Original Article

Plant → animal → book: Magnifying a microhistory of media circuits

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Abstract In his *Anatomy of Plants* (1682), Royal Society Fellow Nehemiah Grew writes: ‘So that a Plant is, as it were, an Animal in Quires; as an Animal is a Plant, or rather several Plants bound up into one Volume.’ Zooming in on the circuit of metaphors packed into this sentence, this essay explores: (a) how medieval zoophytes – marvels like the vegetable lamb and the barnacle goose tree – spurred early modern experiments in comparative anatomy (‘a Plant is, as it were, an Animal ... as an Animal is a Plant’), and (b) how bibliographic tropes came to mediate these plant–animal comparisons (‘an Animal in Quires ... or rather several Plants bound up into one Volume’). As I argue, not only the affordances of print culture but the book as a material object gave structure to the study of life in the seventeenth century, transforming the medieval ‘book of nature’ device into an actual printed book.

‘Plant → animal → book’ has an accompanying ‘digital essay’ (www.palgrave-journals.com/pmed/journal/v3/n1/plantanimalbook/). The noun ‘essay’ derives from the French verb *essayer*, meaning to try, to attempt and to experiment. First used in English by Francis Bacon – and fittingly so, given the subject of this project – early modern ‘essays’ tested the limits of genre by gathering aphorisms culled from commonplace books into thematically cohesive writing. By adventuring into the digital realm, ‘Plant → animal → book’ moves to reclaim this earlier, more experimental sense of the essay’s potential as a form. It is primarily a work of history (histories, more likely), and as such attempts to excavate concepts – such as ‘plant,’ ‘animal’ and ‘book’ – which have fossilized with the passing of time. Yet it also *essays* an awareness of its own mediation, inviting readers to share in the exegetical fever of archival discovery that inspired it.

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So that a Plant is, as it were, an Animal in Quires; as an Animal is a Plant, or rather several Plants bound up into one Volume.

This sentence comes from the dedicatory epistle to Nehemiah Grew's *The Anatomy of Plants*, published by the Royal Society in 1682. With 82 detailed plates showing the magnified structures of leaves, seeds, stems and cross-sections of branches – much of it produced by looking through a microscope – Grew's book collates over a decade's worth of his research on the morphology, phytotomy and physiology of plants.

Nehemiah Grew occupies an uneasy place in the history of science. On the one hand, historians have long acknowledged the significance of his *Anatomy*, a book which, in the words of Morton, 'put forward what was in effect the first comprehensive programme of botanical research' (Morton, 1981, 194). Indeed, his microscopic illustrations are among the finest the Royal Society ever produced, as skilled as those in the much more critically acclaimed *Micrographia* (1665), by Grew's colleague Robert Hooke. On the other hand, Grew's metaphors were too 'strange' (Hall, 1962, 290) and his terminology too 'homely' (LeFanu, 1990, 20) for scientists of a later paradigm to adopt them. For over a century after the book's publication, 'plant anatomy remained where they [Grew and his colleague Marcello Malpighi] left it; no one questioned their observations and no one added to them' (Morton, 1981, 179–180; see also Sachs, 1890, 225). Thus, critics have largely ignored Grew's monumental monograph, considering it too Baconian in method to be counted among medieval herbals but not modern enough to be included among those antecedents thought to 'anticipate' future discoveries in biology.

Even in his own day, Grew struggled to secure financial support for his work. While first-generation figures like Robert Boyle, John Wilkins and Henry Oldenburg loom large in histories of seventeenth-century experimental philosophy, the younger scholars whose work they championed, like Nehemiah Grew, remain relatively obscure, caught between the heady excitement of the Royal Society's Gresham College days and its decline in the eighteenth century.¹ After finishing the *Anatomy*, Grew never returned to the study of plant physiology, and in fact his final publication, *Cosmologia Sacra* (1701), turns away from the purely mechanistic explanations of his earlier work to pursue a Christian vitalist conception of life (Garrett, 2003).

These apparent tensions make Grew a poor representative of what we today perceive as the dominant episteme of early experimental philosophy, a fact that no doubt accounts for the relative critical silence on his work. Yet the very characteristics that render Grew illegible to, or at least on the periphery of, current perceptions of early science also help bring these histories (and their artifacts) into focus. By zooming into precisely the moment in which Grew's tropes seem most bizarre – namely, the sentence quoted above analogizing plants, animals and books – I attempt to recenter a (micro)history of biology

1 In a 1672 letter to Henry Oldenburg, the Secretary of the Royal Society at the time, Grew begs for funds to complete his research, pointing out that his financial stability, his medical practice in the country and his reputation had all suffered since he

within a history of textual mediation, magnifying and dissecting the bibliographic tropes that in very concrete ways shaped the study of life toward the end of the seventeenth century.

I have chosen two plant–animal hybrids as the starting points for my investigation: the vegetable lamb and the barnacle goose tree. Latent in Grew's contention that 'a Plant is, as it were, an Animal ... as an Animal is a Plant,' these marvelous zoophytes originated in medieval travel books and bestiaries but persisted in various forms well into the seventeenth century, spurring on early experiments in comparative anatomy and embryology. The choice of the vegetable lamb and the barnacle goose tree is somewhat arbitrary; I could have chosen the screaming mandrake, the *arbor inversa* or the sea sponge, since, like the preformed plant tucked inside a bean, the wondrous plant–animal atavisms folded into Grew's analogy seem limitless. However, unlike other examples, these vestigial epistemic structures provide ready evidence of how the third analogy in Grew's triad – that a plant is an 'Animal in Quires,' and an animal 'several Plants bound up into one Volume' – evolved. Not only print culture (Eisenstein, 1979; Johns, 1998) but the book as a *material object* gave structure, both literally and figuratively, to the study of plants and animals during the seventeenth century. Thus from reading the divinity inscribed in zoophytic marvels to structuring plant–animal bodies as quires and volumes, nature was, as Grew writes, beginning to be conceptualized as an actual book – a material artifact that unfolds like the two leaves of a plant, or binds together the organs of an animal body.

'So That a Plant is, as it were, An Animal in Quires'

The fourteenth-century book of John Mandeville, drawing on material from Odoric of Pordenone's travel narrative, describes in chapter 33 a 'kyngdom þat men clepen Caldihe':

And þere groweth a maner of fruyt as þough it weren Gowrdes, and whan þei ben rype men kutten him a to & men fynden withjnne a lytyll best in flesch, in bon & blode, as þough it were a lytyll lomb withouten wolle. and men eten bothe the frut & the best, And þat is a gret merueylle. Of þat frute I haue eten all þough it were wonderfull but þat I knowe wel þat god is merueyllous in his werkes. (Hamelius, 1919, 175–176)²

This plant/animal hybrid is the vegetable lamb of Tartary, also known as the Borametz or Scythian Lamb. Tales of this marvelous plant-born animal circulated widely in late medieval and early modern Europe (see, for example, Parkinson, 1629; Kircher, 1643, 639; Harsdörffer, 1653, 583, frontispiece), first as a kind of meat developed in a gourd, then as an animal fixed to the ground by

moved to London at the urging of John Wilkins. Grew would, of course, go on to complete his lectures on plant anatomy and even succeeded Oldenburg as Secretary in 1677, producing the Society's first catalog of its collections, the *Musaeum Regalis Societatis* (1681), during his tenure. However, as Michael Hunter points out, Grew's trouble securing support, even among Society fellows who clearly acknowledged the significance of his research, shows the 'gap between reputation and reality' in the Restoration-era operations of the Royal Society (Hunter, 1982, 196).

2 This quotation comes from the British Library, Cotton Titus manuscript version edited by P. Hamelius (1919) for the Early

English Text
Society. The
Richard Pynson
edition (ca. 1496)
omits the final
sentence.

a plant stem at its navel. In a later version of the late sixteenth and seventeenth centuries, the lamb was said to devour all the vegetation within range of its tether until, having stripped the earth around it bare, it starved.

One of several examples of marvelous zoophytes, the Borametz is neither wholly plant nor wholly animal. Its quadruped portion walks, eats and digests like a lamb – it even *tastes* like a lamb, according to some – at the same time the parent plant quite literally roots it to the earth. In a strange reversal of Aristotelian hierarchies, then, the higher sensitive soul of the animal, able to perceive and respond to stimuli with locomotion, depends vitally upon the soil-bound immobility characteristic of lesser plant life. Indeed, the lamb portion of this hybrid creature cannot survive the severing of its vegetable stem. Do these restrictions imposed by the plant demote the animal? Or does the lamb-fruit promote the plant to the status of a sentient creature? From both directions, this hybridic life-form exerts pressure on Aristotelian metaphysics, so much so that several seventeenth-century commentators refused to believe in it. ‘Untill either an autoptical experiment, or the observation of some, who are more curious of Truth, then exotique Rarities, shall remove those scruples which I have in me,’ Walter Charleton writes, ‘... I shall beg leave to suspend my belief, that there are any such Heteroclites or middle Natures, half Vegetable, half sensible’ (Charleton, 1652, 131–132).

The reasoning of skeptics like Charleton – or believers like (perhaps) the compiler of John Mandeville’s book – offers a glimpse into the epistemic structures that shaped and reshaped beliefs about the natural world. For Charleton, writing in the middle of the seventeenth century, only an ‘autoptical experiment’ (that is, an experiment seen with one’s own eyes) can prove the existence of mixed creatures (although in a later text he suggests the vegetable lamb may be an example of ‘Sensation without Sense,’ or a kind of proto-sense, without commenting on the possibility of its existence; see Charleton, 1659, 123). Rather than demanding direct proof, Francis Bacon seeks alternative explanations, pointing out that the plant may only *look* like a lamb; ‘and as for the Grasse, it seemeth the Plant, hauing a great Stalke and Top, doth prey vpon the Grasse, a good way about, by drawing the Iuyce of the Earth from it’ (Bacon, 1627, 155). Sir Thomas Browne echoes Bacon’s explanation in his *Pseudodoxia Epidemica or Enquiries into very many received tenents and commonly presumed truths*, suggesting that the supposed marvel may be ‘no more, then the shape of a Lamb in the flower or seed, upon the top of the stalk’ (Browne, 1672, 208) – a statement later refuted by Alexander Ross (1652, 143). The dragonfruit bleeds, Ross writes; peaches have woolly skin, and the sensitive plant (*mimosa pudica*) responds to touch. Why, then, is the vegetable lamb an impossible creature?

Thus in seventeenth-century discussions of the vegetable lamb, both skeptic and believer treat its ostensibly marvelous characteristics as a set of accountable phenomena, with the given explanations either confirming or denying its

existence. In other words, for Charleton, Bacon, Browne and Ross, wonder initiates inquiry into the natural world as a material reality comprised of objects able to be dissected, examined and compared. The vegetable lamb's curious hybridity also served as a tool for testing the boundaries of given Aristotelian categories – for, as the title to Browne's book puts it, 'enquir[ing] into very many received tenents and commonly presumed truths'. In this way, 'strange facts' like zoophytes were, as Daston and Park have argued, 'Ur-facts, the prototypes of the very category of the factual', helping to define 'many (though not all) of the traits that have been the hallmarks of facticity ever since: the notorious stubbornness of facts, inert and even resistant to interpretation and theory; their angular, fragmentary quality; their affinity with concrete things, rather than with relationships' (Daston and Park, 1998, 236). As an 'Ur-fact,' the vegetable lamb's actual existence mattered less than its role as (to borrow a modern term from Ted Nelson) an ideological 'thinkertoy,' helping experimentalists delimit what counted as scientific evidence from a set of complex alternatives (Nelson, [1987] 2003, 330).

Writing several decades earlier than Bacon, Charleton or Ross, Girolamo Cardano mounts a critique of the vegetable lamb that illustrates how marvels were encouraging experimental methods. Describing it as a *fabula*, a myth, Girolamo Cardano points out that 'an animal that is endowed with blood has a heart; but the earth cannot support its beating and warmth' ['animal quod sanguine praeditum est, cor habet: terra aute pulsationi & calori inepta est']; therefore, a plant could never support an organism with animal organs. Furthermore, 'animals which are generated from semen need heat[;] ... but earth and air are not able to be hot enough' to incubate embryos ['animalia quae ex semine generantur, calido indigere ... at terra & aer non possunt esse adeo calida']. 'For that reason,' he concludes, 'is it not obvious why no plant has flesh' ['inde patet, cur nulla planta carnem habet'] (Cardano, 1557, 216; my translation)? Not all of Cardano's contemporaries accepted his reasoning – Julius Caesar Scaliger, for one, mocked him – but the failures of his logic and its cultural impact are beside the point. By prompting Cardano to imagine the supposed functions of animal organs in relation to the morphology of a plant, the hybridic nature of the vegetable lamb produced a process of analogical reasoning that moves away from wonder and toward comparative anatomy. Or, put in less linear terms, wonder persists in Cardano's reasoning as a kind of residual affect whose presence alters his relationship to plants and animals as material objects sharing the very immaterial attribute of life.

Experimental philosophers pursued these analogies with renewed vigor as new discoveries in animal anatomy fed back into microscopical observations of dissected plants. For instance, following William Harvey's work on blood circulation, Martin Lister argued that the observable tubes in leaves operated like the veins and arteries found in mammals (Roos, 2007, 80–81, 99) – a hypothesis debated by John Willis, who thought they were some form of

nervous system (Webster, 1966, 18). Similarly, when explorers introduced the *mimosa pudica* or 'sensitive plant' from the New World, amazed philosophers used animal functions to account for its response to touch. Thus, in an article read to the Royal Society in 1661, Timothy Clarke utilized contemporary theories of muscular contraction to provide a mechanistic account of the sensitive plant's movement (Webster, 1966, 16). Henry Power even goes so far as to suggest that, because plants show a 'continuall transpiration ... like to that in animals,' they may also share certain forms of life with animals. 'I can easily stretch my belief a little farther,' he writes in a letter to Thomas Browne, 'and that is to conceive that all plants may not only have a transpiration of particles but a sensation also like animals' (Wilkin, 1835, 406).

By the time Grew was writing, then, the idea that a 'Plant is, as it were, an Animal' dominated natural philosophy – so much so that Delaporte (1982) argues plant–animal comparisons blocked our modern understanding of vegetality until the eighteenth century. (Indeed, Barker points out that animal-centered thinking continues to 'impinge on [children's] learning about plants' in classrooms today [Barker, 2002, 293].) Rooted as they are in the 'strange facts' of travel book marvels, it is easy to dismiss such analogies as marginal within early modern scientific thought; yet Grew himself pursues the comparison with depth and vigor, writing that,

there are those things within a Plant, little less admirable, than within an Animal. That a Plant, as well as an Animal, is composed of several Organical Parts; some whereof may be called its Bowels. That every Plant hath Bowels of divers kinds, containing divers kinds of Liquors. That even a Plant lives partly upon Aer; for the reception whereof, it hath those Parts which are answerable to Lungs. (Grew, 1682, 'Epistle Dedicatory')

Like many of his contemporaries cited above, Grew returns to this comparative method throughout his research, using the 'divers material Agreements betwixt' plants and animals 'not only to compare what is already known of both; but also, by what may be observed in the one, to suggest and facilitate the finding out of what may yet be unobserved in the other' (Grew, 1682, 4). Of course, he warns, 'if any one shall require the Similtude to hold in every Thing; he would not have a Plant to resemble, but to be, an Animal' (Grew, 1682, 173) – an important distinction. For Paracelsus, who initiated the strand of thought that Grew is distancing himself from here, material resemblances reveal immaterial sympathies, such that, for instance, the mandrake's human form and its feeling for pain point to its ability to cure barrenness in women (see, for example, della Porta, 1588; Findlen, 1990; Newman, 2007).

By contrast, Grew compares plants and animals as physical objects, almost as *media* objects – that is, platforms that store and transmit biological information in similar ways. Though not referring to Grew specifically,

Wilson (1995) points to the kind of distinction he makes here as indicative of a broader epistemological shift among the early microscopists: 'The microscope takes away the privilege of surface,' Wilson writes, since 'what the object looks like on the outside is no guide to what it is in the sense of what it can do.' Thus, she concludes, 'there is no resemblance' seen under a microscope: nature is not 'a system of signs meant for us to read,' and 'nature is not a book' (Wilson, 1995, 62–63). However, nature no longer glowing with the illuminated *signatura rerum* does not indicate that it is no longer a book, only that it no longer takes the form of a handwritten manuscript. In fact, as shown above, nature was becoming *more* like a book, an artifact marked in the early modern period by a sameness of species across an entire print run of a title. Stretching from Grew's analogy back to the Mandevillean description of the marvelous vegetable lamb, one finds not a cultural rupture between the ostensibly medieval and the ostensibly early modern but a subtle shift in the ontology of objects – in the ways that immaterial relationships imbue and give shape to material things. For a late medieval writer, to taste the vegetable lamb is to read the marvelous divinity written into all Creation (Findlen, 1994, 50–57; Williams, 1996, 207; Johns, 1998, 47; Verner, 2005, 157): 'of þat frute I haue eten,' reads *Mandeville's Travels*, 'all þough it were wonderfull but þat I knowe wel þat god is merueyllous in his werkes' (Hamelius, 1919, 176). For Cardano and (to various extents) Bacon, Browne, Charleton and Ross, wonder is less a process of reading what has already been written than of interrogating the physical conditions of possibility for such a creature's existence – of, as Cardano writes, 'handling the *matter* by *nature*' [*rem tractare naturaliter*] (Cardano, 1557, 216). By the time Grew is writing at the end of the seventeenth century, thought experiments on the marvelous hybridity of zoophytes had inspired observations in comparative anatomy, and the book had become not a metaphor for reading, but a material object mediating the structure of life. Thus metaphors for the natural world shift around the axis of technological transitions, dragging structures of knowledge with them.

In his dedicatory epistle to Book I of his *Anatomy of Nature*, addressed to Bishop John Wilkins, Grew writes:

MY LORD,

I Hope your pardon, if while you are holding That best of Books in one Hand, I here present some Pages of that of Nature into your other: Especially since Your Lordship knoweth very well, how excellent a Commentary This is on the Former; by which, in part, GOD reads the World his own Definition, and their Duty to him. (Grew, 1682)

Grew is ambiguous: does he refer to the metaphoric 'Pages' of nature, or the actual pages of his own book, presumably being held by Wilkins while he reads

these lines? As a compilation of all he has ever written on plants, Grew's *Anatomy* is, in some sense, a literal book of nature: it translates the matter of plants (in both senses of that phrase) into descriptive text and precise visual representations, thereby materializing human knowledge of the vegetable world. The physical book participates in this reconstitution of nature's matter, turning the fibers of the flax plant into paper, nut oils and lampblack into ink, animal bones into glue and animal skins into a cover. Indeed, this text analogizing animal organs to plant parts is, in its material form, a zoophytic assemblage of both.

However, Grew is careful to distinguish his observations of nature from nature itself. Describing his work as a form of exploration, a common metaphor in early texts on microscopy (Wilson, 1995; Fournier, 1996), he willingly credits himself with the discovery of these new territories or knowledge (under, of course, the king's patronage): 'we are come ashore into a new World,' he writes, 'some will say into another Utopia' (Grew, 1682, 'Epistle Dedicatory'). Yet, he quickly points out, 'not I, but Nature speaketh these things: the only true Pallas, wherewith it is treasonable for the most couriously handed Arachne to compare.' Although Grew appears here to deny attempting to reproduce or mimic nature, the metaphor is an odd one; for of course Arachne *does* best Pallas Athena at weaving, a fact which so galls the envious goddess that she turns the girl into a spider. In a similar fashion, Grew's illustrations reveal sections from nature's book which nature itself claps between the covers. Dozens of full-page plates show garden-variety stems dissected into dizzyingly complex cross-sections, then magnified to reveal geometric forms never before seen in plant life (see Figure 1). These blown-up images of seemingly alien landscapes do not mirror the medieval book of nature and in fact cannot, since such perspectives only become visible through the lens of the microscope, a relatively new technology. Rather, Grew's *Anatomy* is actively engaged in producing, in *printing* a new edition of nature's book – one that, like Arachne's web, is both an homage and a rival to that written by God.

'As an Animal is a Plant, or Rather Several Plants Bound Up into One Volume'

Cardano does not wholly discount the possible existence of an in-between creature. In fact, he speculates that 'there might, perhaps, be a plant having sensation and also imperfect flesh, such as that of mollusks and fishes' (Cardano, 1557, 217) – an example which points to another marvelous plant-animal hybrid, the legendary barnacle goose tree.

Purported to be found growing along the ocean's edge in Ireland and the Hebrides, the barnacle goose tree traces its roots to the twelfth-century

Figure 1: Table 37, in Nehemiah Grew, *The Anatomy of Plants* (1682). From the David M. Rubenstein Rare Book and Manuscript Library, Duke University, Durham, North Carolina. Image photographed by the author.

Topographia Hiberniae, wherein Gerald of Wales describes birds that ‘appear as excrescences on fir-logs carried down upon the waters,’

hang[ing] by their beaks, like seaweeds attached to the timber. Being in the process of time well covered with feathers, they either fall into the water or take their flight in the free air, their nourishment and growth being supplied, while they are bred in this very unaccountable and curious manner, from the juices of the wood in the sea-water. (Cambrensis, 1863, 36)

Although Gerald, like his contemporary Peter of Cornwall, describes the barnacles as clinging to a piece of driftwood, other medieval texts by Peter Damian, Thomas of Cantimpré, Gervase of Tilbury and Vincent of Beauvais understand them as a kind of proto-beak that grasps the living tree's bark as the goose develops (Beare, 1997, 460, 6). Not all medieval writers believed in the barnacle goose tree's existence; for instance, Gerald's near-contemporary Albert the Great dismisses it as myth, pointing out that the story probably arose because 'barnacle geese are born in such remote places that men are ignorant of where they nest' (quoted in Daston and Park, 1998, 64). For the majority that did, though, the zoophyte's status as both plant and animal, fish and fowl, prompted questions about religious proscriptions. If its birth from a barnacle classifies the goose as a shellfish, its eating is *not* proscribed during Lent and on Fridays; in fact, Gerald reports certain bishops in Ireland eating the geese on fast days, 'as not being flesh, because they are not born of flesh.' However, Gerald cautions, 'these men are curiously drawn into error,' for 'if any one had eaten part of the thigh of our first parent, which was really flesh, although not born of flesh, I should think him not guiltless of having eaten flesh' (Cambrensis, 1863, 36). Moreover, for Gerald, nature provides mankind with the marvel of the barnacle goose precisely to inspire this kind of religious reflection – or, as he puts it, 'for our instruction and in confirmation of the Faith.' By allowing the possibility of a tree-born goose, then, the medieval writer confirms the reality of the virgin birth of Christ, or the making of Eve from Adam's rib. Thus the presence of this marvel signifies a metaphysics beyond its own material instantiation, beyond the details of *how* a bird emerges from a barnacle, or a barnacle from a tree – beyond, even, the question of whether the goose exists or not. Although Gerald assures his reader that he has 'often seen [them] with my own eyes,' physical proof matters less for him than accepting the conditions of possibility for its existence, which are none other than those of the Christian cosmology.

The travel book of John Mandeville also mentions the barnacle goose tree in chapter 30. Immediately after his description of the vegetable lamb (quoted above), the narrator retorts:

natheles I tolde hem of als gret a merueyle to hem þat is a monges vs And þat was of the Bernakes. For I told hem þat in oure contree weren trees þat baren a fruyt þat becomen briddes fleeynge. And þo þat fellen in the water lyuen, And þei þat fallen on the erthe dyen anon; and þei ben right gode to mannes mete. (Hamelius, 1919, 176)

Here, as elsewhere, the traveler's boast hints at the text's broader mercantilist motives (Verner, 2005, 136–141), a suggestion made more explicit in an illumination from the manuscript *Livre des merveilles du monde est un ouvrage rédigé par Jean de Mandeville* (Paris, Bibliothèque Nationale Française 2810, f. 210v).

In the image, two men in Islamic garb offer three Christians a gourd cracked open to reveal a lamb; in return, the three men give a tree branch bearing a small bird. Thus, while Gerald treats the barnacle goose's marvelous procreation as *ipso facto* evidence of Christianity, in a later medieval treatment wonders exist as tangible goods within a patchwork of competing belief systems, opening up lines of communication and, importantly, trade routes between them.

While Mandeville's stories continued to circulate widely in printed editions, the barnacle goose tree also began appearing in printed herbals, including John Gerard's (1597) monumental *Herball*, perhaps the most well-known English book of plants in the seventeenth century. Even before it appeared, Gerard's volume was accused of inaccuracies, and the printers halted production in order to hire the naturalist Mathias de L'Obel to proofread and correct the manuscript (Harkness, 2007, 17). Gerard, furious, fired L'Obel before he could finish, and two plants of marvelous origin remain tacked onto the book's final pages: 'stonie wood', water that turns wood to stone, and the barnacle goose tree (Gerard, 1597, 1390–1391). Although it is impossible to know whether L'Obel would have removed these plants – or indeed if he saw them and chose not to remove them – their illustrations are strikingly different from the other woodcuts, almost all of which come from Tabernaemontanus's *Eicones plantarum* (1590). Rather than depicting the entire plant floating free from its natural environment, as the illustrations from Tabernaemontanus do, Gerard's original woodcuts show these comparatively unusual species situated within their surroundings: a log of stony wood emerges out of water, while the twisted trunk of the barnacle goose tree huddles at the edge of the sea, geese-topped waves stretching off into the background (see Figure 2). In place of leaves, the tree has only five disproportionate, tulip-shaped barnacles hatching birds. Visually, then, Gerard's barnacle goose tree has more in common with those shown in sixteenth-century cosmographies, such as Sebastian Münster's *Cosmographia* (1544), than with the clean, leafy renderings of other plants in the *Herball*, or indeed of plants in other contemporaneous herbals, and it is tempting to read the style of these woodcuts as a nod to the travel book tradition from which the marvel emerged. Here, then – in the very book which came to define the printed herbal genre in early modern England – is present one of Mandeville's marvels, iconically tagged as unusual but not, importantly, as an exotic good for trade. Rather, Gerard recontextualizes the barnacle goose tree as one of many plants found along the familiar coasts of the British Isles.

Situating the barnacle goose tree within the context of an herbal incites Gerard to observe its marvelous properties in different ways. Examining its physical form, he writes:

I founde the trunke of an olde rotten tree [where] I founde growing many thousandes of long crimson bladders, in shape like vnto puddings newly filled before they be sodden, which were verie cleere and shining, at the

Figure 2: 'Of the Goose tree, Barnacle tree, or the tree bearing geese', in Book III, Chapter 167, p. 1391, John Gerard, *The Herball, or Generall Historie of Plantes* (1597). From the History of Medicine Collection, David M. Rubenstein Rare Book and Manuscript Collection, Duke University, Durham, North Carolina. Image photographed by the author.

neather end whereof did grow a shelfish, fashioned somewhat like a small Muskle, but much whiter, resembling a shellfish that groweth vpon the rocks about Garnsey and Garsey, called a Lympit: many of these shells I brought with me to London, which after I had opened, I founde in them liuing things without forme or shape; in others which were neerer to come to ripenes, I found liuing things that were very naked, in shape like a Birde; in others, the Birds couered with soft downe, the shell halfe open, and the Birde readie to fall out, which no doubt were the foules called Barnakles. I dare not absolutely auouch euery circumstance of the first part of this Historie concerning the tree that beareth those buds aforesaide, but will leaue it to a further consideration: howbeit that which I have seene with mine eies, and handled with mind handes, I dare confidently auouch, and boldly put downe for veritie. (Gerard, 1597, 1392)

In his analogical thinking and domestic metaphors, Gerard sounds very much like Cardano investigating the vegetable lamb, or indeed like Nehemiah Grew himself. Although he never speculates *how* a bird came to be in a barnacle, his curiosity about the tree both as a wonder found in travel books *and* as a physical life form cataloged in herbals drives him beyond the scope of *both* genres to investigate claims about its marvelous reproduction. Thus, the weight of earlier epistemologies, mediated through widely circulated, oft-copied images, presses upon a form attempting to define itself anew and in doing so alters that moment's relationship to the past. The barnacle goose tree's position at the end of *Herball* also points forward to the marvel's 'end' in the seventeenth century, as experiments like Gerard's increasingly treated it not as a religious icon but as an object – something to be carried home to London, where, like the *Herball* itself, it could be displayed and examined.

Roughly a half-century later, the same curiosity would impel Nathaniel Highmore (1651) to investigate the growth of the fetus inside a chicken egg, diagramming its different stages beside a cross-section of a bean containing a tiny plantlet curled in on itself. Highmore was, of course, not the first embryologist to compare plant seeds with animal eggs. Aristotle himself described embryo formation in terms of plant growth, initiating a tradition of comparative analysis that, as in the study of plant physiology, would continue into the eighteenth century. Moreover, Malebranche's 'famous lines credited with having marked the birthplace of preformation' begin with the more evident example of preformed tulips and trees before remarking that 'we can also think of animals in this way' (Pinto-Correia, 1997, 19). In fact, although its significance has been underemphasized in histories of the field, the bean was second only to the chicken egg in providing seventeenth-century researchers – both preformationists and epigeneticists – with a readily observable example of 'embryonic' growth. Marcello Malpighi and William Harvey, who worked alongside Highmore, both experiment with beans; Theodor Kerckring, turning

an explicit analogy into a conceptual metaphor, calls a fetus he dissects a 'black cherry' (Kerckring, 1672, 4021; see also Keller, 2000).

It is impossible (and methodologically undesirable) to link causally Gerard's curious investigation of a barnacle fruit to Highmore's bean-egg diagrams. Yet, each of these singular descriptions forms one star in what would, by the mid-seventeenth century, appear as a constellatory shift in the study of life's conception, indeed in the study of life itself. Catalyzed by the metamorphic marvel of zoophytic reproduction, naturalists like Gerard began inventing new methods for investigating animal reproduction as a physical phenomenon, but in doing so also distanced themselves from the wondrous epistemology that initially sparked their curiosity. Thus, while in the twelfth century, Gerald reads the virgin birth in the barnacle goose tree, the seventeenth-century microscopist Jan Swammerdam chides Harvey for darkening his experiment on bees with the 'clouds of imaginary metamorphosis,' then warns colleagues against blasphemously comparing metamorphic animal reproduction with Christ's death and resurrection (quoted in Pinto-Correia, 1997, 25; see also Fournier, 1996, 69). Nonetheless, Swammerdam – who, similar to Grew, abandoned experimental philosophy to devote himself to his religion – does not shy away from analogizing man's development to that of an insect in a collection of his posthumously published writings aptly titled the *Book of Nature* (Pinto-Correia, 1997, 26). Importantly, these analogous relationships are not currents of immaterial sympathies but structural frameworks mediating how natural philosophers interpreted the physical form of life. In other words, the material *object-ness* of life – of flesh not as a religious prohibition, but as gross matter to be compared, dissected, collected and distributed across national boundaries – is in the process of being invented; and, importantly, this occurs not *in spite of* but in part *because* of the investigatory fodder zoophytic marvels provided.

Once forms of life relate to each other through their physical structure, other objects – non-living objects – may enter into the analogy, participating as equals in this 'parliament of things' (Latour, 1993, 142–144). As has been widely noted, mechanistic philosophy encouraged the study of physical form by blurring the lines between art and nature, between automata like watches and living animals (see, for example, Bensaude-Vincent and Newman, 2007). Less remarked, though, is the influence of other ostensibly less mechanical artifacts like the book. In the form of journals, letters, reference works, manuals, essays and systems, texts were immediately present objects populating the desks of seventeenth-century experimentalists in the same way that, as Latour and Woolgar have shown, they do the laboratories of scientists today (Latour and Woolgar, 1986, 47–49). As such, textual artifacts provided a ready analogy for the ways in which form gives way to function; the ways that immaterial meaning courses through material things; and the way pleats of matter can fold up into a tightly bound organ, or unfold like the leaves of a plant (see, for example, Deleuze, 1993, 31). Indeed, natural philosophers used books as an

analogy for ideating the structure and emergence of life as much they used them as a platform for disseminating their ideas.

The metaphor of the book entered debates about reproduction with particular force through the image of the epitome or compendium. As an abstracted or compilatory abbreviation of a longer text, the compendium perfectly mediates the problematic difference between growth and development. For an abstract can (and presumably should) grow into a full-length volume; but in doing so, new examples, new ideas, new organs of thought develop. In other words, from compendium to volume, a text moves from both general to specialized knowledge *and* from smaller to bigger, encapsulating both preformed thought and a kind of epigenetic potentiality. Thus in the mid-seventeenth century, Pierre Gassendi describes the seed as an ‘epitome of the plant’s whole soul’ [*epitome Animae totalis*], containing ‘the idea, so to speak, and impression of the other parts’ [‘caeterarum partium veluti ideam, impressionemque contineat’]; it ‘communicates’ [*communicantes habeat*] life to all other parts of the plant as it develops (Adelmann, 1966, 799–800). Likewise, in his instructions for constructing an herbarium (a book of dried plant specimens), Adriaan van den Spiegel writes that ‘the seed is a fetus, and a compendium, so to speak, of the entire plant’ [‘semen vero est foetus, & quasi totius plantae compendium’] (Adelmann, 1966, 902). Writing several decades after Spigelius, Malpighi also describes the seed as a fetus but applies the compendium metaphor to the bud: ‘a compendium of the not-yet-unfolded plantlet’ (quoted in Adelmann, 1966, 902), as does Grew: ‘the Growth of a Bud ... carries along with it, some portion of every Part in the Trunk or Stalk; whereof it is a Compendium’ (Grew, 1682, 57). Grew further describes the small cluster of flowers in a composite blossom as the flower’s ‘Epitome’ (Grew, 1682, 38), a word that today is used largely metaphorically, but which in the seventeenth century was often used to title books.

In fact, Malpighi – who studied the buds of over 20 different species, often in sections under a microscope (Morton, 1981, 182) – frequently turns to the image of a condensed text, using it to describe seeds, plantlets, pre-existent coverings in bark, indeed most any part of the plant in which leaves unfold around a central stalk (Adelmann, 1966, 844, 902). He also applies this metaphor to the development of animals, writing that,

there is present in the cicatrix a compendium of the animal, by which I mean the first outlines of the principal parts, or in other words, their outermost boundaries, which – through the *mediating liveliness*, communicating fluid motion – is made sensible when the cavities are gradually filled up and swell.

[in cicatrice adesse compendium animalis, hoc est, delineationes primas principalium partium; extimos scilicet fines, qui *vegetatione media*,

3 Adelmann translates this sentence: 'there is present in the cicatrix a compendium of the animal, by which I mean the first outlines of the principal parts, or in other words, their outermost boundaries, which through the agency of growth become visible when motion has been communicated to the fluids and the cavities gradually fill and become turgid' (Adelmann, 1966, 867). I have modified his translation to emphasize Malpighi's use of the words 'media' and 'communication.'

communicato fluidis motu, cum sensim repleantur concavitates & turgeant, obviae fiunt sensibus.]³ (Adelmann, 1966, 867; emphasis added)

Note the phrase 'vegetatione media' – which Adelmann translates as 'the agency of growth' but might more directly be rendered as 'mediating liveliness,' akin to a vital spark – as well as the verb *communicato*. When paired with the metaphor of the compendium, these words construct an image of animal development as the enlargement of a text that expands to communicate ever more details about the organism. Importantly, the metaphor draws on both the generic *and* formal qualities of a compendium. In other words, the bud (or fetus) does not only conceptually 'abbreviate' the fully grown plant (or animal) but physically mimics the structure of a compiled text, abstracting its 'principal parts' [*principalium partium*] into its 'first outlines' [*primas delineationes*]. Interestingly, at least twice in his correspondence Malpighi refers to actual books as 'compendia,' once in a letter to Henry Oldenburg describing his own dissertation on chick development (Adelmann, 1966, 844n6).

Though words like 'compendium,' 'epitome,' 'media' and 'communication' are easily overlooked, they document how bibliographic and textual tropes mediated the study of life in the seventeenth century. Once used to describe a single observed phenomenon, these terms tended to encourage experimentalists to describe entire biological processes as circuits of communication. For instance, note how Highmore builds a networked theory of reproduction around the words 'abstract' and 'compactly':

This blood, that all parts might be irrigated with its benigne moisture, is forc'd by several chanel, to run through every region and part of the body; by which means every part out of that stream, selects those Atomes which they finde to be cognate to themselves. Amongst which the Testicles ... *abstract* some spiritual Atomes belonging to every part; which had they not here been anticipated, should have been attracted to those parts, to which properly they did belong for nourishment. As the parts belonging to every particle of the Eye, the Ear, the Heart, the Liver, Stomach, Guts, the Hand, every particular bone, and muscle, &c. which should in nutrition, have been added (to repair the continual deperdition) to every one of these parts, are *compactly*, and exactly extracted from the blood, passing through the body of the Testicles; and being in this Athanor cohobated and reposit in a tenacious matter (lest being spiritual, and very fine, they should lose their vigor) at last, passe from the body of the Testicles, by certain vessels, in which through infinite Meanders, it undergoes another digestion and pellicanizing (as in another place I have shown). And from thence, being now delivered from all its excrements, and furnisht with Atomes, fit for the making of every part and particle of an other Individual; is treasured up in certain Granaries, till the seed time comes.

And this is the nature, substance, and manner of collecting the Seed. This shall be further illustrated by the several ways of Generation in several Creatures, and first in Plants. (Highmore, 1651, 44–46; emphasis added)

Here, the body is a vast landscape irrigated with channels that, like streams, communicate the nutrient-rich seeds of life to other regions – to the eyes, the ears, the heart, each body part its own ecosystem. While most of these seeds take root, thereby repopulating (and expanding) the body's landscape with new life, some collect in the testicles, the body's granaries, which collate these seeds into a compendium. Reproduction, then, is the act of migrating this human compendium – each chapter a set of instructions for seeding new body parts – to another territory, the female body. Thus, folding the life cycle of plants into a flow model of communication, Highmore's account imagines the human as a fertile, productive territory, spitting out abstracts to seed its ideas on the New Worlds of other bodies. Indeed, Highmore uses the social life of texts to conceptualize reproductive mechanisms in much the same way, three centuries later, Richard Dawkins would turn to genetics to explain how ideas spread.⁴

Far from novel, the conceit of man as compendium or epitome is an ancient one. If the world is the Book of Nature – a similitude for God's book, the Bible – then man was an abstract or microcosm of the entirety of Creation (see, for example, Nicolson, 1950, esp. 22). Like the Book of Nature, this trope experienced a revival in the seventeenth century, in no small part because the observations and debates of experimental philosophers infused the metaphor with new meaning. In his *Religio medici* Thomas Browne links preformationist theories of plant reproduction to the compendium model of man, writing:

In the seed of a Plant to the eyes of God, and to the understanding of man, there exists, though in an invisible way, the perfect leaves, flowers, and fruit thereof: (for things that are in *posse* to the sense, are actually existent to the understanding). Thus God beholds all things, who contemplates as fully his workes in their Epitome, as in their full volume, and beheld as amply the whole world in that little compendium of the sixth day, as in the scattered and dilated pieces of those five before. (Browne, 1643, 115–116)

Thus, the seed encapsulates the preformed plant the same way man encapsulates the glory of God, who alone can view the whole volume of creation. In a letter to Thomas Browne, Henry Power recapitulates this view, writing that 'the smallest seeds are nothing but their own plants shrunk into an atome, which though invisible to us, are easily discernable to nature, and to that piercing eie, that sees through all things.' Power goes on to suggest the vanity of expecting 'an ocular demonstration of these things, unless,' he hopefully (and perhaps

4 Pointing to early descriptions of blood and sap as flowing like canalized water, Canguilhem argues that 'man first experiences and experiments with biological activity in his relations of technical adaptation to the milieu' (Canguilhem, 2008, 9). Though Highmore's use of bibliographic tropes is more subtle than his territorial metaphors, it is important that we include the book among those technologies that mediated early biological experiments.

a bit sarcastically) adds, ‘wee had such glasses (as some men rant of) whereby they could see the transpiration of plants and animals, yea the very magnetically *effluviiums* of the loadstone’ (Wilkin, 1835, 405–408). Thus, by extending the human eye, the microscope brings the vision of compendious man closer to that of God, who sees the full volume – which itself turns out to be nothing but nested compendia all the way down. Here, the weight of materiality – that is, of the experimental philosopher’s insistence on nature as no more than physical mechanisms – presses the book of nature trope to the point of cracking.

Grew resolves these tensions by collapsing the textual metaphor of reading or interpreting nature’s compendium into a structural analogy whereby the book’s form mediates living objects. Here, finally, we can begin to piece back together the sentence we have been dissecting to understand why Grew describes a plant as ‘an Animal in Quires,’ or an animal as ‘several Plants bound up into one Volume.’

The quire was an important structural unit in the production of books, both manuscript and printed. To facilitate binding, conjugate leaves cut from a sheet of paper or parchment were nested into small pamphlets, or quires. In printing, then, the number of leaves in a quire – and note the metaphoric use of ‘leaf,’ dating at least to Old English – determined the order in which the pages were imposed on a whole sheet of paper. (For instance, in a quire of four leaves, two conjugate pairs are stacked and then folded together, the first printed with pages two and seven on the front, and pages one and eight on the back; the second printed with pages four and five on the front, and pages three and six on the back.) Because a quire with many nested pairs of leaves complicated the process of ordering and imposing pages, signature marks along the bottom of the leaves guided printers and binders in gathering the conjugate pairs into one fold, as well as in stacking the quires to form a full volume. To analogize a plant to an ‘Animal in Quires,’ then, is to imagine the organism as an assemblage of individual parts, each part related to the whole in the same way, and each part’s placement known and laid out before it is inscribed with content. Pairs of leaves unfurl from a single stalk like folia from a quire’s fold; cut one leaf and the structure survives, though its symmetry suffers.

By contrast, the animal operates at the level of the individual, its parts subordinate to the operation of the whole organism. Cut off a deer’s leg and it may live; however, unlike a tree with one less branch, the three-legged deer is critically transformed, its ability to survive greatly diminished. Thus, if a plant is like a paper quire both in structure and in function, the animal is, Grew posits, like several quires ‘bound up into one Volume.’ That is, the animal’s anatomy is not loosely gathered, like that of the plant, but ‘bound’ together as a whole, its inner text shut between leather covers. A single volume has a spine to hold it together, and a title to give it a unique identity in the ecosystem of ideas. As a compilation of his previous publications, each printed with a unique title page

and dedication, Grew's own book reconfigures his many organs of thought into a single unit – it is both an 'Animal in Quires' *and* 'many Plants bound into one Volume.' In this ostensibly homely analogy, then, Grew presents a comparative anatomy, an incipient physiology and, perhaps most interestingly, a theory of the book – all mediated through the physical structure of the book. Life arises mysteriously from organized matter, Grew seems to be saying, in the same way immaterial concepts – life-altering, world-changing *ideas* – emerge from the mediated materiality of texts.

Man as compendium; as the bud of the Book of Nature; as a landscape seeded with the texts of life. When Grew opens his magnum opus on plant physiology with the sentence, 'So that a Plant is, as it were, an Animal in Quires; as an Animal is a Plant, or rather several Plants bound up into one Volume', he draws on a rich history of relating plants to animals, and animals to plants, using the metaphor of textuality. Grew's sentence is no dead timber, then, but a living system of thought situated within an ever-changing media ecology.

As this tangle of ideas has shown, the history of science is always also a history of media – of how the objects, laws and mechanisms of our world come to be known as and through our own technologies. Much of the field of book history explores how the book fomented particular forms of knowledge or social transformations; however, few scholars have focused on what Andrew Piper (2009) calls the 'bibliographic imagination,' that is, the symbolic dimension of the book as a cultural apparatus. In Grew's work, as well as in the bibliographic imagination of seventeenth-century experimental philosophy writ large, the book not only literally disseminated ideas but metaphorically inspired them, providing a kind of blank page onto which writers projected complex models for understanding the structure of life. These models have not disappeared: in fact, as Kay (2000) and van Rijn-van Tongeren (1997) point out, textual metaphors persist in biology today in how scientists conceptualize DNA synthesis and genes. For instance, in a rewriting of Grew's own metaphors, our bodies – themselves increasingly cyborgized – are today imagined as giving material form to nature's 'code' much as the book conceptually mediated life's matter in the seventeenth century.

Attending to the ways in which these bibliographic tropes remediated the vestigial epistemologies of marvelous zoophytes like the vegetable lamb or barnacle goose tree has shown how residual forms of knowledge alter a (micro)moment's relationship to its *own* media ecology. Thus, the process of 'becoming media' is also one of 'becoming *medieval*,' as our speculative futures transform the past both intellectually *and* materially. The task, then, is not to historicize so-called (or still-called) 'new' media forms – as if to prove, bluntly and ironically, Solomon's maxim – but to experiment with the surprising, sometimes inconsistent ways in which our present media ecologies re- and even *dis*-mediate the weight of history. As Grew well knew, in doing so, the marvels of earlier times become maps for discovering new worlds.

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