Nehemiah Grew's Method of Studying Plants

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The latter half of the seventeenth century was a transitional period in the study of plants in England. Prior to this time the herbal had been the chief published source of information about plants. In this transitional period the herbal, a compilation of medical and botanical information, gave way to the medical pharmacopoeia and the botanical flora. The late seventeenth and eighteenth century saw the rise of English systematic botany.[1]

Nehemiah Grew (1641-1712), the son of a Puritan minister, attended Cambridge University and received a medical degree at Leyden in 1671; he practiced medicine the remainder of his life. Grew began to study plants in 1664, and in 1671 a treatise by Grew was read to the Royal Society of London. The Society ordered it printed and also in that year elected Grew a member. He presented papers on plants to the group for the next ten years, and the Society published several of them. Grew wrote papers and books on various other subjects after he completed his plant study.[2]

In 1671 and 1672 Grew described at length in two treatises the method he planned to follow in his study of plants; these treatises were *The Anatomy of Vegetables Begun* and *An Idea of a Phytological History Propounded*.[3] Grew studied plants for the next ten years; however, the new ideas he developed during this period did not result from the method he had sketched but were derived from his metaphysical commitments.

In *The Anatomy of Vegetables Begun*, Grew commented that both animals and plants had been created by God and that comparatively little work had been accomplished in the field of study of plants in relation to study of animals; Grew said he would devote his time to studying plants. He proposed three steps of procedure. First, in Grew's procedure, observations of parts of plants are to be made of seeds, roots, trunks, leaves, flowers, fruits, and newly-formed seeds in that order, for this is the way, according to Grew, that these parts develop. Second, observations are to be made in all seasons of the year. Third, comparative anatomy of plants and plant parts is to be employed. This last approach is a consequence of Grew's postulate that "the Essential Constitutions of the said Parts are in all Vegetables [plants] the same," and some parts may be better observed in different plants.[4]

In January of 1672 Grew read *An Idea of a Phytological History Propounded* to the Royal Society. This treatise is a plan for plant study in which he indicated that he would restrict his search to material causes and not seek the *anima vegetalis, vis formatrix,* or *vis motiva*. His aim was the compilation of accurate and numerous observations, perhaps the consequence of Baconian influence, from which he suggested that plants might be grouped according to their "degrees of affinity" and that some correlation of a material nature might exist between animals and plants. He also hoped to contribute to the knowledge of taste, color, and odor through his work on these qualities in plants, and he expected to find improvements in cultivation and propagation of plants and in medical, alimental, and commercial uses of plants.[5]

In order to achieve these ends, Grew listed five "means," which were detailed proposals by which he would organize his investigation of plants. The first means proposes a survey of the exterior of plants and their parts with observations of their forms, positions, proportions, motions, and environment; second, the plant is to be dissected with a similar study of its internal parts. The third means suggests the investigation of the contained parts of plants, *i.e.*, the "airs," "vapours," "saps," "milks," "oyls," "gums," "sugars," and "salts" contained in the various plant parts. The

fourth means carries the observational activity further and is a proposal for an investigation of the number and properties of the "vegetable principles," which are the material bodies that compose plants. The fifth means that Grew proposed is the study of the materials external to the plant that contribute to its being: air, earth, water, and the sun. Due to an "abyss of obscurity" about the vegetable principles, Grew announced he would not undertake to prosecute a sixth means that was: "In what manner are these Principles so adapted as to become capable of being assembled together in such a Number, Conjugation, Proportion, and Union, as to make a Vegetable Body?"[6]

In the first four means collectively proposing a detailed observation of the plant and all of its parts, Grew incorporated and emphasized the same three procedures of investigation that he had set forth the year before. Grew was aware of the microscopical observations of Robert Hooke (1635-1703) and Marcello Malpighi (1628-1694), and he accepted the use of the microscope and magnifying glass; however, these instruments are to be used only after complete observations have been made by the unaided eye. Grew recommended experimentation in the application of the last three means; these experiments are to consist of numerous and various chemical compoundings and mixings of the plant parts. But Grew was not satisfied with merely recording his observations and experiments. He sought much more, such as the material cause of plants, the relationships of various plants, practical uses of plants and plant parts, and the nature of vegetation itself. He described the process by which he would achieve these ends during and after the prosecution of his means:

> For thoughts cannot work upon nothing, no more than hands; he that will build an house, must provide Materials. And on the contrary, the Materials will never become an house, unless by certain Rules he joyn them all together. So it is not simply the knowledge of many things, but a multifarious copulation of them in the mind, that becomes prolifick of further knowledge.[7]

Thus Grew sketched his plans to the Royal Society, and he followed this sketch during the next ten years.

Grew is known historically as the co-founder of plant anatomy and physiology with Malpighi, his Italian contemporary, who engaged in very similar but independent research. In the prosecution of his means, Grew described plants in detail and drew illustrations of plants and plant parts, thereby making contributions to the establishment of plant anatomy. As important to Grew, however, was his attribution of functions, or "uses" as he termed them, to plant parts. Grew's God had created nothing without a purpose; therefore, every part of a plant or animal has a function. His God had created both plants and animals, so there might be material similarities, as well as differences, between them. Grew suggested that one should not only "compare what is already known of both, but also by what may be observed in the one, to suggest and facilitate the finding out of what may yet be unobserved in the other."[8]

The assumptions of a non-vain God and of some correlation of animal and plant parts had great influence on his ideas concerning function. For Grew not only assigned a use to every part, but he also kept these in some degree of analogy to animal functions. An example of Grew's theories of function is his most successful theory—successful, that is, in terms of popularity and importance placed on it by later botanists. This theory is his explanation of reproduction in flowering plants in terms of the sexuality of parts of the flower. In a paper read before the Royal Society on November 9, 1676, Grew described the flower parts in detail and out-

lined the primary function of the "attire," Grew's term for that part of the flower within the petals, as serving for the generation of seed. His commitment to animal analogy may be seen in the paragraph in which he stated the use of the attire:

> And as the young and early *Attire* before it opens, answers to the *Menses* in the *Femal:* so is it probable, that afterward when it opens or cracks, it performs the *Office* of the *Male.* This is hinted from the *Shape* of the *Parts.* For in the *Florid Attire,* the *Blade* doth not unaptly resemble a small *Penis,* with the *Sheath* upon it, as its *Praeputium.* And in the *Seed-like Attire,* the several *Thecae,* are like so many little *Testicles.* And the *Globulets* and other small *Particles* upon the *Blade* or *Penis,* and in the *Thecae,* are as the *Vegetable Sperme.* Which, so soon as the *Penis* is exerted, or the *Testicles* come to break, falls down upon the *Seed-Case* or *Womb,* and so Touches it with a *Prolifick* Virtue.[9]

It is interesting to note that in 1671 Grew had suggested the function of the attire to be beauty, food for the insects usually found therein, or for distinction of various kinds of flowers by man or these insects. However, these uses did not fully satisfy Grew, and he speculated: "What may be the primary and private use of the *attire* (for even this abovesaid, though great, yet is but secondary) I now determine not."[10]

In the pursuit of the last three means, which urged investigations of a chemical nature, Grew's commitments to an atomistic viewpoint heavily influenced his work. His fourth means of 1672 purposes a vague inquiry into the vegetable principles, *i.e.,* materials that combine to produce plants. Later, in 1673 and 1674 he identified these vegetable principles as seven in number: earth, salt, acid, oil, air, spirit, and water.[11] In a lecture read to the Royal Society on December 10, 1674, Grew began by stating: "And first, by *Principles,* I mean *Atomes,* or certain *Sorts* of *Atomes,* or of the *simplest* of *Bodies.*" These atoms, mathematically divisible but materially impenetrable, differ only in size and shape, and these differences are responsible for all other material properties of bodies compounded of these atoms. In other lectures delivered from 1674 to 1677 Grew pursued his means by attempting to explain his observational and experimental data on the basis of his atomism and the seven particular vegetable principles that were among the large number of kinds of atoms. For example, the taste of plant parts is resolved into ten sensible tastes composed of combinations of the seven vegetable principles or atoms. Then allowing these ten tastes to combine in threes, Grew produced a table of one hundred twenty vegetable tastes. Other qualities, such as color and odor, and other properties of plants and plant parts are explained on the basis of his atomistic assumption.[12]

Grew in his five means proposed a systematic method of investigation of plants. First multitudinous observations and experiments are to be compiled, and from this theories are to be produced to explain numerous aspects of the nature of vegetation. Grew's observations were influenced by his commitment that not only are all plants essentially the same but also that there is possible material agreement between plants and animals. His experiments were fundamentally tied to his conception of atomism. Grew's ideas of the function of plant parts were influenced by his assumptions of a non-vain God and of animal correlation; likewise, his work on the vegetable materials is based on an atomistic assumption. Although Grew superficially followed the pattern of investigation that he had specified, his theories evolved from his basic metaphysical commitments and were not the product of mental "copulation" of massive observational and experimental data. Grew had set up a Baconian plan of investigation, but

his theories were attempts to explain his observational data and not simply derived from data alone.

NOTES AND REFERENCES

[1]Agnes Arber, "From Medieval Herbalism to the Birth of Modern Botany," *Science Medicine and History: Essays on the Evolution of Scientific Thought and Medical Practice Written in Honour of Charles Singer*, ed. E. Ashworth Underwood (2 vols.; London: Oxford University Press, 1953), I, 317-36; Agnes Arber, "Nehemiah Grew 1641-1712," *Makers of British Botany: A Collection of Biographies by Living Botanists*, ed. F. W. Oliver (Cambridge: University Press, 1913), pp. [44]-64.

[2]George Simonds Boulger, "Grew, Nehemiah (1641-1712)," *The Dictionary of National Biography Founded in 1882 by George Smith: From Earliest Times to 1900*, ed. Leslie Stephen and Sidney Lee, VIII (1937-1938), 609-11.

[3]Nehemiah Grew, *The Anatomy of Vegetables Begun. With a General Account of Vegetation Founded Thereon* (London: Spencer Hickman, 1672); Nehemiah Grew, *An Idea of a Phytological History Propounded. Together with a Continuation of the Anatomy of Vegetables, Particularly Prosecuted upon Roots. And an Account of the Vegetation of Roots Grounded Chiefly Thereupon* (London: Richard Chiswell, 1673).

[4]Grew, *The Anatomy of Vegetables Begun*, pp. [A 8 *recto*]-2.

[5]Grew, *An Idea of a Phytological History Propounded*, pp. 8-10.

[6]*Ibid.*, pp. 10-52.

[7]*Ibid.*, p. 17.

[8]*Ibid.*, p. 8.

[9]Nehemiah Grew, *The Anatomy of Plants. With an Idea of a Philosophical History of Plants. And Several Other Lectures, Read before the Royal Society* ([London]: The author, 1682), p. 172.

[10]Grew, *The Anatomy of Vegetables Begun*, pp. 145-48.

[11]Grew, *The Anatomy of Plants*, pp. 132-33; Grew, *An Idea of a Phytological History Propounded*, pp. 41-43, 106.

[12]Grew, *The Anatomy of Plants*, pp. [213]-304.