



## Fictional Science and Genre: Ectogenesis and Parthenogenesis at Mid-Century

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**Abstract:** Little-known literary treatments of the artificial creation of human life appear at mid-century, two generations before Shelley's *Frankenstein*. These works reveal complex responses to new experiments in the life sciences, despite their satirical elements, and they also allow glimpses into early generic formations before the existence of a 'science fiction'.

**Keywords:** fictional science, ectogenesis, parthenogenesis, artificial life, genre formation

Largely unremarked in the history of the sexes and the sciences in the long eighteenth century is the appearance of a handful of narratives from the 1740s and early '50s in which fantasies of artificial reproduction and human incubation appear. With one exception (John Hill, below) these materials are largely unknown to scholars: James-Brown Ashton, *An Essay on Increasing the Inhabitants and Riches of Ireland, and Propagating Mankind by Incubation* (1747); John Hill, *Lucina sine concubitu: A Letter Humbly Adress'd to the Royal Society, in Which Is Proved by Most Incontestable Evidence [...] that a Woman May Conceive and Be Brought to Bed without any Commerce with a Man* (1750); Richard Roe (pseud.), *A Letter to Dr. Abraham Johnson, on the Subject of His New Scheme for the Propagation of the Human Species* (1750); and Vincent Miller (pseud. ?), *The Man-Plant: or, Scheme for Increasing and Improving the British Breed* (1751). This article tries to answer two historically significant questions: why would fantasies about the artificial creation of human life begin to appear at mid-century? And what are the implications for our study of eighteenth-century literary history?

Answers to the first of these questions involve the impact on the literary imagination of then emerging technological developments in artificially assisted reproduction, greenhouse techniques, selective breeding and hybrids, chick incubation, artificial plant propagation and growth, and speculation that electricity might be a life force and play a role in generation. These new experimental contexts in what we now call the 'life sciences' together opened the startling possibility that humans might be able to imitate, control or even replace nature's own processes. Life itself, in other words, could be, and in some instances was, artificially created and manipulated, and the most dramatic imaginative frontier was not the impressive results that had been obtained with plants or animals but the possibilities with humans. Long before Lazzaro Spallanzani's late eighteenth-century experiments with electricity as a possible fecundating agent or John Hunter's artificial insemination of a human, creative literary minds of the mid-century imagined such possibilities. One might say that in this case the literary could sometimes imagine and articulate what science could not yet quite see.

Answers to the second question engage issues of origins and genre. My claim is that something new is emerging here on the literary scene. Avoiding an anachronism such as 'science fiction', I call these experimental narratives 'fictional science', drawing

attention to some of the earliest novelistic attempts to make use of *then* current science and technology (this excludes the fantastic voyage, utopias or dystopias, futuristic fantasies and so forth). The point I will try to make is that in this melting-pot of literary experimentation we witness the uneven and adventitious cultural remixing of newer and older materials that, taken together, represent a new literary undertaking, which, if sustained and repeated by others, will in time gain some generic status. Modern literary historians have been only too happy to assign the moment of generic origin to *Frankenstein* – with its mythical status as the originator of science fiction – forgetting that there is a history pre-1818 of writers who turned science into fiction, imagining the artificial creation of human life.

### I. *The Fictional Scientific Treatises: 1747-51*

In 1747 James-Brown Ashton's *An Essay on Increasing the Inhabitants and Riches of Ireland, and Propagating Mankind by Incubation* appeared. It is the shortest and least important of the four fictional sciences I present in this article, and has received no scholarly attention that I know of. The title page has 'Martinus Scriblerus, the Younger' as the author, instantly signalling a satirical agenda that will turn out to be reminiscent of Swift's *A Modest Proposal*. This thirteen-page mock treatise uses a fundamental theory of political arithmetic – that a greater population equals greater national wealth – in order to satirise 'the general Depravity and Degeneracy of Human Nature' caused by fashionable immorality and a decline of healthy reproduction.<sup>1</sup> Initiating a mock-logic based on William Harvey's *omne viva ex ovum* – 'all Things are produced from Eggs' (p.9), thus all women are egg-layers/hens – Ashton wants to bypass full-term pregnancies altogether, proposing that 'Every Female [...] shall [...] within three Days after Impregnation, lay or bring forth one Egg, with the same Ease and Safety that any other Fowl lays its Egg' (p.10). How this will be made to happen he doesn't say. Eggs can then be hatched variously by anyone sitting on 'Hatching Seats': 'by barren, old, superannuated Men as well as Women' or even by members of Parliament, who will provide a double service 'in Talking, as in Hatching' (p.11). His calculation is that 'a healthful young Female' will 'bring forth about one hundred and twenty well impregnated Eggs in one year' which, given a breeding career of some twenty years, will produce 'about four thousand two hundred Eggs' (p.12-13). The eggs from these 'well-fed human Pullet[s]' (p.12) have a twofold purpose: for consumption by the fashionable (here the Swiftian allusion becomes clearer) and for producing healthy, VD-free patriots who increase the population and national wealth, and allow greater competition with the arch-enemy France. Ashton concludes with a direct allusion to Swift's *A Modest Proposal*, contending that the proposal of 'a certain ingenious Cook, some time ago' (p.14) for slaughtering and eating young children is a heinous crime compared with eating the embryo taken from the shell 'for Ragout, or Fricacy': 'For as an Egg is no Flesh, it can be no Murder to destroy it' (p.14).

Of far greater complexity, and the object of some scholarly attention, is John Hill's fifty-three-page *Lucina sine concubitu*.<sup>2</sup> This is Hill's most acerbic satire of the Royal Society (which had rejected him), dramatising ludicrous scientific practice with a whiff of eroticism. Hill's pseudonymous author, Abraham Johnson, narrates a scene describing a distraught teenage daughter (and her horrified parents) who has just given birth but 'begged of Heaven to blast her immediately with Lightning, if ever she had known a man'.<sup>3</sup> Finally convinced (for no apparent good reason) of her veracity, Johnson picks a then outmoded reproductive theory from William Wollaston's *The Religion of Nature*

*Delineated* (1722) – i.e., the panspermist notion that all seminal elements were created at the beginning by God, and these primordial sperms reached the proper genitals of each species through food, water or air – and concludes that, like Virgil’s mares which had been impregnated by snuffing the western wind, his young lady has similarly conceived and given birth by swallowing or breathing in one of these microscopic animalcula.<sup>4</sup> To this he adds the concept of preformationism, the notion that embryos are miniature humans residing in the ovum or the sperm. After asking ‘why might not the Foetus be as completely hatched in the seminal Vessels of the Woman, as when it passes through the Organs of both Sexes?’ (p.10–11), he resolves to conduct an experiment in which a mechanical device – ‘a wonderful cylindrical, catoptrical, rotundo-concavo-convex Machine [...] electrified according to the nicest Laws of Electricity’ (p.15–16) – filters out sperm floating in the air: ‘when I had caught a sufficient Number of these small, original, unexpanded Minims of Existence’ and then applied ‘my best Microscope, [I] plainly discerned them to be little Men and Women [...] ready to offer themselves little Candidates for Life’ (p.16). Adding these to a chemical preparation, he administers the liquid to a virgin chambermaid ‘as a Dose of Physick’ (p.20), and she becomes pregnant. With certain proof ‘that a Woman may conceive without any Commerce with Man’ (p.25), he itemises a handful of classical examples of parthenogenesis that might presage his own discovery, and concludes with the various advantages his technique will permit: unmarried women’s reputations need no longer suffer if a pregnancy occurs; matrimony will no longer serve a purpose; and sexually transmitted diseases need no longer produce a diseased ‘unmanly Race’ (p.43). Instead, ‘your single-distill’d Infants’ will offer ‘an Offspring robust and healthy; British Valour will then recover its ancient Glory’ (p.46). Accordingly, he has set up a clinic in the Haymarket, where he will accept all patriotic ‘Women desirous of breeding’ – women who now, thanks to his discovery, have it ‘in their Power to raise our Vigour, and as I may say, to mend the Breed of Englishmen’ (p.47).

Shortly afterwards, Hill penned a fifty-four-page response to his own *Lucina sine concubitu*, this time authored by ‘Richard Roe’: *A Letter to Dr. Abraham Johnson, on the Subject of his new Scheme for the Propagation of the Human Species* (1750).<sup>5</sup> Pretending to admire Abraham Johnson’s scheme – ‘You have started a noble Subject, Sir! but you have failed in the Pursuit of it’<sup>6</sup> – Roe would take matters one step further and eliminate the need for women to suffer the physical inconveniences of pregnancy and the pangs of childbirth altogether. He has come upon a work by the French polymath René Antoine Ferchault de Réaumur, whose *Art de faire éclore et d’élever en tout saison des oiseaux domestiques de toutes especes* (1749; translated in 1750 as *The Art of Hatching and Bringing Up Domestick Fowls of All Kinds, at Any Time of the Year*) offered a detailed account of experiments with Egyptian techniques for using artificial heat to incubate chicks without a hen. Inspired by this technological leap, Roe uses carefully prepared wine casks as his ‘artificial Uteri’ (p.19), placing them in hot beds of dung where the interior temperature of each cask will be carefully monitored by thermometer so as ‘to regulate the Degree of Heat exactly to that of the human Uterus’ (p.20). The remaining obstacle is ‘finding a Way to fetch Embryo’s out of the Womb’ (p.24) at an early stage, and this will be accomplished by the tactical use of eagle-stones (hollow stones with a small pebble in the centre): worn about the arm, they will prevent abortion; worn on the leg, they ‘will immediately bring forth the little Embryo’ (p.25). Ready to experiment, Roe

publishes it among the Neighbours, that every Woman that pleased might now repair to me, and dance without Fear of paying the Piper! [...] That they might with me have all the Amusement that attended the being made with Child, and that they might be assured of

being delivered from all the Effects of their Entertainment, at the End of a Week and three Hours, without the least Pain or Danger.  
(p.26)

Predictably, he is 'soon crowded with Customers' (p.27), a common enough eighteenth-century satire of an unbridled female sexuality. Having impregnated his first test subject, a week later he deploys the eagle-stone and has her straddle the cask; the embryo slips out, and he adds a specially prepared liquid food as nutrient. As in Réaumur's lengthy account of trial and error, Roe experiences mixed results: many of his embryos die from over- or under-heated environments; others die from the intensity of the vapours; some drown in the liquid nutrient. Having once fancied 'myself at the Head of an Army of Embryo's, not less than Four Thousand strong' (p.35), he is now left only with the hope that he will indeed some day perfect the Réaumurian method, enriching England with an increased population, removing the national debt and enlarging the number of military men: 'Let the French, Sir, hatch Pullets, but let us breed Soldiers!' (p.38). Reflecting on human ingenuity and artificial ways to enhance plant and animal life (greenhouses, incubation) or even human life (Paracelsus' infamous baby 'in a Chymical Bottle [...] without the Help of any other Uterus at all' [p.46]), Roe contemplates classical examples of the artificial uterus (Bacchus, Erichthonius) and concludes by pretending to defend the honour of the Royal Society from Abraham Johnson's defamations: 'We are the People, Sir, who have prov'd Things – Things that no Body but ourselves would imagine required proving – We, Sir, are the only people in the World who ever proved that *Fire will burn*' (p.52).

Vincent Miller is probably a pseudonym; no one has yet identified the author behind the fifty-two-page *The Man-Plant: or, Scheme for Increasing and Improving the British Breed*.<sup>7</sup> This fictional scientific treatise is the most complex of the four, and mimics elements found in Hill's *Lucina sine concubitu* and *A Letter to Dr. Abraham Johnson*. In brief, the treatise presents a scheme for removing the pains of pregnancy and childbirth, as well as 'for increasing and improving the British Breed', by transplanting embryos into an artificial matrix; they are then placed in a hot-house where controlled heat and nutrients allow gestation to proceed normally until full term, when the baby is finally released through a Caesarean section of the external uterus.

Miller's influences, he says, are threefold: in Julien Offray de La Mettrie's *L'Homme plante* (1748) he has encountered 'the Analogy between the animal and vegetable Kingdoms' (p.5), in which similar physiological and especially reproductive systems were thought to be present.<sup>8</sup> His second inspiration comes from botanists whose parallels and analogies between plants and animals (both have veins, breathe, receive nutrition through tubes and have vascular function) include a common animating principle: 'The Principle of Life is in both the same; viz. the Solar Heat' (p.7). And he does not forget the most famous eighteenth-century botanist, Linnaeus, whose use of human sexual analogies and metaphors to describe the propagation of plants would soon become, in the Swede's account, the most influential and notorious version.<sup>9</sup> Plagiarising La Mettrie's text on the analogy between animal and plant realms, Miller illustrates the concept through a Latin 'Formulary, in which the Female of the human Species is described, as a Flower Plant, in the Method of *Linaeus* [*sic*]' (p.9). Miller's two pages of racy Latin treat the female human as a plant, yes, but emphasise sexual and reproductive parts.<sup>10</sup> Miller's thoughts go no further until he reads Richard Roe: 'the Communication of a Pamphlet wrote with much Fire and Spirit, by one of the greatest Naturalists of the Age, tending to establish the Possibility of hatching Men by an

artificial Heat, upon a Hint caught from *Monsr. Reaumer [sic]* (p.12). With this convergence of ideas and technologies – plant–animal/human analogy, some common reproductive/propagative element and Roe’s experiments with Réaumur’s incubation methods – Miller attempts his grand experiment. The ‘Solar Heat’ will come from ‘the vivifying electric Touch produced by the Friction of the generative Process, and radiated up the Womb’ (p.16), where the vital heat will be maintained. He will, like Roe, use eagle-stone to induce premature delivery. His artificial uteri will be soft, well-oiled, leather bladders placed inside wicker baskets and kept in a hot-house, where temperature and humidity can be strictly controlled. He develops a nutritional fluid for the foetus. Happening on a newly impregnated nineteen-year-old suitable for his designs, he induces premature delivery and the embryo slips out into his hand, at which point Miller reports: ‘with the Help of a magnifying Glass, I could easily discern a vermicular Motion, and the rubid Speck, or *Punctum Saliens*; which satisfied me, that I had got a well conditioned *Embryo*, endued with the necessary Principles of Vitality. I immediately then put it gently into the prepared Bladder’ (p.30). A boy child is born. Miller is hounded by women willing to participate in the experiment. He moves to his conclusion by pointing to the advantages of his scheme: women no longer suffer the painful consequences of reproduction; a healthy woman can contribute nearly 150 citizens in her reproductive lifetime; her body is maintained longer for the pleasure of her husband; there is now a physical equality between the two sexes; and the effeminate ‘fribbling Race [of men] that now totters about Town’ (p.38) will be replaced by true men ‘who antiently made such a Figure at the Battles of *Crecy* and *Agincourt*’ (p.38). Like Abraham Johnson and Richard Roe before him, he catalogues the best-known classical examples of the ‘artificial Matrix’ (p.44) – Bacchus, Erichthonius, Orion – congratulating himself that he has introduced ‘a new, and nobler System [...] of multiplying and meliorating the human species, by an Association of the Principle of Botany with the Powers of Pyrotechny’ (p.50).

The very few scholars who have examined these materials have tended to focus almost exclusively on satirical objects such as the Royal Society, the figure of the natural philosopher, the new science in general (as in the third voyage of *Gulliver’s Travels*), the use of human sexuality metaphors in botany, female sexuality, a degenerate population or competing theories of generation. (All but Ashton’s are a spoof of preformationism, or the embryonic development explained as a mechanical expansion of the miniature but fully formed human.) Current analyses of Hill’s two treatises and Miller’s *The Man-Plant* place them within the satire-of-science tradition that had sprung up in the late seventeenth century alongside the chartering of the Royal Society and the emergence of its new empirical methods. I certainly understand the reasons for such placement, but there is a literary-historical problem with an exclusive satire-of-science approach – namely, that it obscures developments in fictional science evident in my mid-century examples. I will return to this issue in the final section below. For now, I offer an assessment of the converging developments that pushed ectogenesis and parthenogenesis onto the fictional scene.

## II. Controlling Life, Replacing Nature

We might begin by reflecting on well-known claims that ‘life itself did not exist’ in the eighteenth century, that (in Michel Foucault’s words) ‘Historians [who] want to write histories of biology in the eighteenth century [...] do not realize that biology did not exist



then'.<sup>11</sup> Or François Jacob's observation that 'Throughout the seventeenth century and most of the eighteenth century, that particular quality of organization called "life" by the nineteenth century was unrecognized. There were not yet functions necessary to life; there were simply organs which function.'<sup>12</sup> I do not disagree with these expertly nuanced judgements; indeed, the word 'biology' did not appear until 1802, when Jean-Baptiste Lamarck and Gottfried Reinhold Treviranus independently coined the word. And I am persuaded by Denise Gigante's deft historical analysis that 'the ancient ideas of vitalism' or 'some invisible living principle' were temporarily tabled by the late seventeenth-century vogue for preformationism until discoveries of the 1740s made such mechanist approaches increasingly untenable and 'the concept of vital power reentered the scene of generation', where it would flourish in the second half of the century until it was replaced by cell theory in the nineteenth century.<sup>13</sup> And I agree with Giulio Barsanti's persuasive argument that it was with Lamarck that the new word 'biology' was used to describe 'life' in ways that we might think of it now: as the emerging property of particular organisations of matter.<sup>14</sup> But as the historian of science Jacques Roger has pointed out, 'It might well be [...] that there were "biologists" even before there was a "biology"',<sup>15</sup> and I would like to suggest that indeed a science of 'life' and the technologies of life (or some technological control over living matter) were present before the mid-century in ways that Foucault and Jacob would perhaps accept.

There is a surprisingly rich and varied background suggesting how such fictional possibilities would have been available to the collective imaginary by mid-century. A handful of key developments in the 1740s precipitated some of the imaginative concepts dramatised in the four fictional scientific treatises described above, and I will say a bit more about them shortly. However, it is useful to recognise that well before the mid-century what 'generation' meant had changed dramatically to include possibilities that had been taken out of nature's hands and placed within the reach of human intervention and artificial control. Notions that humans could artificially bring life into being, or manipulate and control it by imitating or even replacing nature, was on the historical radar screen. The brief survey of cases below is meant to illustrate the developing frameworks that prepared the ground for these fictions of human ectogenesis and parthenogenesis. I expect that my readers will recognise many of these examples, but are unlikely to have encountered them in this configuration. (At a few points I include post-1750 examples to show historical continuity.)

### I. 1653, Witnessing Life, Power over Life

There is a remarkable moment in William Harvey's *Anatomical Exercitations Concerning the Generation of Living Creatures* (London, 1653) in which he recounts the development of the embryo in the hen's egg:

If therefore you observe on the *fourth day*, you will meet a great *Metamorphosis*, and wonderful alteration [...] about which time the *Egg* beginneth to step from the life of a *Plant*, to the life of an *Animal*. For now the *Limbus* or *hemme* of the *colliquamentum* beginneth to blush and purple, being encompassed with a slender bloody line: and in the center almost of it, there leapeth a capering bloody point, which is yet so exceeding small, that in its *Diastole*, or *Dilatation*, it flasheth onely like the most obscure and almost indiscernable spark of fire [...] So slender are the first *Rudiments* of *Creatures* lives, which the *Plastical faculty* sets on foot by so undiscoverable beginnings.<sup>16</sup>

In this famous account of the *punctum saliens* is the heightened drama of witnessing the emergent moment of life and animation in an organism, which is interesting enough in its own right. But more remarkable is Harvey's experimentation with the effect of heat:

Moreover, expose an *egge* too long to the *colder aire*, and the *Punctum saliens* beats slower, and hath a languishing *motion*; but lay your finger warm upon it, or cherish it kindly any other way, and it presently gaineth *strength* and *vigour*. And after this *Punctum* hath declined by degrees, and being full of *blood* hath ceased from all *motion*, exhibiting no *specimen* of *life* at all, and was given up for lost, and dead, upon laying of my finger *warm* upon it, for the space of only *twenty pulses*, the poor heart hath awaked, and recovered again, and as it were rescued from the grave, proceeds to its former *harmony* afresh. And this hath been done again and again by me, and others, by any other reviving heat, were it of the Fire, or warm Water: as if it were in our dispose to condemne the litle *Soule* to the Shades, or reprove it to *life*, at pleasure.<sup>17</sup>

Striking here is Harvey's wondrous playing with life, the time he takes to explain his control and power over the animating heart, and the idea that he might or might not, at will, resuscitate or not: 'and this hath been done again and again by me'.

## 2. 1710, Before Eugenics

Human manipulation of nature's reproductive processes had several faces in the first half of the eighteenth century, one of the more peculiar examples coming in the anonymous twenty-four-page *Procreation Refin'd: A New Method for the Begetting Children with Handsome Faces* (London, 1710). Part of a burgeoning print culture of sexual advice manuals,<sup>18</sup> the treatise offers a regimen for how to engineer the beautiful baby, although it simply repeats notions present in medical treatises and anatomies that contained sections on the organs of generation. The formula is an oft-repeated one in the eighteenth century: marriages of convenience are a bad thing; conception will be enhanced by a positive frame of mind; mutual orgasm is a good thing; the spermatic economy must be carefully observed (not too much or too little male ejaculation in the man's sex life); and the impact of the female imagination during intercourse and gestation must be governed carefully: 'A breeding Woman to influence the *Beauty* of the Infant in her Womb, of all things in the World, must have her Eye entertain'd with fair and Beautiful Objects [ ... ] *Fancy* [...] so works with the pregnant Woman [...] that it goes very far in *Forming* and *Deforming* the Embryo in the Womb.'<sup>19</sup> The two anxieties here – worries about the quality of semen, suspicion about the disastrous effect of the wandering female mind – have significant presence in treatises on generation throughout the eighteenth century. The recurrent agenda was how to intervene or counsel so that unwanted results were pre-empted or forestalled.

## 3. 1717, The First Hybrid

Some time in the second decade of the eighteenth century the nurseryman Thomas Fairchild crossed a sweet william with a carnation, becoming 'the first person known to have raised a hybrid scientifically'.<sup>20</sup> The Fairchild Mule, as it was called, caused quite a stir, and the well-known and historically important horticulturalist Richard Bradley published the details of this hybrid in his *New Improvements of Planting and Gardening* (London, 1717). Animal breeders had long known that they could manipulate outcomes by controlling reproductive combinations in particular ways, and the livestock breeder Robert Bakewell of Dishley in Leicestershire would do so famously in the 1760s. Could such engineering be deployed more widely to species inter-mixing?

#### 4. 1717, Artificial Interventions

Notions of the 'artificial' inform the language used to describe both spurious quack prescriptions for how to grow a plant or tree in an hour or days and, more importantly, the language and techniques for successful hot-house or greenhouse productions. The anonymous *Artificial Gardiner: Being, a Discovery of a New Invention for the Sudden Growth of all Sorts of Trees and Plants* (London, 1717) would for a certain price reveal the chemical paste, liquids and method by which a remarkably accelerated growth could be achieved: 'In the space of one Hour, by the help of Fire and my Vegetative Mixture, I have made Twelve Slips of Limon Trees to produce Roots, Branches and Leaves, and from thenceforth the said Plants have continued to grow, and to bear Fruit'.<sup>21</sup> Included in the cost were directions for 'How to raise a Sallad in Two Hours Time' (p.28).<sup>22</sup> Far more significant is Richard Bradley's *The Artificial Gardiner: The Second and Last Part. Containing 1. The Nature of the Hot-Bed, and its Use in Gardening. 2. Some Farther Remarks Concerning Vegetation ...* (1717). Bradley pooh-poohs the extravagant claims of part one, and goes on to provide the details – about heat sources, ventilation, construction, light angles, moisture, nutrients – that would assure the capacity of a well-managed hot-bed to grow 'fine Flowers in the Winter Months'.<sup>23</sup> The point here is that notions of artificial life or growth had entered the market-place of ideas, offering the attractive possibility that natural processes could be replicated strategically in modified form so as to increase the speed of growth in man-made conditions.

#### 5. 1726, Greenhouses

Richard Bradley's various descriptions of greenhouse construction and management in *The Gentleman and Gardeners Kalendar* (1718) and especially in *New Improvements of Planting and Gardening* (1717-18) – the popularity of the latter is confirmed by its appearance in more than half a dozen editions – helped to spread knowledge about these practical matters. In vol. II of *A General Treatise of Husbandry and Gardening; Containing a new System of Vegetation* (London, 1726) he boasts that, 'As a great Curiosity which deserves to be noted in the Way of Gardening, Mr. Thomas Fowler, Gardiner to Sir Nathaniel Gould of Stoke-Newington, Middlesex, presented his Master upon New-year's Day, with a Brace of Cucumbers well grown'.<sup>24</sup> A small matter in one sense, of course, but these cucumbers also contained demonstrable proof of the possibilities of artificial generation, control and maintenance of ordinary or exotic plant life. Bradley's techniques offered the real possibility of a man-made generation and maintenance of life – in this instance, of plants – through the imitation and manipulation of nature's processes. Greenhouse potential was just one of the exciting new developments that seemed to place the mysteries of life-giving into human hands.

#### 6. 1740, Nature Controlled

In another instance of the powerful effect botany and horticulture were having, Andrea Wulf has described the extraordinary hot-houses constructed by Robert James Petre, the eighth Baron Petre, following the plans of another famous gardener-horticulturalist, Philip Miller:

One hothouse was entirely given over to the production of large numbers of pineapples, which were still so rare that they were often not eaten but passed around to show off at parties [...] The sixty-foot-long 'Tan Stove' or 'Ananas Stove' [...] was so sophisticated that



not even the harsh frost interrupted the harvest: in January 1740, with temperatures well below zero degrees centigrade, Petre sent one pineapple by coach to London, so that [Peter] Collinson would not miss the treat.<sup>25</sup>

'For many', Wulf adds, 'pineapples were the proof that man controlled nature and therefore a most sought-after status symbol'.<sup>26</sup> By the mid-1760s, 'Gardeners now produced cucumbers at Christmas, peas and beans in February, and grapes in May – and for the outrageous sum of a guinea or two the spoilt customer could even buy a pound of cherries in March'.<sup>27</sup>

## 7. 1740, Generation without the Male

The 1740s witnessed the proliferation of remarkable findings that would challenge previously held positions about generation and open up all manner of possible answers and possibilities. In 1740 the Swiss naturalist Charles Bonnet discovered parthenogenesis in aphids. He was able to rear ten generations without any males.<sup>28</sup> The implications were significant: traditional explanations requiring male and female conjunction, the merging of fluids or egg and sperm were challenged by these findings, and the lack of a male suggested that perhaps ovist preformationism was the correct theory.

## 8. 1742/1744/1750, Artificial Wombs

The artificial womb can be found as early as 1742, in William Smellie's *Course of Lectures upon Midwifery*, not as a fantasy but as a mechanical and practical device for teaching students how to perform deliveries:

By wet and dry Preparations, and other artificial Contrivances, plac'd in different Machines, are shewn the following Parts. The *Vagina* [...] the *Uterus* [...] The *Fallopian Tubes*, *Ovaria* [...] The gradual Opening of the Orifice, and the Stretching of the Neck of the Womb.<sup>29</sup>

Two years later the fashionable male midwife Richard Manningham would offer similar assistance in *An Abstract of Midwifry, for the Use of the Lying-In Infirmary* (London, 1744): 'I have [...] prepared a *Machine* for the Performance of Deliveries of all kinds, by Means of a Contrivance made on the Bones or *Skeleton* of a Woman, with an *artificial Matrix*' by which 'Pupils become [...] Proficients in the Business, before they attempt a real Delivery'.<sup>30</sup> In her assessment of the mechanical wombs used by Manningham and Thomas Young (in 1750) Pam Lieske remarks that 'These artificial, yet real, bodies had to mimic the look, the feel, and touch of live bodies, and all bones and organs – the pelvic basin, uterus, amniotic sac, cervix, placenta, and vagina'; she concludes that 'obstetrical machines [...] should still be viewed as an Enlightenment attempt to approximate nature' in 'the belief that human life could be simulated'.<sup>31</sup>

## 9. 1745, Human Cross-Breeding

Cross-breeding of both animals and plants had produced interesting and sometimes profitable results, but could selective breeding and hybrids allow humans to engineer improvements to a human population? In the mid-1740s Pierre-Louis Moreau de

Maupertuis pondered the production of new species: 'We find new breeds of dogs, pigeons, canaries appearing on the market, though they did not exist in nature. At first they were individual freaks, but art and repeated generations turned them into new species [...] Why is this art restricted to animals?'<sup>32</sup> Theories about improving or altering human populations through various means – race/class mixing, purification of blood by limiting reproductive partners, selecting for desirable characteristics, health regimes, fertility enhancements – would soon enter the larger context of generation and early eugenics theories.<sup>33</sup>

## 10. Late 1740s, Sex and Electricity

William Stukeley was probably the first to insist on the importance of electricity for fertility, writing in his notebooks that electricity 'is the principle of all generation in animals. The [...] action is purely electrical, as is the impregnation of the ovum of the female, which contains the embryo.'<sup>34</sup> The idea would be replayed in erotica such as *Teague-Root Display'd, Being Some Useful and Important Discoveries Tending to Illustrate the Doctrine of Electricity in a Letter from Paddy Strong-Cock* (1746) and carry forward to the quack James Graham's theories in the 1780s that the very friction of copulation was inherently electrical.<sup>35</sup>

## 11. 1749, The Great Incubation

As mentioned above, the most spectacular example of assisted reproduction using incubation was Réaumur's *Art de faire éclore et d'élever en tout saison ...* (1749; translated and published in London in 1750 as *The Art of Hatching and Bringing Up Domestick Fowls of All Kinds ...*). Spanning nearly 500 pages, this work had quite an impact, and references to Réaumur's practices were routinely indexed in scientific dictionaries under 'hatching' and 'stoves'. The fundamental premise is one we now take for granted, but one that in the mid-eighteenth century was brand-new to most: using artificial means to sustain chick development until hatching and beyond *without* the hen. Réaumur refers to the interior of his incubation device as 'the artificial mother'.<sup>36</sup> We need an act of historical imagination here to appreciate the powerful implications of Réaumur's demonstrations that human interventions could mimic the necessary conditions for life to come into being, and one of the memorable features of his painstaking accounts is his excitement in the recognition that his experiments have generated life outside nature's normal course:

I could hardly let the first four and twenty hours pass without attempting to view the effect which a well proportioned and well managed heat had produced in the eggs; I broke two, in which I had the pleasure to see the beating of the little heart [...] this was a sight which a naturalist cou'd not be tired of, were it to last much longer than it does.<sup>37</sup>

Not only imitating nature but also, according to Réaumur, improving, outdoing and replacing nature by incubation, an 'artificial mother' and a set of artificial maternal functions to generate life and raise it, the practical results were not inconsiderable: the mass production of eggs and poultry for human consumption.

## 12. 1749, Artificial Propagation

In the spring of 1749 Johann Gottlieb Gleditsch made a nine-day journey transporting pollen from a male date-palm in Leipzig to fertilise a female palm successfully in Berlin.<sup>38</sup>

The implications are significant: the portability of reproductive matter, in this case for propagation, and later, with John Hunter in the 1770s, for human insemination.

### 13. 1749, Spontaneous Generation

John Turberville Needham, an English Roman Catholic and a colleague of Buffon, claimed that there was a kind of universal semen from which all generation originated, and at microscopic levels one could see this in the spontaneous generation of animalcula in boiled meat infusoria:<sup>39</sup> ‘To the naked Eye, or to the Touch, it appear’d a gelatinous Matter, but in the Microscope was seen to consist of innumerable Filaments; and then it was that the Substance was in its highest Point of Exaltation, just breaking, as I may say, into Life.’<sup>40</sup> While many disagreed – his experiment inadvertently led to micro-organisms; matter itself couldn’t flip the reproductive life-switch on – Needham was nevertheless one of several experimentalists in the 1740s who wondered if generation was somehow the property of matter itself. Of course, the philosophical and theological implications of such discoveries and theories were complex.<sup>41</sup> Had God made all organisms in advance at the beginning? Could matter contain within itself the power to develop life, or did it need a divine ‘push’ for it to reproduce? Like Harvey and Réaumur, Needham recorded his fascinated presence as a witness of matter ‘just breaking [...] into Life’.

The influence of these contexts on the fictional science is clear enough, I think, because without such developments James-Brown Ashton, John Hill (under the pseudonyms of Abraham Johnson and Richard Roe) and Vincent Miller would probably not have been able to conceive their central fictional premises in these ways. And it is important to reiterate: the fact that there are satirical elements in all four ought not to disguise or negate the fact that these writers were engaging then current scientific technology and theory derived from experimental and observational data. While making no claim to literary greatness, these fictional sciences *can* claim our attention as the earliest experiments in narrating what were then the frontiers of reproductive possibilities: ectogenesis and parthenogenesis.

### III. Of Melting Pots, Remixes and Genre

Something new is emerging here, a generic tendency unlike anything that had gone before. We are witnessing the first extensive engagement with scientific theory and experimentation as the entire subject for literary treatment. Quick scrutiny of earlier literature that engages science as content suggests a very different character from these four fictions. Shadwell’s crack-brained Gimcrack in *The Virtuoso* (1676) is only part of the overall thematic agenda, and *The Third Part of the Works of Mr. Abraham Cowley, being his Six Books of Plants, Never Before Printed in English* (1689) poeticises horticulture and botany towards political ends. Matthew Prior’s *Alma; or, The Progress of the Mind* (1718), James Thomson’s *A Poem Sacred to the Memory of Sir Isaac Newton* (1727) or his *The Seasons* (1726–30), Alexander Pope’s *An Essay on Man* (1733–4) and John Armstrong’s *The Oeconomy of Love* (1739) all bring scientific themes within poetic registers for complex ends, but without making the scientific enterprise – theory, experimentation, observation, collection of data, rendering of likely results – the centrepiece of the poems. Swift’s lunatic scientists in the third voyage of *Gulliver’s Travels* are likewise incidental to his comically dark vision of humanity rather than

its major players, and Henry Fielding's *Some Papers Proper to be Read before the Royal Society, Concerning the Terrestrial Chrysisus, Golden-Foot or Guinea; an Insect or Vegetable. Resembling the Polypus* (1743) mimics the rhetorical procedure of the *Philosophical Transactions*, supposing that gold coins – like Abraham Trembley's polyps – might also multiply by being cut in half, although Fielding's real targets are money and greed rather than science. Mark Akenside's *The Pleasures of the Imagination* (1744) is a fascinating use of the period's nervous physiology, but its ultimate aim is to craft a view of British creativity. These works certainly reflect aspects of what was happening in science, but then current science and technology were not yet the central subject.

Setting aside the less interesting and very brief James-Brown Ashton incubation-hatching treatise, the rest of my remarks concern the two John Hill pieces and Vincent Miller's *The Man-Plant*, which represent remarkable mid-century developments in how the literary world used science as the main subject matter. Each of these three first-person narratives fictionalises elaborate scientific undertakings based on cutting-edge theory and practice related to aspects of generation – in botany, horticulture, electricity, incubation, studies of heat, functions of sperm and egg – and tracks in considerable detail the steps in the experiment leading to the emergence of life under artificial conditions. The entire narrative frame in each is the scientific experiment itself, and its form is modelled on non-literary treatises (such as Harvey's, Bradley's or Réaumur's) describing theory and methods used in practical experimentation. The satirical elements in each fiction momentarily redirect attention away from the experiment at hand to social commentary and criticism – of fashion, masculinity, sexuality or unhealthy populations – and sometimes the comical mirror is held up to the figure of the scientist himself or to the Royal Society, but we must not let the readerly pleasures of identifying satirical demolitions obscure the primary narrative platform of these three fictions: the natural philosopher telling the story of the technological details of experiments in ectogenesis and parthenogenesis. This is all new ground.

An important qualification, however: in saying that the Hill and Miller works are modelled on non-literary treatises I do not mean to suggest that they have adopted a new discourse that exclusively marked the rhetorical protocol for the new sciences, since (as is well documented by scholars<sup>42</sup>) the languages of science from, say, 1650 to 1750 were still informed by literary elements and discursive mixes: metaphor, analogy, the scene, novelistic moments, classical and Biblical allusion, even the use of poetry. A brief list will help to make this point: Francis Bacon the proto-novelist; key tropes and metaphors in Thomas Willis serving as a kind of imaging technology; erotic scenes in eighteenth-century botanical publications such as Sébastien Vaillant's *De structura florum* (1718) – one of the first French publications to promote the theory of sexuality in plants – and Adriaan van Royen's Latin poem *Carmen elegiacum de amoribus et connubiis plantarum* ('Elegiac Song on the Loves and Weddings of the Plants', 1732); novelistic scenes and characterisation in Réaumur's *Art de faire éclore et d'élever en tout saison ...*, which sometimes reads a bit like the detailed daily work accounts in Defoe's *Robinson Crusoe*. As Claire Preston has aptly reminded us,

It is not too audacious to say that the humanist curriculum, with its huge emphasis on the rhetorical as the mother art, preconditioned and shaped the conduct of early-modern science [...] [T]he fact that early-modern natural philosophers and historians all came to science [...] from the intensely rhetorical humanist training of the grammar schools, universities, and Inns of Court means that it would be extremely peculiar had scientific practitioners themselves *not* been rhetorically adventurous and adept, and it is hardly surprising that scientific

practice, scientific theory, scientific training, and scientific results were rhetorically dense, imaginatively suggestive, and often formulated in verse, plays, elegies, inscriptions, and utopian essays.<sup>43</sup>

Similarly, in their discussion of John Hill and the mid-century cultural scene, Clare Brant and George Rousseau have also pointed to the ‘Strong affinities between science and non-science [that] were clearly present at mid-century’.<sup>44</sup>

Indeed, the rhetorical and conceptual protocols that gradually narrowed the communications of science to a more specialised and professionalised idiom were still in their formative stages well into the second half of eighteenth century. In similar fashion – and of course in related ways – these mid-century fictional science narratives also contained, unsurprisingly, an admixture of older and newer materials from several discursive domains: the newer scientific details in a language increasingly associated with the scientific treatise (measurement, chronological reportage, recording of data, the first-person assurances of veracity etc.); classical allusions; historical references; references to the work of other natural philosophers; ironic glances at fashionable behaviour; satirical swipes at the over-sexed female or the effete man of the town; implied satire of the man of science; erotic scenes and pornographic hints. And of course there are the many novelistic moments, as in *The Man-Plant*: ‘I pitched then upon my Gardener’s Daughter, for an Essay of this infinite Importance. Her name was *Sally*, a ‘very pretty, healthy’ eighteen-year-old who ‘was in that critical Season, when the Integrity of a Girl hangs upon a single Hair, and her Virgin-flower sits so loose, that it drops with the least Shake, or warm Breath, as one sees a Peach-blossom blown away with the lightest Puff of a Western Breeze’.<sup>45</sup>

I use metaphors such as ‘melting-pot’ and ‘cultural remix’ because they capture the rhetorical and discursive messiness of the literary experimentation we are witnessing here; and they are perhaps more effective heuristic images for early generic formations than some pristine notion of ‘the birth of science fiction’ or ‘first example of the genre’. John Reider has offered a shrewd and trenchant observation about science fiction and the problem of origins: ‘Genre [...] is always found in the middle of things, never at the beginning of them.’<sup>46</sup> These mid-century fictional sciences are certainly somewhere at the beginning of what will later gain traction as a generic type; they are promiscuous narratives (in the eighteenth-century sense of indiscriminate mixture), putting new aspects of the life sciences and experimentation at the centre of the story and delivering the whole in a *mélange* of subject styles, first-person tones and multiple sub-agendas. Just as we can eavesdrop on biologists before there was a biology, so we are here able to trace the mixing together of literary, scientific and other cultural elements before such confluences had been narrowed to a name, a category, a subgenre of its own.

There is an interesting historical zig-zaggery that gets us from mid-century fictions of ectogenesis and parthenogenesis to Victor Frankenstein’s ‘bestowing animation upon lifeless matter’ in 1818;<sup>47</sup> but this mapping is beyond the space limitations allowed here. Mary Shelley – who apparently had no knowledge of these minor publications, fascinated understandably with heavyweights such as Erasmus Darwin and the brilliant new chemists and electricians – had been unknowingly scooped by these minor publications. Not that anyone noticed or cared.

The mid-century fictions I have presented here will seldom be read or taught in graduate seminars; they are unlikely to be included in anthologies; they will, understandably, be overshadowed by much finer literature such as Shelley’s *Frankenstein*. But these



odd little works are the first fictions about artificial life and its creation invoking then current science, and they offer us a glimpse into the mix of early formative materials before a stable generic status would be invented in hindsight by our twentieth-century presentist colleagues.

## NOTES

1. James-Brown Ashton, *An Essay on Increasing the Inhabitants and Riches of Ireland, and Propagating Mankind by Incubation* (London, 1747), p.5. Subsequent references are cited in parentheses within the text.

2. John Hill, *Lucina sine concubitu* (London, 1750). Julie Peakman, *Mighty Lewd Books: The Development of Pornography in Eighteenth-Century England* (London: Palgrave, 2003), p.78-80, situates the treatise in the history of the emerging science-erotica conjunction, as well as in satires of the Royal Society. George Rousseau, *The Notorious John Hill: The Man Destroyed by Ambition in the Era of Celebrity* (Bethlehem, PA: Lehigh University Press, 2012), p.65-80, 85-90, provides the most searching account of the biographical context and Hill's satirical agenda. In 'Panspermist Jokes, Reproductive Technologies, and Virgin Births: Some Enlightenment Luciniades', in Raymond Stephanson and Darren N. Wagner (eds), *The Secrets of Generation: Reproduction in the Long Eighteenth Century* (Toronto: University of Toronto Press, 2015), p.500-529, Rousseau revisits the treatise, unpacking Hill's complex management of then current theories of generation.

3. Hill, *Lucina sine concubitu*, p.7. Subsequent references are cited in parentheses within the text.

4. Conway Zirkle reviews the historical contexts of Wollaston's panspermism and Hill's satire briefly in 'Animals Impregnated by the Wind', *Isis* 25 (1936), p.122-5.

5. Richard Roe' [John Hill], *A Letter to Dr. Abraham Johnson, on the Subject of his new Scheme for the Propagation of the Human Species: In Which, Another Method of obtaining that great End, more adequate to the Sentiments of the Ladies, is proposed; and, The Reflections that Author has cast upon The Royal Society of London, are answered. By a Fellow [of the Royal Society]* (London, 1750). The only scholarly comment on this work is Peakman, *Mighty Lewd Books*, p.83-4, who views it as a parody of René Antoine Ferchault de Réaumur's *Art de faire éclore et d'élever en tout saison des oiseaux domestiques de toutes especes* (1749; trans. 1750 as *The Art of Hatching and Bringing Up Domestick Fowls of All Kinds, at Any Time of the Year*), and as a satire of male fears of female sexuality. Peakman repeats this argument in 'John Hill and His Erotic Satires', in Clare Brant and George Rousseau (eds), *Fame and Fortune: Sir John Hill and London Life in the 1750s* (London: Palgrave, 2018), p.162-5.

6. 'Richard Roe' [John Hill], *A Letter to Dr. Abraham Johnson*, p.7. Subsequent references are cited in parentheses within the text.

7. Vincent Miller [pseud. ?], *The Man-Plant: or, Scheme for Increasing and Improving the British Breed* (London, 1751). Subsequent references are cited in parentheses within the text. Extant scholarship is small. See: Paul-Gabriel Boucé, 'Chthonic and Pelagic Metaphorization in Eighteenth-Century English Erotica', *Eighteenth-Century Life* 11 (1986), p.213, who views the treatise as an instance of horticultural metaphorisation of the reproductive body; Peakman, *Mighty Lewd Books*, p.88-9, who notes that it foregrounds then current questions about gender and pleasure in reproduction; Karen Harvey, *Reading Sex in the Eighteenth Century* (Cambridge: Cambridge University Press, 2004), p.83-5, 142-4, who finds in it competing theories of conception and underlying concerns about regenerating the male population during a mortality peak in the 1740s; and Sam George, *Botany, Sexuality and Women's Writing, 1760-1830* (Manchester: Manchester University Press, 2007), p.13, who briefly notes that it is a satire of botanical treatises inspired by La Mettrie.

8. In his preface to *L'Homme plante* (Potsdam, 1748) La Mettrie boasts that 'the singular analogy between the plant and animal kingdoms has led me to the discovery that the principal

parts of men and plants are the same' (*Man a Machine and Man a Plant*, trans. Richard A. Watson and Maya Rybalka (Indianapolis, IN, and Cambridge, MA: Hackett Publishing, 1994), p.77. The analogy, and plant–animal parallels, are hardly any 'discovery' in 1748, having been around since the late seventeenth century, but the radical French materialist presented perhaps the most challenging version of the idea.

9. The *sexus plantarum* was not invented by Linnaeus; the idea of the sexes of plants went back to Andrea Cesalpino and Nehemiah Grew.

10. La Mettrie doesn't bother with Latin as a polite cover, instead bluntly explaining that the 'nectarium [...] is like the breast that contains the milk [...] The *stylus* in a woman is the vagina. The vulva or mount of Venus and the odor that exhales from the glands of these parts correspond to the *stigma*' (*L'Homme plante*, p.79).

11. Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (New York: Vintage Books, 1973), p.127-8.

12. *The Logic of Life: A History of Heredity*, trans. Betty E. Spillman (Princeton, NJ: Princeton University Press, 1973), p.34.

13. *Life: Organic Form and Romanticism* (New Haven, CT, and London: Yale University Press, 2009), p.7, 12-13, 40. The definitive study of the complex shifts from mechanism to vitalism is Peter Hanns Reill, *Vitalizing Nature in the Enlightenment* (Berkeley, CA: University of California Press, 2005).

14. 'Lamarck: Taxonomy and Theoretical Biology', *Asclepio* 52:2 (2000), p.119-31.

15. 'The Living World', in G. S. Rousseau and Roy Porter (eds), *The Ferment of Knowledge: Studies in the Historiography of Eighteenth-Century Science* (Cambridge: Cambridge University Press, 1980), p.263.

16. William Harvey's *Anatomical Exercitation Concerning the Generation of Living Creatures* (1653), p.89-90.

17. Harvey, *Anatomical Exercitation*, p.95.

18. See Roy Porter and Lesley Hall, *The Facts of Life: The Creation of Sexual Knowledge in Britain, 1650-1950* (New Haven, CT, and London: Yale University Press, 1995), p.11, 33.

19. [Anon.] *Procreation Refin'd: A New Method for the Begetting Children with Handsome Faces* (1710), p.18.

20. Blanche Henrey, *British Botanical and Horticultural Literature before 1800, vol. I, The Sixteenth and Seventeenth Centuries* (London: Oxford University Press, 1975), p.338.

21. [Anon.] *Artificial Gardiner: Being, a Discovery of a New Invention for the Sudden Growth of all Sorts of Trees and Plants* (1717), p.18.

22. [Anon.] *Artificial Gardiner* (1717), p.28.

23. Richard Bradley, *The Artificial Gardiner. The Second and Last Part. Containing 1. The Nature of the Hot-Bed, and its Use in Gardening. 2. Some Farther Remarks Concerning Vegetation ...* (1717), p.1.

24. Richard Bradley, *A General Treatise of Husbandry and Gardening; Containing a New System of Vegetation*, vol. II (1726), p.454.

25. Andrea Wulf, *The Brother Gardeners: Botany, Empire and the Birth of an Obsession* (London: William Heinemann, 2008), p.89-90.

26. Wulf, *The Brother Gardeners*, p.41.

27. Wulf, *The Brother Gardeners*, p.167.

28. Elizabeth Gasking, *Investigations into Generation 1651-1828* (Baltimore, MD: Johns Hopkins Press, 1967), p.64.

29. *Course of Lectures upon Midwifery, Wherein the Theory and Practice of that Art are Explain'd in the Clearest Manner [...] The Manner of Delivering Women, in all the Variety of Natural, Difficult, and Preternatural Labours, Perform'd on Different Machines made in Imitation of real Women and Children* (1742), p.4.

30. Richard Manningham, *An Abstract of Midwifry, for the Use of the Lying-In Infirmary (1744)*, p.33.
31. “Made in Imitation of Real Women and Children”: Obstetrical Machines in Eighteenth-Century Britain’, in Andrew Mangham and Greta Depledge (eds), *The Female Body in Medicine and Literature* (Liverpool: Liverpool University Press, 2011), p.78, 75, 80.
32. Pierre-Louis Moreau de Maupertuis, *Vénus physique* (Paris, 1745), trans. S. B. Boas as *The Earthly Venus*, with notes and introduction by G. Boas (New York: Johnson Reprint Collection, 1966), p.72.
33. For example, see Susanne Lettow, ‘Improving Reproduction: Articulations of Breeding and “Race-Mixing” in French and German Discourse (1750-1800)’, in Stephanson and Wagner (eds), *The Secrets of Generation*, p.120-40.
34. Quoted in Mary Fairclough, *Literature, Electricity and Politics, 1740-1840* (London: Palgrave, 2017), p.81.
35. The most recent scholarly discussion of electrical eroticism in *Teague-Root Display’d* and Graham is Fairclough, *Literature, Electricity and Politics*, p.79-103.
36. René Antoine Ferchault de Réaumur, *The Art of Hatching and Bringing Up Domestick Fowls of All Kinds (1750)*, p.249.
37. Réaumur, *The Art of Hatching*, p.61.
38. H. F. Roberts, *Plant Hybridization before Mendel* (New York and London: Hafner, 1965), p.106.
39. Shirley A. Roe, *Matter, Life, and Generation: 18th-Century Embryology and the Haller–Wolff Debate* (Cambridge: Cambridge University Press, 1981), p.18-19.
40. John Turberville Needham, *Observations upon the Generation, Composition, and Decomposition of Animal and Vegetable Substances* (London, 1749), p.31.
41. Aram Vartanian, ‘Trembley’s Polyp, La Mettrie, and Eighteenth-Century French Materialism’, *Journal of the History of Ideas* 11:3 (1950), p.259-86.
42. For example, see Londa Schiebinger, *Nature’s Body: Gender in the Making of Modern Science* (Boston, MA: Beacon Press, 1993), p.26.
43. *The Poetics of Scientific Investigation in Seventeenth-Century England* (Oxford: Oxford University Press, 2015), p.12.
44. ‘Introduction’, in Clare Brant and George Rousseau (eds), *Fame and Fortune: Sir John Hill and London Life in the 1750s* (London: Palgrave, 2018), p.16.
45. Miller (pseud.), *The Man-Plant*, p.25.
46. ‘On Defining SF, or Not: Genre Theory, SF, and History’, *Science Fiction Studies* 37 (2010), p.196.
47. Mary Shelley, *Frankenstein*, ed. D. L. Macdonald and K. Scherf (Peterborough, Ont.: Broadview Press, 2012), p.78.

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