Were early modern naturalist collectors carrying out experiments?

In its early modern form, experimentation as a concept owed much to Robert Boyle. It consisted of a prescribed set of practices for creating scientific knowledge, which acquired hegemonic influence through the Royal Society. When naturalists of the late seventeenth century and beyond referred to experimentation, it is fair for the historian to assume that they meant Boyle's method. Although such a focus will restrict historical analysis to the English-speaking world, it provides for a fairly stable structure upon which to base any analysis of the behaviour of those early modern people who self-consciously aspired to generate scientific knowledge through an experiential process. To restrict its focus to those who were aware of Boyle's scientific method, this essay will only address the activities of naturalists who maintained scientific collections, rather than the informal collections of recipes, natural medical supplies, or trade equipment maintained by many people in the early modern world.

The dominance of Boyle's experimental philosophy within the early Royal Society, and thus the intellectual world of early modern Britain, is central to many histories of the rise of experimentalism, including Simon Schaffer and Steven Shapin's seminal *Leviathan and the Air-Pump*. When collections of natural objects were constructed with

the aim of creating scientific knowledge, and collectors interacted with their specimens to this end, such as through dissection or comparative analysis, their use of collections might be considered a form of experiment. This was the case for many early modern naturalists, such as John Ray, Francis Willughby, and others, who reached scientific conclusions on the basis of their collections. Boyle's experimental natural philosophy also differed from the Aristotelian model of observing nature that it supplanted because, as well as demanding the interaction of the scientist and their experimental subject, it also required the construction of an artificial, controlled context in which this interaction was to take place. A great deal of scientific procedure for obtaining and preserving specimens in a sufficiently lifelike way was then required for a collection to be considered experimental. Although many scientific collectors took great care to assemble extensive bodies of representative and comparable specimens of well-known provenance through either fieldwork or purchase, this was a difficult task, with the adequate preservation of materials proving a serious obstacle to scientific research of the time. Similarly, given the extensive social demands incumbent upon early modern naturalists for impressive displays, they often found their practice at odds with good experimental procedure. The diary of Zacharias Conrad von Uffenbach, a German student who made social calls to essentially every major scientific figure of this period in 1710, provides a particularly useful record of this sort of practice, which includes the collection of falsified specimens in order to make collections more interesting. Although early modern scientists usually aspired to a form of experimentalism, limitations in the quality of their collections often meant they fell short of the Boylean ideal.

For the purposes of this essay, it will be held that the ideals of early modern experimentalism were those which Boyle elucidated in the mid-seventeenth century. These

consisted principally of the requirement that original scientific knowledge was generated through sustained interaction with an experimental subject, either by comparison or by physical manipulation. With the conclusion of his conflict with Hobbes and the domination of the Royal Society by his experimental philosophy, there came, as Shapin and Schaffer argue, an early modern consensus on the proper experimental way of generating scientific knowledge, and the forms of practice which accompanied it. Developing on the programme of intellectual rigour which Bacon had espoused decades before, Boyle wrote multiple prescriptive texts to be published by the Royal Society on this theme. Contained within these was the direction that experiment demanded the creation of knowledge, with the demand that naturalists "either bring New Experiments and Observations, or else must consider those that are known already after a new Manner, and thereby make us take notice of something in them unheeded before."[1] Passive observation did not fulfil the requirement for experimental practice either, with Boyle stating that "though there be many things in nature that may be readily enough made out by the size, motion & figure... there are many more that cannot be well explain'd without a great deal of discourse, and divers successive Deductions of one thing from another."[2] Thus, experimentation can be said to have demanded a line of scientific enquiry and a degree of interaction with the subject.

Shapin and Schaffer suggest that the influence of this Boylean philosophy, which quickly became hegemonic within the early Royal Society, represents the triumph of this ideal of experimentalism across the educated early modern scientific world. Boyle's social victory over the traditionalist Hobbes among the ranks of Society members meant that by the later part of the seventeenth century, the iconography of experimentation came to represent the Society as a whole. An image of Boyle's air pump, engraved by Wenceslaus

[1]Robert Boyle, *Certain physiological essays* (London: Henry Herringman, 1669), p. 7.
[2]Ibid., p. 21.

Hollar as a symbol of experimental life, appeared as the frontispiece to Thomas Sprat's *History of the Royal Society* in 1667. This was a work which Shapin and Schaffer described as being particularly emblematic of the "apologetic [Boylean] texts that appeared in the 1660s."[3] So total was the commitment of this work to the Boylean philosophy that its followers equated the rise of experimentation with the decline of civil strife in Restoration England, writing that the existence of experimental procedure "gives us room to differ without animosity; and permits us to raise contrary imaginations upon it, without any danger of a civil war."[4] The primary question must then be the degree to which early modern naturalists abided by Boyle's directions in their interaction with their collections.

Although much of the experimental programme was formalised through the auspices of the Royal Society, it is nevertheless not only the Society that should demand our historical attention when considering early modern experimentation. The study of individual experimenters' activities, often independent or even antagonistic to the Society, allows for a more comprehensive survey of English scientific collecting. Often through those long trails of correspondence that defined the often-talked-about republic of letters in that period, this collaborative form of scientific endeavour has much in common with the collective intellectual labour that Bacon envisaged would be central to the new form of experimental science.[5] This understanding has preeminence in the historiography of the mid-twentieth century. It informs, for example, Jean Jacquot's 1953 judgement that Hans Sloane's use of comparative observation rendered him an experimentalist. He writes that "the wide range of his curiosity and the amplitude of his means as a collector, enabled him to bring together facts which, by their mere juxtaposition, gave rise to

[3]Steven Shapin and Simon Schaffer, *Leviathan and the air-pump* (Princeton: Princeton University Press, 1985), p. 301.

[4]Thomas Sprat, *The history of the Royal Society of London for the improving of natural knowledge* (London: John Martyn, 1667), p. 346.

[5]Michael Hunter, *Establishing the new science* (Woodbridge: The Boydell Press, 1989), p. 187.

new problems which in their turn required new interpretation." Victoria Pickering has placed Sloane's collection of 'vegetable substances', many of which had specific medical applications, within the category of material collected for "didactic research purposes"[6] and had experimental value. The specimens to which Pickering refers were essentially materia medica, plants which were purported, typically within the non-European setting from which they had originally been gathered, to possess some medical value. Pickering argues that Sloane preserved these specimens, among whose number were a Guinean "shrub called Haa-hah... made use of by the natives in a fever or the dry gripes" as well as the "Bellyach root of Virginia", in order to test their medical efficacy. Pickering argues that this had a place within a wider phenomenon of experimental medical collections by other late seventeenth-century physicians, including John Francis Vigani at Queens' College and John Addenbrooke at St Catherine's. These were forms of collections created with the intention of generating scientific knowledge through experimental means.

Indeed, with natural science in this period largely concerned with the taxonomic organisation of the natural world, much of the scientific knowledge created by naturalists concerned the construction of categories for specimens in their collections. This was the case for the naturalist Nehemiah Grew, who became the first to describe a uniform process of sexual reproduction in plants through a publication to the Royal Society in 1682. Achieved by the comparative study of specimens in his collection, Grew sought to establish the commonalities between 'conspicuously well attired' flowers such as the woodbine with its prominent anthers, and its more modestly endowed brethren. It was through such a process of constant comparison, as William LeFanu has stated in his study

[6]Victoria Pickering, 'Sealed and concealed: the uses of Hans Sloane's collection of vegetable substances', *The Journal of the History of Collections* 33 (2021), p. 484.

of Grew's writing, that Grew sought explicitly to "report new knowledge."[7] Another associate of the Royal Society, John Woodward, elected a fellow in 1693, whose work was predicated on the creation of new mineral categories, provides another example. Woodward compartmentalised all natural minerals into eleven classes, ranging from "earths and earthy substances" to "metals, and metallic minerals that run to a reglus" and boasted to his close friend the Swiss Johann Scheuchzer that he had, "some time since" reorganised "all the Native Fossils into a Classical Method."[8] In this way, he imposed his scientific judgement upon nature. His analysis might be regarded as an experimental process that yielded conclusions based on his observations and comparisons of specimens of assured scientific value. Indeed, "Woodward was adamant,"[9] as Roy Porter has stated, that his collection did not constitute "merely a peepshow of curiosities but rather a philosophical museum in which each object would serve to advance scientific knowledge."

Moreover, Woodward was aware of the experimental nature of his interaction with his collection, and contrasted his behaviour with that of some of his contemporaries. He attacked such collectors in the preface to his 1729 catalogue of geological specimens, *An Attempt Towards a Natural History of the Fossils of England*, stating that he knew "well there are those who would have the study of nature refrain'd wholly to observations; without ever proceeding further." The desire of these men, Woodward argues, would be that collectors "should be perpetually heaping up of natural collections without design of building up a structure of philosophy out of them and advancing some propositions that might turn to the benefit and advantage of the world."[10] Although this can be considered

[7]William LeFanu, *Nehemiah Grew: a study and bibliography of his writings* (Winchester: St Paul's, 1990), p. 12.

[8]Joseph Levine, *Dr Woodward's shield: history, science, and satire in Augustan England* (Ithaca: Cornell University Press, 1977), p. 103.

[9]Roy Porter, 'John Woodward: a droll sort of philosopher', *Geological Magazine* 116 (1979), p. 342.

[10]John Woodward, *An attempt towards a natural history of the fossils of England* (London: F. Fayram, 1729), p. 14.

to almost certainly represent a personal attack on Hans Sloane, a rival of the famously self-important Woodward, it might also be held to signal the existence of another sort of gentleman collector, one who was less scrupulous with the provenance and identification of their specimens, and most importantly, did not seek to use their collection to generate knowledge.

Cases in which scientific mysteries were resolved through recourse to a collection provide further evidence of the generation of knowledge which Boyle demanded. The comparative observation of insect specimens by English naturalist Francis Willughby is perhaps the most apt example. The study of insects posed a specific question that had been misunderstood by scientists since antiquity: how do insects breed and grow? With no apparent evidence to the contrary, they had long been believed to generate spontaneously directly from inert or rotting material, with no interceding stage. This was an Aristotelian scientific consensus among practitioners of natural philosophy that had been little changed until the early modern period. It was through careful study of specimens in the collections of early modern naturalists that metamorphosis gradually came to be understood as a process through which insects grew, rather than being created almost from scratch. Willughby became one of the first British naturalists to describe larvae and adult insects alongside each other. Although he fails to explicitly link any particular variety of larvae in his collection to a corresponding adult insect, a passage of text attributed to him in Ray's *Historia Insectorum* indicates his awareness, through experimental observation, of a link between larvae and insects as distinct stages in the life of one creature. It was in this text that he wrote about a sort of larva which he observed "turn into chrysalises that produce butterflies... others, in fact, the majority turn into white fly-like chrysalises, out of which flies emerge.... Those that turn into butterflies do

so more quickly than those that become flies."[11] This observation, based on insects which he had collected for explicitly scientific ends, formed a part of a paper of Willoughby's on the subject of insect reproduction, which he would then present before a meeting of the Royal Society, and informed a distinctly novel hypothesis.

The close relationship between this form of observation and more traditional modes of experiment is evidenced by Willoughby's use of his collection to conduct formal experiments. In an effort to verify another naturalist's claim that a specific sort of insect, the beetle grub, ate earthworms, he left two specimens, which he had collected in a box filled with them overnight. When only one of them ate these worms, he decided, in true experimental fashion, to conduct a repeat test. Such a strategy, of "manipulating the insect and its surroundings" to exact scientific conclusions, has been described by Mary Terrall in relation to another early modern entomologist, the French René Antoine Ferchault de Réaumur, as distinctly "emblematic of the experimental approach" in early modern science.[12] Brian Ogilvie has cited another of Willoughby's experiments as further evidence of his genuinely scientific thinking. This was an "elaborate experiment [which] involved a pet flea wearing a collar and chain... kept in a box with some wool insulation... until after three months it died of cold." Although conceding that the desired outcome of this experiment is unclear, at least in Ray's account, Ogilvie argues that it further illustrates "Willughby's interest in close, repeated observation,"[13] and as such his experimental temperament when approaching his collection.

There is another element of Boyle's conception of experimental values which might

[11]John Ray, *Historia insectorum* (London: A. Churchill, 1710), p. 15.

[12]Mary Terrall, 'Experimental natural history', in *Worlds of natural history*, eds. Helen Anne Curry, Nicholas Jardine, James Andrew Secord, and Emma Spary (Cambridge: Cambridge University Press, 2018), p. 177.

[13]Brian Ogilvie, 'Attending to insects: Francis Willughby and John Ray', *Notes & Records of the Royal Society* 66 (2012), p. 366.

be applied to early modern collections. This concerned the degree of scientific good practice involved when naturalists carried out the menial element of 'collecting', that is, the act of gathering specimens from nature. More recent historiography has moved towards the study of this side of the process of collecting, led by granular studies of particular collections such as James Delbourgo's work on Sloane. The raft of procedural questions which Boyle addresses in his essay *Inquiries Touching Mines*[14] might then be considered necessary to evaluate the experimental quality of a collection. The essay addresses problems inherent in the gathering of scientific information from the natural world, to be followed by the complete 'experimental' collector. His recommendations come in the form of a set of 'inquires' directed for the use of those natural historians who were interested in the study of mines, divided into a set of ninety 'specific' queries and eleven 'promiscuous' ones. These ranged from questions about surroundings such as "whether there be any Earths of peculiar kinds, as to Colour, Consistence ect"[15] through to more traditionally experimental forms of observation such as "whether, after the Metal has been once melted, the remaining part of the Ore being exposed to the Air, will in the tract of time be impregnated or ripen'd, for as to afford more metal?"[16] As such, it can be said that Boyle considered the scientific validity of specimens in a collection as a significant measure of their experimental worth. An experimental collection was then one in which specimens were of recorded provenance, and were true to their natural form.

That the working method of some scientific collectors, such as James Petiver, did appear to align with Boyle's dictum might then suggest that the approach of these early modern scientists towards collecting from nature was indeed 'experimental'. This is an

[14]Robert Boyle, 'Articles of interest touching mines', *Philosophical Transactions of the Royal Society* 1 (1665), pp. 330-343.
[15]Ibid., p. 333.
[16]Ibid., p. 342.

approach that is usually best reflected in the working correspondence of early modern scientists. In order to add to the scientific validity of the observations possible with his collection, Petiver, who was notorious among early modern English collectors for being particularly poorly travelled, included many directions for his assistants to conduct prolonged contextual viewing of their subjects. His directions insisted that extended viewing be carried out of their subject in its natural environment, and as such, his assistants should bring into their own garden "all such trees shrubs or herbes as do not grow near yu because you may have a better opportunity more frequently to observe ym."[17] This insistence upon the recording of natural specimens in life was quite typical among early modern natural philosophers, and might then point to the desire of those who maintained scientific collections to ensure as full an understanding of those natural objects in their collection as was possible to obtain. Petiver wrote lengthy and highly prescriptive instructions for those who sent him specimens from abroad, which included a set of directions on the best practice to preserve specimens for transport to his collection. Upon being collected, Petiver stressed that a specimen should be treated on "the same day, or within two or three at farthest after you have gathered them".[18] He instructed that they should then be boxed or submerged in solutions, and by this method, Petiver's collectors successfully transported to him specimens which were well preserved and with which experimental investigation was possible.

However, the generally poor quality of specimens which natural philosophers were able to gather presents an evident limitation on the extent to which any natural collection could aspire to generate real scientific knowledge. When the specimens which populated a collection did not resemble the creature as it would appear in nature, that form of studied

[17]James Petiver, *Jacobi Petiveri opera, historiam naturalem spectantia* (London: John Millan, 1767), p. 102.
[18]Ibid., p. 118.

observation which has been established as being central to the experimental programme would no longer be possible. Foremost amongst the causes of this problem was the long journeys which specimens often had to take to reach European collectors. Although there were cases where proper preservation was possible, these were rare enough that their notability proves the general scarcity of good specimens. One such example, discussed excitedly in the minutes of the Royal Society, was when Petiver was able to present "a llarge snake... from Virginia preserved in rum" in such good condition that he was able to dissect it and find it "a female in whose belly was 17 young ones all perfectly formed."[19] Generally, naturalists seemed rather unenthusiastic about their ability to preserve exotic specimens. Writing about the time he spent collecting in Jamaica, Sloane recalled many incidents where adequate preservation was not possible, and specimens could not be transported to his collection. He wrote that when he encountered "fruits that could not be dried or kept, I employ'd the Reverend Me. Moore, one of the best Designers I could meet with there, to take Figures of them, as also of the Fishes, Birds, insects, etc., in Crayons, and carried him with me into several places in the country that he might take them on the place."[20]

Even when it was possible to dry specimens, this was a process which had a profoundly negative effect on the quality of the specimen, and thus the experimental value of consulting one's collection. This has been a matter of concern among both contemporary collectors and within later historiography. The correspondence of contemporary collectors points to this issue, with Ray complaining in one letter to Petiver of the uselessness of the dried specimens on which he had been forced to rely by his poor health and by

[19]Minutes of the Royal Society (1966/1967), Sloane MS 3341, fol. 55, British Library.

[20]Arthur MacGregor, *Sir Hans Sloane: collector, scientist, antiquary, founding father of the British Museum* (London: British Museum, 1994), p. 14.

whose account "I must needs be liable to commit a thousand mistakes."[21] This letter appears to indicate that many eminent scientists, although apparently aware of the poor 'experimental' value of dried specimens, continued to use them. Most methods of preservation were strongly affected by location, as indicated by the fact that Petiver's instruction to a correspondent that he should preserve a collected plant specimen in "strong bryne sea water" was hedged by his comment in the margin that this method was merely "ye best way I att present can think to preserve its shape and colour".[22] Indeed even Sloane, who was capable of travelling to see specimens in life, was still satisfied to amass a collection of animals which Von Uffenbach described with some disapproval as being "preserved by drying."[23] Often, it was not possible to construct a collection of specimens which were true to nature.

The scarcity of many types of physical specimens and the resulting reliance on images further affected the experimental accuracy of early modern collections. Marlise Rijks has traced this problem among Dutch early modern collectors of natural history with regard to a specific sort of exotic creature, the horseshoe crab. Identifying that the first dried specimen of this 'zeespinnecop', or sea spider, probably came to the Netherlands in 1603, she traces the growing confusion that emerged in secondary representations of what she deduces is a singular artefact. She attributes anatomical differences across contemporary zoological illustrations of the horseshoe crab to this phenomenon, with illustrators who worked only from existing drawings tending to undermine scientific accuracy. One illustrator, she argues, "normalised the image [of the crab] by including

[21] *The correspondence of John Ray*, ed. Edwin Lankester (London: The Ray Society, 1848), p. 389.
[22] 'Directions concerning plants', Sloane MS 3332, fol. 1v, British Library.
[23] *London in 1710: from the travels of Zacharias Conrad von Uffenbach*, trans. and ed. William Henry Quarrell and Margaret Mare (London: Faber & Faber, 1934), p. 10.

larger pincers in order to render it more like the crabs with which he was familiar."[24] In many cases, it was impossible to generate accurate scientific knowledge from those objects which formed some collections.

Cases such as that of the Chelsea Physic Garden, in which ardent collectors attempted to get around the transportation of specimens by assembling a library of living specimens, might demonstrate that their desire was to create collections which represent a sort of natural truth. Sparked by the determination of the Royal Society that the experimental needs of its members could not be met by dried plants, the landowner Hans Sloane manipulated the terms of the conveyance of this botanical garden to the ownership of the Society of Apothecaries to include the requirement that they would supply the Society with fresh specimens for scientific study. As per the terms of the lease, the apothecaries were obliged to "render yearly to the President, Council, and Fellows of the Royal society of London, fifty specimens of distinct plants, well dried and preserved, which grew in their garden in the same year, with their names or reputed names: and those presented each year to be specifically different from (those of) every former year until the number of two thousand shall have been delivered."[25] Some collectors were evidently aware of the limitations imposed on the experimental value of their work by the quality of their specimens, and took steps to remedy this, albeit in a rather measured way.

Not all specimens were intended to contribute to scientific knowledge, however, and the presence of invented natural curiosities in many otherwise scientific collections points to an entirely non-experimental reason for collection. This was a form of curiosity that was not particularly scientific, and might account for the presence of fantastical

[24]Marlise Rijks, 'A painter, a collector, and a horseshoe crab: connoisseurs of art and nature in early modern Antwerp', *Journal of the History of Collections* 31 (2019), p. 348.

[25]Walter Harry Green Armytage, 'The Royal Society and the apothecaries 1660-1722', *Notes & Records of the Royal Society* 11 (1954), pp. 22-37.

creatures such as hydra and dragons in eminent collections. These objects, Paula Findlen has argued, "became fully integrated into... cabinets of curiosities"[26] in the period and were testament to the existence of the private collection as a "theatre of wonder"[27] above all else. Findlen illustrates this with the example of the basilisk, a winged and poisonous animal that Pliny and Galen described as native to Africa, and of which dried specimens occasionally appeared in collections. She points to the cabinet of Francesco Calzolari, of which an illustrated 1622 catalogue written by Benedetto Ceruti exists. Included alongside naturalistic engravings of fish and other sea creatures is an image of a grotesquely snarling dried animal cadaver, meant to appear as a dragon. This was accompanied by the admission that the reader "should know... that this is neither a basilisk nor a dragon, but a fish from the sea, an ill-shaped ray of course worked into this shape by the hand of an artisan."[28] It was an image that was reproduced across many collection catalogues, always accompanied by an acknowledgement that it was not an authentic example of a dragon. Those who collected these specimens might not be considered to have carried out an experiment but rather, as Findlen has argued, fulfilled their role as a "critical consumer in... [a] marketplace of marvels."[29]

The presence of this marketplace might be said to have created non-experimental incentives to collect items from the natural world, in particular, the pursuit of profit. Although such activities generally attracted scorn from educated circles, the existence of this practice among both merchants and scientific collectors certainly casts doubt upon the wholly experimental nature of collection. The marketisation of natural curiosities

[26]Paula Findlen, 'Inventing nature: commerce, art, and science in the early modern cabinet of curiosities', in *Merchants and marvels: commerce, science, and art in early modern Europe*, eds. Pamela H. Smith and Paula Findlen (London: Routledge, 2002), p. 302.
[27]Ibid., p. 297.
[28]'Musaeum Franc[isci] Calceolarii Iun[ioris] Veronensis', cited in Findlen, 'Inventing nature', p. 313.
[29]Findlen, 'Inventing nature', p. 315.

outside of intellectual circles appeared to be widespread in both Europe and in Britain, with natural specimens being sold as curiosities, reliably without any scientific context or instruction, in town squares and apothecaries. John Evelyn's account of walking through the Isle du Palais in Paris, and being assailed by merchants selling "all curiosities naturall or artificial, Indian or European, for luxury or use, as cabinets, shells, ivory, porselan, dried fishes, insects, birds, pictures, and a thousand exotic extravagances"[30] is illustrative of the very broad attraction of this economy of curiosity. However, it was not just charlatans or dilettantes who collected specimens to sell; this category included those who professed to practise serious natural philosophy, including Petiver. Uffenbach made two visits to Petiver's house in Aldersgate during the course of his visit to London. His testimony as a foreigner and fellow scholar of natural history might give an impression of how collecting practice was viewed from the perspective of a social outsider. Uffenbach recounts that Petiver offered him and "all foreigners who come to him of a sample of his collection. . . [and] takes care to ask a vast sum for it".[31] Although knowledge of such an offer, made to a little-known student during a social visit, indicates that Petiver maintained his collection for reasons beyond experimentation, the fact that it was "declined with thanks" suggests it ran contrary to expectations of proper scientific practice at the time. Uffenbach essentially dismissed Petiver following this incident, writing that "with his collection we expected to see a paragon of learning and refinement; but he was quite deficient in both."[32] This indicates that commercial exchange did not align with contemporary ideals of scientific collecting among the educated. Nor has historiography been kind to Petiver for selling his specimens onward, with David Allen equating this strategy with a lack of intellectual

[30]*The diary of John Evelyn*, ed. William Bray (London: Bickers and Son, 1906), p. 51.
[31]*London in 1710*, p. 122.
[32]Ibid., p. 127.

rigour.[33] Although knowledge was central to the idealised form of early modern scientific collection, there were, in practice, fewer experimental incentives to collect.

Uffenbach's keen sense of social embarrassment might speak to another, less scientific dimension to early modern collecting. This was that social cachet rather than experimental ideation was a significant driver for collecting among the affluent classes of early modern Europe, in which a collection served principally to communicate the intelligence of its owner. An example found with the collection of the seventeenth-century merchant William Courten, to which Carol Gibson-Wood refers as something of a "typical cabinet of curiosities whose breadth of representation" was intended to testify to the "universal learning of its owner."[34] It contained not only a broad range of natural history specimens and images of natural things, but also works of European art and man-made curiosities. Indeed, the coexistence within his collection, so far as Gibson-Wood is able to recreate it from what remains of Courten's inventories, of his massive collection of zoological and botanical illustrations with what Courten describes as 'his best stamps', suggests that the mixing of scientific objects with manmade curiosities was done to demonstrate a collector's intelligence.

The regularity with which visitors were usually received by eminent collectors might further evidence the claim that many collectors felt that the greatest value of their collections was their social worth. The fact that Uffenbach, for example, a man of relatively little scientific experience at this point, so successfully infiltrated British scientific collections, provides another useful reference in this regard. The reception he received upon visiting Hans Sloane suggests the particular social value of collections. He recounts

[33]David Elliston Allen, 'Petiver, James (c. 1665-1718)', *Oxford Dictionary of National Biography* (Oxford: Oxford University Press, 2004).

[34]Carol Gibson-Wood, 'Classification and value in a seventeenth century museum: William Courten's collection', *Journal of the History of Collections* 9 (1997), p. 72.

that, after arriving at Sloane's house as part of a group consisting of eminent members of London society, "Dr Sloane invited us into another room, where we all sat down at a table and drank coffee while he showed us all manner of curious books."[35] The enthusiasm with which social visitors were welcomed into collections might even have compromised the practical experimental value of its contents. It was a story famously recounted by Sloane's contemporaries that buttered crumpets served by Sloane had the tendency, when absentmindedly placed down by his guests, to ruin rare artefacts in his collection.[36] Naturalist collectors faced many obstacles in their pursuit of truly experimental practice, and the social demands of early modern gentlemen numbered among these.

For the majority of early modern English collectors, particularly those who aspired to be regarded as serious naturalists, appearing to possess experimental principles was of significant importance. Much of this can be attributed to the communication of this principle through emergent scientific institutions, among which the Royal Society was the most significant. This does not necessarily entail that their engagement with the idea of experimentalism was shallow; indeed, many collectors sought to generate legitimate scientific knowledge using their collections, aspiring to treat them as a form of experimentation. Interactions with the specimens that made up their collection through formal dissection or experiments, as well as through comparative observation, can be considered a part of this practice. The limitations of their time, however, left many early modern collectors unable to behave in a truly experimental manner. This is because they were unable to ensure the quality of their collections. A great deal of imported natural specimens, for example, were very poorly preserved, and thus failed Boyle's test that experimental material ought to resemble its state in nature. In this way, many

[35] *London in 1710*, p. 185.

[36] James Delbourgo, *Collecting the world: the life and curiosity of Hans Sloane* (London: Penguin, 2017), p. 124.

collections which aspired to be forms of experiment were unable to truly fulfil this ambition, although some collectors were successful. However, there existed a host of other motives for people in early modern England to collect natural specimens, which bore little relation to experimentalism or science in general. From collections assembled purely on the basis of aesthetic appeal to those created for social cachet, other forms of early modern collection failed, and indeed did not aspire to meet the standards of experiment.

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