proportion you first set it to.’ [571]

In their designs and inventions these agricultural improvers grappled with the economies of improving yield. Their literary landscape was not the enclosed protected environment o9f a garden, but rather the expanse of the field. They had some understanding of the botanical requirements of the seed and began to experiment planting seeds at specific depths and spacing. They took and developed the technical plans of Plat, and with contemporary botanical knowledge, set out to secure technological innovation that would, not only meet the environmental needs of the seed and lead to an increased yield, but important in the agenda of improvement, could provide employment for the poor. They endeavoured to secure efficiency through technological innovation but were unable to produce on paper a design that was suitable for the cheap labour offered by the labouring poor. The weight of the wooden structure still required animal or human energy to manoeuvre it and a ‘skilfull man’. However, these early attempts fully materialized in the innovation of Jethro Tull (1674-1741) recognised as having perfected a horse-drawn seed drill in 1701 that economically sowed each seed in situ, in rows, and at the correct depth.

[571] John Worlidge, *A Compleat System of Husbandry and Gardening: Or, the Gentleman’s Companion* (1716), 84

PART III

Trading Nature

Chapter 11

Nature's Nurseryman

Leonard Meager's 1643 description of Captain Leonard Gurle as 'a very Eminent and Ingenious Nursery-man'[572] provides us with an example of the concept of a nurseryman as it begins to appear in the literary landscapes of the improvers. In the same way as authors of horticultural treatises invented themselves (see Chapter 3), so too 'nurseryman' was a description used to identify an individual who was reliable and authentic, with special knowledge and skills. More than a gardener, the nurseryman used his nursery to propagated plants for trade. This chapter will argue that nurserymen were key contributors to seed improvement, and held within their 'art', knowledge of the science and botany of seeds and plants, that was crucial in the quest for the model seed. To understand seed production, they had to understand the continual cycle of production and reproduction of a diverse selection of plants. They had to understand the complete lifecycle of a plant, from seed to seed. Previous chapters have discussed the science of the seed as knowledge developed over time. It was this accumulation of knowledge that led to specialization and the advent of the nurseryman.

The historiography of seeds and seed production in the early modern period is slim, with the main contributors Ronald Webber, John Harvey and more recently Malcolm Thick.[573] For the purposes of this discussion, the historiography will be divided into three main strands, market

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[572] Leonard Meager, *The English Gardener* 1670
[573] Ronald Webber, *The Early Horticulturalists* (David & Charles 1968), John Harvey, *Early Nurserymen*, (Phillimore 1974) and Malcolm Thick, *Garden seeds in England before the late eighteen century: I. Seed growing.*

gardens, seedsmen, and finally, nurseries and nurserymen. Before reviewing this historiography, it is important to define a number of terms commonly used. This thesis has generally used the word horticultural and horticulturalist to describe persons and activities. Derived from the Latin *hortus*, (a garden), horticulture is, the 'art of garden cultivation', with the horticulturalist a gardener. Webber describes horticulturalist as involved in the cultivation of orchards, flowers, fruit, vegetables and ornamental plants, and the horticulturalists knowledge of the 'science and art of cultivating plants'. The most common descriptor used in the literary landscape of the horticulturalists in the period under discussion was gardener. As discussed in Chapter 9, the 'nursery', was a specialized space for the propagation and management of juvenile plants, and 'nursary wares' the produce. What has also been discussed is the construct of the nursery as a space of scientific investigation. But can we take the science of the literary landscapes and place it within the commercial landscapes of the horticultural world of the early modern period? In other words, is it possible to demonstrate the impact of scientific thought on human activity?

The word gardener took on different meanings in the period. The garden of Thomas Hill's project was an ideal for the commonwealth and the gardener the initiator; market gardens were the province of gardeners with specialist knowledge in the production of cash crops, and the nursery became the province of the nurseryman. [574] All would be involved to a greater or lesser degree in seed production, but the construct of the nurseryman was invested with scientific knowledge of the seed. It was the nurseryman who, in Paracelsian terms, would 'add value' to the seed through a programme of improvement. It needs to be noted that the division in horticultural activities between the

[574] Thomas Hill, *The Profitable Arte of Gardening* (1563).

commercial ventures under discussion is not as clear as it might seem. So for example, seed merchants might also be involved in seed production. According to Thick, the Sandwich community was involved in producing new varieties of vegetables, and there is evidence to suggest they sold these in London.[575] Ultimately, however, each venture had a main speciality either procuring seeds, growing cash crops from seed, or raising specimen plants and seed production.

At this point it is worth providing some background, by tracing what little evidence there is regarding seed production from the medieval period. Harvey identifies some evidence of early trading of seeds in estate and monastic account rolls. Fussell considers that from the fifteenth century, households were producing more products for market than for household consumption. He argues that as early as the thirteenth century there were developments in large-scale production of agricultural goods. While it is likely that horticultural produce was sold or traded at markets, it is unlikely there were sufficient garden seeds produced on household plots to release any quantity for sale. Access to good quality seed was notoriously unreliable, as lamented by Parkinson, and much of it during the Renaissance period was imported. Other seeds were acquired from itinerant travellers, at fairs and local markets, and cheaply from seedsmen in London.[576] What is clear is that national reliance on household or small-scale seed production was unsustainable, and by the 1600s large numbers of seeds were imported from Netherlands, Germany, France and Spain and sold by London seedsmen. Certainly our authors lamented the need to import seeds, and this may well have motivated their scientific efforts to increase a plant's potential to produce quantities of good quality seeds. The significance in this quest is rather than sowing more and more plants to increase the

[575] Thick, Garden seeds I and II, 109
[576] Thirsk, *The Rural Economy of England* (Hambledon Press 1984), 200

quantity of seeds, all of which require sustained environmental management, they sought to increase the quantity of seeds per plant.[577]

Market gardens

Thirsk concludes the principle role of market gardening was in helping to feed the population of England and Wales between 1640 and 1750, but she also considers market gardens were often the proving grounds for crops new to both field and gardens.[578] Thick and Webber, argue techniques for growing seeds, for cash crops, were known to the Dutch immigrants who settled in Sandwich in the middle of the sixteenth-century. They also produced 'local strains of beans, peas, radish, and carrot, some of which were sent to London as seeds along with other garden seeds.'[579] Certainly the Sandwich horticulturalists were well recognised for their vegetable production, referred to by Hartlib as, 'some old men in Surrey' who grew 'Cabages, Colleflowers, and to sow Turneps, Carrets, and Parsnips, to sow Raith, Pease, Rape, all of which at that time were relative rarities, we having few, or none in England, but what came from Holyland, and Flanders.'[580] Market gardens in the South and East of England sold most of their produce in markets in London, while in the provincial areas, small enterprises were evident. It is probable that Richard Gardiner ran a small market garden and in his 1599 treatise describes the ways and means to collect and store vegetable seeds.[581]

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[577] See Chapter 9 of this thesis on plant fertility

[578] Thirsk Chapters from the Agrarians History of England and Wales: Vol. 3. See also. See also Rosemary Weistein, "Feeding the city: London's market gardens in the early modern period" in Mireilla Galinou *London's Pride The Glorious History of the Capital's Gardens* (Anaya 1990), 80-99; Rebecca W. Bushnell, *Green Desire: Imagining Early Modern English Gardens,* (Cornell University Press 2003)

[579] Thick, *The Neat House Gardens. Early Market Gardening Around London.* Prospect Books (1998). *Also Garden seeds in England before the late eighteenth-century 1: Seed growing.*

[580] Hartlib, *His Legacy* (1651) 8-9

[581] Richard Gardiner*, Profitable Instrvctions for the Manuring, Sowing and Planting of Kitchen Gardens.*

Generally associated with Dutch and Flemish influence, the art of a 'garden for profit' had spread by the 1600s.[582] Fitted into the network of common-field land, enterprises were set up in Chelsea, Fulham and Kensington, and in coastal towns in Kent, Essex and Suffolk. In 1615, alarmed by competition the Gardeners Company petitioned the Lord Mayor of London, 'to restrain any forreyners to bringe into the cittie anie such commodities as they sell, for the fundamental laws of this land give to all men whatsoever, libertie soe to doe in regard that they bring victual wholesome and according to the laws.'[583] Everitt estimates by the 1650s market gardens comprised a labour force of around 1,500 persons with 24,000 loads of roots sold annually in London and Westminster.[584] In the 1660s Sharrock recommended growing vegetables as like 'London Gardiners' while in 1675, Worlidge also recorded growing practices employed by 'Gardiners near London'.[585] Market gardeners sourced many of their seeds from Europe, but there is some evidence to suggest they traded seeds from their own collections. Their principle role during this period, however, was the commercial production and trading of cash crops.[586]

Seedsmen

In terms of the commercial trade in seeds there were a number of outlets. Although there is currently very little research available on the trade in vegetable or garden seeds in the sixteenth-century, Webber finds some evidence of activity in the 1590s located mainly in London,

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[582] Alan Everitt, "The marketing of agricultural produce, 1500-1640" in John Chartres, (ed) *Agricultural Markets and Trade 1500-1750* (University of Leeds, Vol.4 1990) in Joan Thirsk (ed) *Chapters from the Agrarian History of England and Wales 1500-1750.* See also Thick, *Garden seeds in England before the late eighteen-century:* I and II, and Webber *The Early Horticulturalists.*

[583] Carolyn Steel, "Feeding the Great Wen, Alimental Portraits of Eighteenth-Century London", in Christian Emden, Catherin Keen, David R. Midgley (eds) *Imagining the City. The Politics of Urban Space,* (Peter Lang, Vol 2, 2006), 155

[584] Everitt, "The marketing of agricultural produce, 1500-1640

[585] Sharrock, *The History of the Propagation and Improvement of Vegetables*, 15

[586] For discussion of growing vegetables on estates and the role of tenant growers see Ch. 2 of this thesis.

from where garden seeds were sold throughout England. Certainly the range of plants in Tusser's landscape was more than one small estate could produce, suggesting access to commercial outlets. Mr Child's small shop in Pudding Lane in 1560, states Webber, was intent on 'providing clean, true-to-type seeds of wide range of varieties'.[587] No seed packets or instructions have survived, although according to Thick, when selling the 'new' fodder seeds, such as clovers, Lucerne and St. Foine, seedsmen often put a 'paper of instruction' in the bags of seeds which told the customers briefly how to cultivate the seeds.[588] Seedsmen's lists, according to Thick, confirm seed production in Sandwich from the 1660s. The earliest seed firms grew out of other occupations for example grocers and basket makers, and initially seed sales were a by-product. Seedsmen were usually merchants, centralizing supplies bought from individual raisers at home and abroad. In smaller country towns, however, the main business of seed production was to be carried out by the local nurseryman in his nursery. In the literary landscapes of authors under discussion, vegetables were as important as timber, fruit and flowers, providing additional food for the household and to sell in the local markets. One way to advertise seeds was through publications as discussed below. As a result of his interest in husbandry, Hartlib used his treatise to advertise agricultural seeds.

[587] Webber, *The Early Horticulturalists*, 55

[588] Thick, *Garden seeds in England before the late eighteen-century:* I and II. I am also grateful to Dr. Thick for email communication regarding this topic.

Annotations upon the Legacy. 259

The Description of the Hop Clover, *or* Trefoil, *in English* Three Leaved Grasse.

THis *Three Leaved Grasse* will grow half a yard in length or more, and at every two Inches, it hath a knot with Leaves and a Bunch of Seed, which is black, almost like Onion Seed; both the Grasse and the Hay made thereof, is finer and sweeter then the great *Clover*. It will grow in any Ground, and being once planted, it will shed so much Seed, that it need never be planted again. It may be sowen with Corn, or without, as they do the great *Clover*; or being sprinkled in Meadows, it will exceedingly mend

L l 2 the

Annotations upon the Legacy.

the Hay, both in burthen and goodnesse.

Such as are desirous to buy any of this Three Leaved Grasse, *or* Lucern, Spurry, Clover-grasse *and* Sinkfoile *Seeds, what quantity they please may have them at* Thomas Brown's *Shop at the* Red Lyon *in* Soper-lane, *where they may likewise see some of the Hay made of this* three Leaved Grasse.

Figure 14. Samuel Hartlib *His Legacie.* [589]

The Nurseryman

Nurserymen were collectors and propagators of specimen plants. Three subjects of this research who were nurserymen were Moses Cook, Ralph

[589] Hartlib, *His Legacy*, 259

Austen and Samuel Gilbert. Their literary landscapes, pictorially and textually, mirrored the botanical gardens of the Renaissance period, and the cabinets of curiosity of collectors. 'Their knowledge of gardening was such that they frequently wrote books on the subject and were the best botanists and plant breeders of their day…and many had been head gardeners in private service earlier in their careers.'[590]

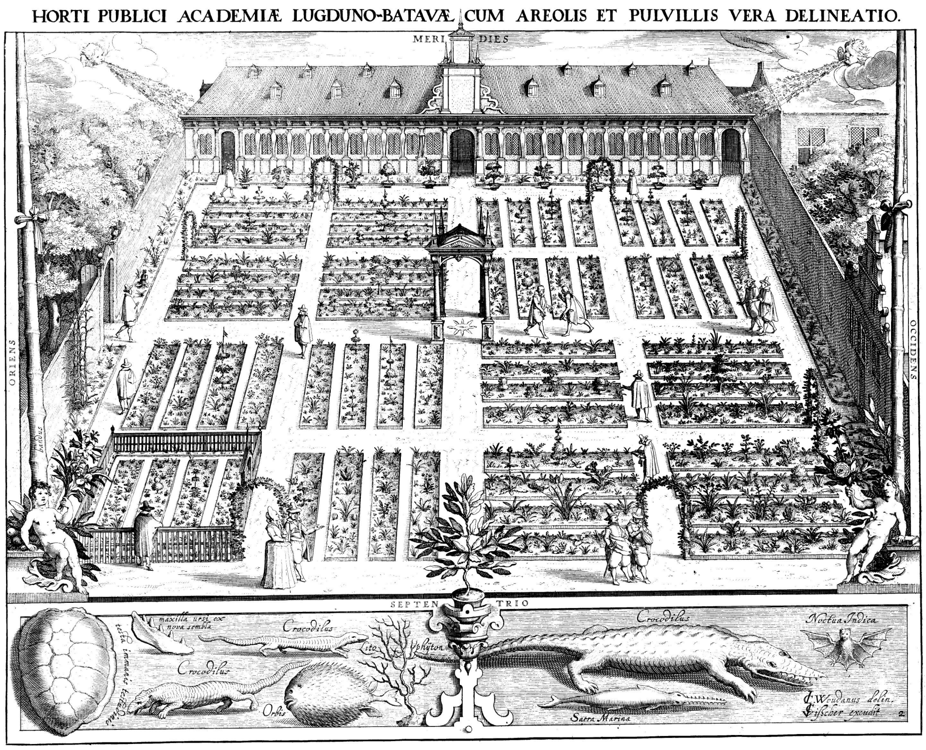

Figure 15. Botanical garden in Lieden[591]

In 1682 Grew wrote of being 'Furnished with a 'good stock of *Seeds*, in order to raise a *nursery* of *Plants*'.[592] There are two elements in Grew's testament, seeds and nursery, the two combining to create the nurseryman. A current dictionary meaning of nursery describes it as a place where young trees or other plants are raised for transplanting, for sale, or for experimental study. At a commercial level the nurseryman

[590] Malcolm Thick, *The Neat House Gardens*, *Early Market Gardening Around London.* (Prospect Books 1998), 59
[591] Botanical Garden in Leiden is the oldest botanical garden in the Netherlands. Taken from Hortus Botanicus Leiden website.
[592] Nehemiah Grew, *The Anatomy of Plants* (The Preface, page unnumbered)

dealt with the propagating and raising of living plants, and within this, according to Harvey, there were further specialisms. Fruitist or orchardmen, raised varieties of fruit trees and forest trees, and florists raised new varieties of flowers. Plants were propagated vegetatively or from seed, and grown on in a nursery until they reached a usable size. The large estates and London houses of Elizabeth courtiers, and ministers like Cecil, had nurseries where their head gardeners raised seeds and stock. Chapter 9 discussed the different types of nursery environments presented in the literary landscape of authors, from large-scale production of timber, to small nursery seed boxes. Gardeners on the estates required diversity and good quality, and were multi-skilled. Tradescant was a plant-hunter for Cecil, and a gardener and nurseryman, working his own, and the Kings' nursery. Nurseries were expensive to set up and manage, and it was not until around 1640s that independent nurseries began to be formed. Most of them specialized in trees (fruit and timber), flowers, and increasingly ornamentals, but all of them had the task of producing sound plants. Poor germination or the deaths of plants and trees would see a stagnation of trade.

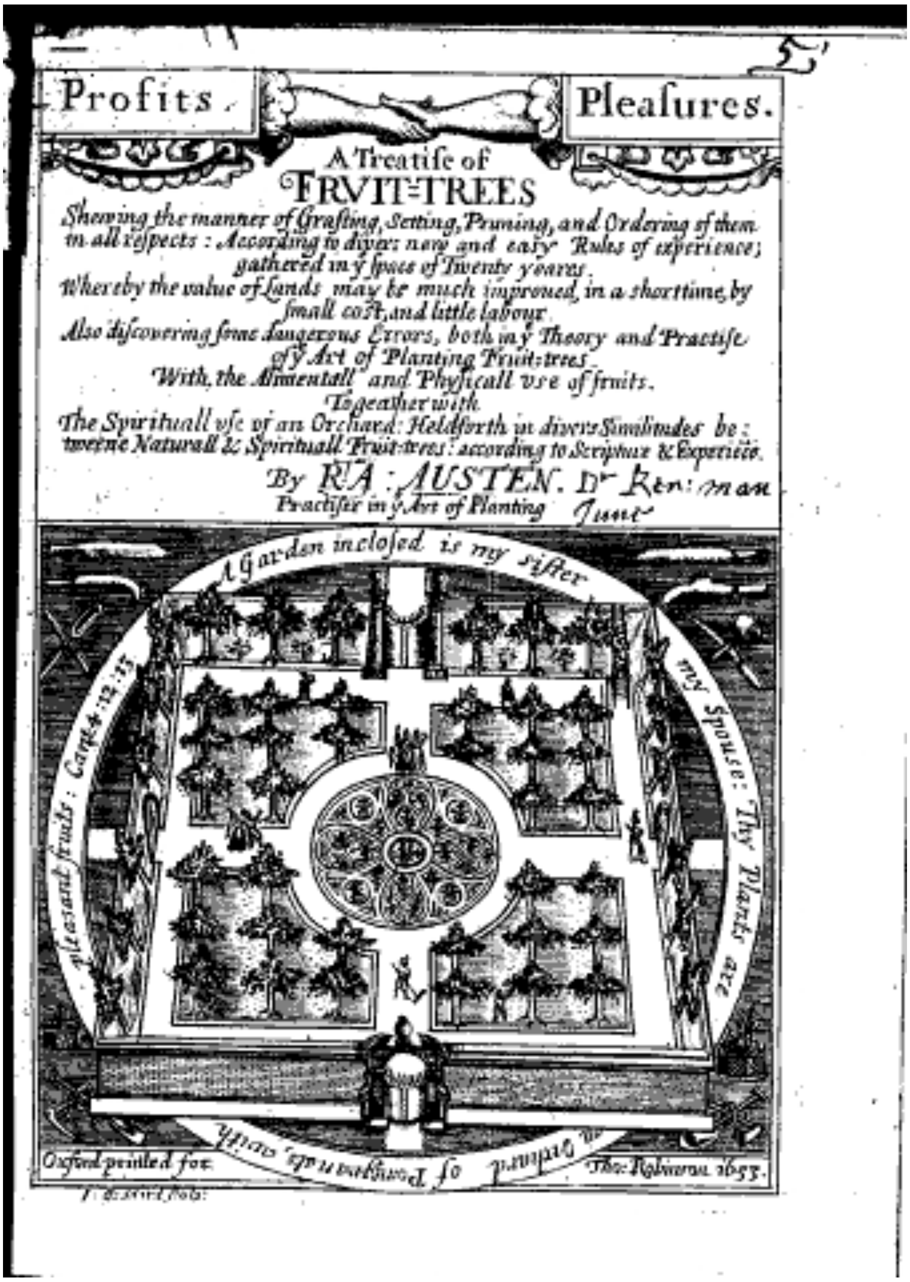

Figure 16. The engraved frontispiece of Ralph Austen: A Treatise of Fruit-Trees 1653

Harvey finds very few provincial nurseries existed before 1700, and dates nurseries with large stock to Leonard Gurle's nursery in Whitechapel in the 1640s, and John Rose London nursery in the 1660s. He considers many of the early nurserymen were 'gentlemen' in that they belonged to families of the lesser country gentry. Harvey traces nurserymen through families and although he mentions Moses Cook, it is a passing reference to him selling his shares in the Brompton Nursery.[593] However, prior to his partnership in the Brompton enterprise, Cook had managed an extensive nursery on the private estate of his employer the Earl of Capell. It is from this experience that we have his treatise, providing us with evidence that supports Thick's contention, that these early nurserymen had considerable scientific knowledge of botany and plant breeding.[594] Two other nurserymen not included in Harvey's overview are florist Samuel Gilbert, and Ralph Austen, fruit and timber grower. Very little research has been undertaken on Cook or Austen, and both seem to have been historically overshadowed by John Evelyn's *Sylva* and *Pomona*. They were, however, two important individuals in the improvement agenda of the Puritan's, and what we learn from their literary landscapes, is they were both self-education, well read and knowledgeable in their trade. They were versed in theology, the classics, philosophy, science, and in Cook's case mathematics. In all probability Cook had access to his employers extensive library, and Austen educated himself in the Bodleian library at Oxford University. They were also both involved in setting up and managing nurseries. It is to Ralph Austen that we now turn.

The Orchard doth with fruit the poore supply,
With which he doth the wealthie gratify[595]

So wrote Austen in his treatise, which, he dedicated to Samuel Hartlib. It is within the literary landscape of his orchard, we find more of Austen, the nurseryman, attending to the business of improvement. He believed there should be a '*general plantation of Fruit-trees*, not only in *Orchards*, and *Gardens*, but also in some *Fields,* and *Hedges*', with all manner of timber and fruit trees. The fruits of this planting regime would mean timber for fuel and fruit for sustenance, an ideology that chimed with

[593] John Harvey, *Early Nurserymen*
[594] Thick, *The Neat House Gardens*
[595] Ralph Austen, *A treatise of fruit-trees*

the Puritan improvement programme. But, aside from his moral and religious stance, (or perhaps because of), Austen was a businessman, but one, who, according to Turner, failed to access capital investment.[596] Within his literary landscape, however, the nursery flourished, as Austen sought his model seed, a seed that would produce a plant of great pleasure and profit.

> I shall first speak of a *Nursery of young Plants,* and shew the manner of sowing of *Kernells,* or *Seeds of Fruits…*for transplanting into *orchards, Gardens*, or *Fields*…preparing the seed bed…turn the seeds in with a spade…cover with small mould..Plants from these seeds placed in *Nursery* for one year, and then used for grafting.. Thus men may in a few yeares prepare multitudes of *Young Trees* for themselves and others, to give or sel as they please.[597]

Austen's was a commercial venture and in his literary landscape he talks about choosing the right kind of stock for propagating specimen plants, and is very selective on the varieties of apples, pears, plums and tender fruits like nectarines. He does not suggest collecting seeds from indigenous plants, as for him, the wild and untamed, represented those not with God. The planting of fruit and timber trees in hedges offered employment for the poor.

> Likewise might be the chiefe way (among others) for imploying and setting worke, very many Poore People…whereby they might maintaine themselves, and profit others, in stead of burthening them….Secondly, Positive advantages; Meat, Drinke, Clothing, Riches, and Profits, to themselves and others.[598]

[596] James Turner, "Ralph Austen, an Oxford Horticulturist of the Seventeenth-Century" in *Garden History*, (Vol.6, No.2 Summer 1978), 39-45
[597] Austen, *A treatise of fruit-trees*, 40-42
[598] Austen, *A treatise of fruit-trees, The Epistle* to Hartlib

Austen's was a pure collection of seeds and plants, raised for the profit and pleasure of the commonwealth. Contained within the walls of his nursery, his model seed was ordered and controlled by the hand of man.[599]

Writing in 1722 nurseryman Thomas Fairchild warned of pretenders who 'call at Houses', and the selling of stock in markets:

> for most of those People who sell the Trees and Plants in *Stocks* and other Markets, are Fruiterers, who understand no more of Gardening than a Gardener does the making up the Compound Medicines of an Apothecary….but when such Plants are bought at the Gardens where they were raised, there can be no Deceit, without the Gardener who sold them loses his Character.[600]

As the improvement of seeds and plants advanced, the landscape of the nursery took on a different perspective. By the 1650s nurseries, like museums of the Renaissance period, were spaces where collections could be viewed, and the artefact verified. No longer a closed, bordered environment, the nursery was now opened commercially, becoming a public space. Each specimen plant had a provenance, the origin of which was the model seed. Not only did nurseries sell the plants, they also sold the seeds, producing lists to promote sales. The ephemeral nature of these lists means virtually none have survived,[601] so we need to look elsewhere to see how collections of seeds were being presented to the public. Collections of plants were catalogued in the Renaissance period in herbals, floras and private catalogues. Seeds did not feature significantly in this style of cataloguing, unless they were noted for medicinal purposes. Seeds were exchanged between neighbours,

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[599] Austen corresponded with Hartlib, and with fellow nurseryman John Beale, who published *Herefordshire Orchards, a Pattern for All England* in 1657. John Beale's father and grandfather had been experts on orchards and cider.

[600] Thomas Fairchild, *The City Gardener* (1722), 68

[601] Harvey has traced some early catalogues see *Early Nurserymen*

contemporaries and across borders and occasionally reference was made to the species of seed. Sales of seeds appear to have been a by-product of other occupations, suggesting there was little profit in the sale of seeds per se.

What this research concludes is the scientific construct of a model seed, led to greater confidence in the management of that seed, and an ultimate scientific belief that it would come true. The evidence of this might have been demonstrated by printed catalogues or inventories, but as already mentioned, there is insufficient evidence. However, the transfer of knowledge between seed and man can be found in other sources, for example, in the treatises of the period, and in a rare example of a private list. In the same way as private collectors in the Renaissance period catalogued their plants, so in his journals, John Locke (1632-1704) listed seeds he had exchanged or received. Locke was connected, through seeds, with French botanist Pierre Magnol (1638-1715) of Montpelier, and Jacob Bobart the Younger, (1640-1719), Keeper of the Oxford Botanical Gardens. This small, loose knit group, was, according to Harris & Anstey, collecting and exchanging seeds and plants, offering an interesting account of private seed collecting.[602] Lock clearly had difficulty ensuring that the seeds he was procuring and exchanging were of the chosen species or variety. Provenance seemed to be a problem, but, nevertheless, Locke provides an example of private exchanges of seeds, and furthermore he lists them.

Another method by which seeds were listed, and their provenance advertised, was through the treatises of the improvers. Cook listed many trees that could be propagated by seed, including chestnut, oak, elm,

[602] Stephen A. Harris & Peter R. Anstey, "John Locke's seed lists: a case study in botanical exchange" in *Studies in History and Philosophy of Biological and Biomedical Sciences* (40:2009), 256-264

sallow, poplar, sycamore, ash and holly.[603] Austen's sales improved following the publication of his treatise. Not only did he provide specific instruction on sowing and growing, but also listed best species and varieties he propagated from seed.

> For the 'Eare, Touch, smell, Sights, Tast, and through the Affections of the mind, Hope, Joy, Admiration….Winter Peremaine, Pippin Apple, Harvey Apple, the Queene Apple. Winsor Peare, Burgamet, Catherine Peare, Greenefield Peare..(a greater bearer) Flanders Cherry, May Cherry, Black Hart Cherry, Musle Plum, Premorden Plum (a very great bearing tree), Aprecock and Nutmeg Peach.'[604]

These treatises produced by nurserymen of the period, provided the readership with the science of the seed, the botany of the plants, and finally examples of the specimen it would become. These early nurserymen set the foundations of what has developed into a specialist profession, the nurseryman, and his seeds.

[603] Cook, *The manner of raising, ordering, and improving forrest-trees*
[604] Austen, *A treatise of fruit-trees,* 54

CONCLUSION

To what extent has the seed revealed its secrets, and to what extent have the aims of this study been achieved? The selected horticultural and husbandry publications were read as scientific treatises, and the research concluded that scientific investigation was vibrant within this group of authors, most of whom had no connection with any scientific or scholarly institution. The introduction raised a series of questions, and this chapter will consider whether or not these questions have been answered.

The Social

What kinds of people were involved and how did they describe themselves?

Authors were selected as representatives of scientific investigations that were themed in many of the publications. The research sets out examples of how the treatises changed during the period under discussion. The early works of Hill and Lawson are project driven, reflecting the political and economic drive from William Cecil for innovative and profitable projects. Francis Bacon and Hugh Plat, were important figures because of their investigative and experiential approaches to scientific enterprise. Both these men influenced the improvers, whose treatises became scientifically reflective, offering the readership an eclectic mix of practical guidance and philosophical erudition. In addition, the majority were self-educated, drawing their knowledge from correspondence, collections, catalogues, plant hunting and botanizing, exchanges of seeds, plants, artefacts and books, as well as their own observations and investigations.

This research has used the word horticulturalist and husbandman as generic terms to define a person or an activity. Authors of these treatises, however, had to define themselves within a social context that had no clear definition. Who were they, and how did they present themselves in their literary landscapes? Chapter 3 explored the ways and means by which they constructed a set of criteria and characteristics that would define them. Some, like Gerard and Parkinson, already had a persona through patronage, others, like Johnson, were attached to scholarly communities. For Bacon, the guardians of natural history should be well-educated gentlemen. It was through the improvers' process of specialization that Bacon's notional scientist began to be formulated in a more distinctive way.

Inscriptions

How did they create their investigative environments?

Chapter 2 reviews a broad spectrum of publications with specific objectives. On a broader level this chapter begins by discussing the writing of natural histories, and cartography, as a means by which territories, and 'land' were defined and mapped. This bordering of space was particularly important for the authors under discussion, for it was within these confines that they set out their investigations and experimentation. Renaissance herbals represent examples of early scientific enterprises, in their botanical display of examples from across the world and local environments. Designed for apothecaries and botanists, they were originally written in Latin and available to medical, scholarly communities, and the libraries of the elite. The main problems experienced by users of these large format publications were concerned with inaccuracies, and that most of them were circulated from the Mediterranean region. Floras were designed to capture plants *in situ*, and to catalogue indigenous examples. When examining and investigating the plants contained within these catalogues, botanists began to question why some plants thrived in particular environments while others failed. Parkinson, for example, set up a programme of propagating tulips from seed, while Goodyer identified foreign trees that had acclimatized in England, and Johnson found the same species of plant growing in different soils and environments. Horticultural and husbandry treatises of the improvers were of a different genre. The books were designed as literary landscapes, strongly reflecting in their illustrations and descriptions, the cabinets of curiosity. Immediately the author was setting the scene of a scientific environment, a literary laboratory for observation and investigation. In terms of Latour's cycles of accumulation, these books were formative in adding layers to scientific knowledge, and demonstrate that knowledge was formed in the social world of interconnected networks.

C*entres of calculation*

What were the scientific activities, and how were they defined?

The centres of calculation were formed in the literary landscapes. The husbandry manuals divided the landscapes into sections, the overall estate, which was then subdivided into agricultural, horticultural and domestic, for example, animal husbandry and bee keeping. The botanical and horticultural literature was divided, even more directly, with the garden sub-divided into orchard, vegetables and flowers. The specialist environments of the improvers were generally species specific, timber, vegetables, fruit and flowers. With each division and specialization, the scientific investigation of the seed became more prominent.

Following on from herbals and floras, authors of horticultural literature demonstrate a familiarity with the classics, theology, philosophy and the continental writings of contemporaries. Much of this knowledge must have come from books, but it has not been possible to ascertain how authors gained their information. Clearly Bacon was well versed in the classics, and had a large library, but so was Plat in both the classics and contemporary alchemical theories. One must assume that he had access either personally, or through shared circulation, to publications. There is a possibility that some authors, who were gardeners on estates, may well have had access to the libraries of their employers or patrons. Nevertheless, these men accessed books, by whatever means, which may well have been in Latin or Greek, read and reviewed the works of Bacon, and considered the scientific theories prevalent in the period. The plagiaristic tendencies of Markham, of course, provides us with an example of how information contained in books could be reviewed, renewed, updated and circulated in a continuous cycle.

Part II of the thesis sets out, in a botanical progression, scientific investigations of the seed. At this stage, the seed becomes the transmitter of knowledge, as it networked with the human agent. The whole of the seed's development came under scrutiny, as authors sought to artificially control its environment. As mentioned in the introduction, it was only towards the end of this research period, and the work of the Cook and Grew in particular, that the life cycle of plants was being systematically defined in Aristotelian manner, from seed to seed. However, carefully scrutiny of the various texts established a common theme that demonstrated the manner in which authors set out their investigation, trials and conclusions. The research illustrates that authors did not rely on observation alone. They combined religious doctrine and classical and contemporary theories, with their own experiences and investigations. To this extent, they were initiating what is now described in social sciences as triangulation, that is the use of one or two methods to check the subject matter.

Was knowledge built and transmitted?

Knowledge was built and transmitted in and through the literary landscapes of the authors. Many of these books went into multiple editions, but we cannot assume they were extensively circulated, while others from Cook and Austen, were clearly subsumed by the works of John Evelyn. It seems the most prevalent location for the work of the improvers was held within the Samuel Hartlib collection. However, Hartlib's circle was in itself, an important centre of accumulation. While authors were carrying out their investigations of the seed, they were also undertaking scientific exploration and explanation of the wider environment. From the heavens to the earth, the seed was transmitting knowledge. The examples provided in *Trials of Nature* are evidence of an experimental, scientific programme, on which these authors embarked.

Is there any evidence to suggest that theory influenced practice?

There are two examples included in this research that are examples of how theory influenced practice. Plat did not invent his drill board, there had been previous designs, and his was not a new initiative, but rather a review, and redesign. Nevertheless, the botanical knowledge did lead to the improvers, and Worlidge in particular, applying this knowledge to technological design.

The most relevant example of theory to practice, however, is that of the advent of the nurseryman. This research concludes that skill alone was not sufficient to produce the specialist seeds and plants so desired by the improvers. Scientific theory and knowledge had to be combined with art, and with this came a new self-fashioning, that of the nurseryman.

The long view

This research has opened a door on the world of early modern science as conducted in a range of natural and artificially designed literary landscapes. The seed was the artefact through which it has been possible to trace how knowledge was transmitted. The research also demonstrates how a scientific history of the seed can be applied to a range of intellectual disciplines.

- Experimentation in precipitating germination by using chemical applications (manures) as a growth promoter is relevant to the history of chemistry.

- The explanations for, and innovations of, protected growing environments can be extended into the history of technology, for example, commercial greenhouses and plant accelerators.
- The concept of improving nature to produce a pure model, in this case the seed, can contribute to the history of eugenics.
- The loss of diversity through selective plant breeding is relevant to ecological studies.
- Collecting examples of seeds both globally and from indigenous environments, can contribute to the anthropology of seeds and agrobiodiversity studies.

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